HUMAN FACTORS IN MESSAGE ACQUISITION FOR A COMPUTER BASED POLICE COMMAND AND CONTROL SYSTEM

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by

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Human Factors in Message Acquisition for a Computer Based Police Command and Control System

Ph.D THESIS - JOHN HULBERT, B.A., M.Sc. (1981)

SUMMARY

An in depth analysis was made of the task of receiving and logging information by a Police Emergency Operator. It was found that there was a considerable cognitive element to the operator's task. There is a strong potential for mental and process overload during the call, and various strategies are traditionally adopted by operators to relieve these pressures. Their actions include the use of cryptic notes and focussing on limited domains of data.

It was found that redundant and non-redundant details were dealt with differently by the operators. Non-redundant details were usually logged accurately, whereas the redundant, incident information, was often highly distorted. In assessing the logs it was seen that the surface structure was not an accurate representation of the words used in the relevant calls, despite the fact that a verbatim style was invariably employed. When the call was analysed in relation to the logged information, the meaning was frequently judged to have been significantly altered.

The operators' mental models of their task and its environment were found to be highly variable, suggesting a need for standardisation training.

The effects of computerisation of message logs was simulated, and the results indicate that any move towards mechanisation is likely to reduce the value of the resultant log. One of the worst modes was the method used by all present Police Command and Control Computer Systems. It was found that speech-input to computer can be accommodated by operators in this environment. Therefore that facility could be legitimately considered for use in future systems.

It is argued that computer based incident logging systems need to provide support facilities to operators, to reduce cognitive and process loads during the critical period of the emergency call.

KEY WORDS: POLICE/COMMAND AND CONTROL/COGNITIVE PSYCHOLOGY/ ERGONOMICS

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PREFACE - I.H.D. RESEARCH

The flavour of I.H.D. projects with their emphasis on relevant timely applied research necessarily means that characteristics of the project undertaken is somewhat different from the course of Ph.D. which is completed largely within the environs of the university.

The fact that the investigation largely centres around a relevant practical problem, in many cases necessarily means that the researcher has to spend a large amount of his time within the organisation. In my particular case this meant that the majority of my time was so spent. The advantages of such an attachment are that it is possible to be close to the source of information and to pick up an accurate view of the problem dimensions.

A difficulty can however be experienced in this area as in many cases the researcher is considered by the firm (in my case the Devon and Cornwall Police) to be another one of its resources. This may particularly be the case when the researcher, such as myself, is in fact a member of the organisation, albeit on secondment. In addition, if the project is relevant to the firm, then a great deal of interest is likely to centre upon the research. In my case this was certainly so and it was frequently the case that early answers were required to questions which were being investigated.

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In addition, quite often at various times during the project I was the only person with relevant knowledge and expertise in the area, and this led to competing objectives being placed upon me.

On the one hand there was the immediate needs of the Force to solve some specific problem related to the research, and on the other there was the need to produce a structured and coherent research project. In some ways these requirements were complementary but in others they were not. The advice of my Ph.D. supervisor in making finely tuned judgements between the immediate practical necessities of the organisation, and maintaining the academic integrity of the investigation, were vital in producing a successful conclusion to the project. Nonetheless, a great deal of time was quite properly spent in assisting the Force with day to day practical problems which were close to the area of research, but which could not be included in the thesis. At certain periods during the course of the Ph.D., research work was essentially suspended whilst I undertook the direction of sections of a computer project on behalf of the Force.

It may be that my particular experiences are unusual, however I would suggest that it must be expected that in any case where an I.H.D. researcher has his finger on a vital issue within the firm, then there is bound to be some degree of conflict between the competing of objectives of the firm for immediate quick answers (and in some cases direction) against the need of the researcher to conduct an in depth and academically respectable investigation.

Preface cont.

The I.H.D. researcher in some ways like the Open University student suffers from some degree of isolation, which his contemporaries within the normal university campus environment are unlikely to experience. The I.H.D. and indeed the university as a whole do everything that they can to ameliorate this problem, but nonetheless, physical separation, particularly if it is by large distances, is bound to reduce the interaction between the researcher and other persons of similar knowledge. During this particular research I found it very difficult to discuss with anyone within the Force the problems on anything like a theoretical or adademic basis. This in no way suggests that they were not interested in such matters, they were in fact extremely receptive to the ideas, but there were a few people within our particular organisation with the necessary academic background. The university on the other hand has the academic background but lacks the in depth experience of the problem. A partial solution is, of course, to brief academics in the university on the problem and then have a discussion. This process, however, tends to be rather stilted and can only occur on a limited number of occasions - it in no way compensates for day to day interaction with persons of like mind, who are attempting to solve a specific problem. I cannot think of any immediate solution to this dilemma but it is certainly one which on occasions causes some difficulties for the student.

The inability to easily discuss the course of a project was to some extent exacerbated by the very different atmosphere in applied research carried out within an organisation from that traditionally carried out within the university, as an I.H.D. student one feels a lack of precision in the applied field compared to the more formal theoretical Ph.D. research. On the other hand, the feeling of relevance of the applied work is very great indeed and to my view wholly compensates for any difficulties in producing a neat step by step research schedule. I would not like, however, to give the impression that there is any lowering of standards in the applied research, merely that the objectives of the project as a whole are often very much more difficult to firmly specify, in the dynamic environment of a working organisation, than they are in the more ordered intellectual environment of the university.

The resources available to the researcher are also quantitatively and qualitatively different. Naturally, in some areas expert advice is more freely available on the applied area than it is in the university. This is particularly true when one is seeking information about the applied problems space. On the other hand assistance with various forms of analysis, or the provision of computer programs, or qualified assistance to aid experiments etc., tends to be more difficult to organise in the industrial setting. Quite often a reasonable amount of labour is available, but it is necessary for the researcher to train people in the techniques that he requires in order to obtain assistance. This of course tends to delay the progress of the project, but has advantageous spin offs in so far as it is another skill gained by the researcher (and possibly the assistants). In some ways I was very fortunate in being able to set up a very advanced analytic unit, by persuading the Force to

Preface cont.

purchase and furbish a sizeable research computer unit. This meant that a great deal of time was spent on that particular work during the early stages of the project, but use of the resources thus established were a great boon in the later stages of the analysis. The existence of this facility made the culminating experiment possible.

I think that it should be emphasised that the benefits of a course of research such as this are not all encapsulated in the resulting thesis.

At the mundane level there are always subject areas which were explored and then not included on the basis of a lack of direct relevance. In my case, I carried out extensive evaluations of the artificial intelligence systems, the mechanics of speech input and output and many computer facilities etc. However, the background knowledge of these parallel areas were often valuable, enriching and supporting the ideas in the the thesis and any subsequent work.

During this investigation I also produced a large number of computer programs, many of which are of continuing value to the Force. In fact the Experimental Management programs, described in the thesis, are going to be used as the nucleus for the future MI system. In addition a whole host of valuable utilities were produced as a by product. These include some statistical packages, a comprehensive set of date manipulations, geographical data manipulators, sorting routines, and a VDU screen form writer etc.

Preface cont.

I have not kept a complete record, but many hundred distinct programs were written, and the versions certainly go into the multiple thousands.

These advantages and skills are additional to the knowledge gained within the focus of the research, and the essential intellectual and administrative skills required to bring that major Ph.D. project to fruition.

Overall, I would say that the difference between an I.H.D. and a normal Ph.D. is that the I.H.D. researcher is likely to get very much more involved with the organisation and that this involvement will make certain demands upon him which are likely to slow down the project as a whole. On the other hand, I think those demands if properly supervised will give him a much richer knowledge of the environment in which he is working and also increase the relevance of his project. Therefore, although I have found the I.H.D. Ph.D. to be a rather harrowing experience, I nevertheless feel that it is also an extremely valuable one.

John Hulbert

Lustleigh, Devon 1981

THESIS PLAN

The first three chapters contain an introduction to the Police Service, leading in to the problem area. Chapters four to eight describe a general preliminary review of the perceived problems.

Chapters nine to fifteen each describe a specific in depth investigation into the human factors aspects of message acquisition. A general theme in these chapters is a progression from the relatively prosaic evaluation of basic physical task elements towards a more speculative review of the operators' relevant cognitive processes.

Chapters sixteen and seventeen explore some potential problem solutions whilst at the same time providing experimental support to some of the 'en vivo' in depth investigations.

To some extent the approach taken has been to describe the investigations in something like the chronology of their actual occurrence. The various disparate modes of enquiry are also an attempt 'triangulate' upon the problem area in a manner aptly described by GARNER.

> Converging Operations
> The concept of converging operations is the key concept to me, and it is actually the specification of a critical realist's position in science. The basic idea is that we come to know things, usually described as concepts, by carrying out two or more experimental operations that converge on the single

concept. A concept that is synonymous with a single operation is nothing more than a restatement of an experimental result. But a concept that arises as a consequence of converging operations has a reality that is independent of any single experimental observation. With sufficient ingenuity in developing observational procedures that provide convergence, we can come to know things that we cannot know from direct observation, because they are inaccessible to us. Memory, encoding, and perception itself are all such unobservable processes, things that occur in the organism, and that we can come to know by observing only inputs and outputs of the organism. However, we must have a variety of inputs and outputs, differing in their nature, to allow convergence to meaningful concepts that are in fact independent of any single observation or experimental result. (GARNER 1974)

THESIS PLAN

PART 1: INTRODUCTION

PART 2: PRELIMINARY INVESTIGATIONS - PERCEIVED PROBLEMS

PART 3: IN DEPTH INVESTIGATION OF PROBLEM AREAS

PART 4: SOLUTION EXPLORATION

PART 5: CONCLUDING SUMMARY

PART 6: BIBLIOGRAPHY

CHAPTER ONE

INTRODUCTION

The objective of this chapter is to introduce the background facts which were relevant to the choice and prosecution of this particular research area.

The Service

The Service in the United Kingdom comprises of 49 independent Forces, each under the command of a Chief Constable, who is in theory answerable for his executive actions only to the law.

The administration and finance of each Force (with the exception of the Metropolitan Police) are under the control of local bodies, whose members are made up of County Councillors and Justices of the Peace. The powers of these local bodies involve the approval of budgets and the appointment of the senior officers of each police force.

At least 50% of the budget of every police force is met from central funds and the allocation of this portion of the Force's finances is controlled by the Home Secretary, who has to satisfy himself that the Force is conducted efficiently before he may approve these grants.

The Home Office also maintains a number of central services. These cover interests which are general to the Service as a whole rather than specific Forces. These services include research, certain training facilities, and an Inspectorate.

Whilst the Home Office civil servants have no direct power (except for a few minor exceptions) over individual Forces, in practice their financial sanctions and their expertise in certain areas, effectively means that a considerable amount of central control is exercised in the executive, as well as the administrative and financial areas.

The Devon and Cornwall Constabulary

This Force is responsible for policing the two counties of Devon and Cornwall. Considerable policing problems are caused by the large area of this Force, approximately 2½ million acres, and the elongated nature of its terrain. It extends for 130 miles from east to west and is about 75 miles at its widest point, (north to south). The resident population is approximately 1½ million but this is greatly increased during the summer season owing to the influx of holiday visitors. The degree and timing of these population fluctuations is also changing due to the recent improvements in motorway and trunk routes, both to, and within the region. The character of the area to be policed varies from the very sparsely populated areas of Dartmoor and Exmoor, to urban conurbations like the naval port of Plymouth.

The Force consists of 2,750 police officers and about 1,250 civilians. It was originally comprised of the four Police Forces of Cornwall, Plymouth, Devon and Exeter. The amalgamation of these units being concluded in 1967.

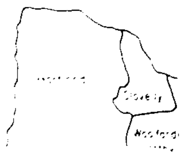
The organisation of the Force is presently centred on eight territorial Divisions, although a new structure with only six Divisions is due to be implemented shortly (Fig. 1.1). These Divisions are relatively autonomous in their administrative and executive functions, and to all intents and purposes operate as separate police forces in so far as their day to day activities are concerned. Each division is further partitioned into sub-divisions each of which has a considerable degree of executive power, although most administrative functions are carried out in the Divisional offices. Certain large Sub-Divisions are further divided into Sections (Fig 1.1).

An officer of the rank of Chief Superintendent is likely to be in charge of a division, the size of which may vary between 200 and 400 police officers, and about 50 to 150 civilians. The sub-division is usually under the command of a Superintendent or a Chief Inspector and contains in the region of 100 individuals. The section stations would be controlled by an officer of the rank of sergeant and can contain up to 30 men.

FIGURE 1.1

DEVON & CORNWALL CONSTABULARY

DIVISIONAL AND SUB-DIVISIONAL BOUNDARIES



Chapter One cont.

Superimposed on these territorial areas is a Traffic Division which has a responsibility for road traffic matters within the whole of the Force. The Traffic Division has stations situated throughout the Force, and is under the command of a separate hierarchy from the territorial Divisions.

In overall command of the Force is a Headquarters Division which houses the Chief Constable, Senior Officers, and certain Specialist Departments such as Research and Development, Complaints, and Force Training. The Headquarters Division is responsible for the overall finance of the Force, and general policy matters. Only in exceptional circumstances will an operational or executive matter be dealt with at Headquarters level.

Computing History in the Police Service

Approximately 10 years ago (towards the end of the 1960's), the Police Service started to become aware of the advantages that computing systems could give. Historically the forces had worked very closely with the local authorities, all of whom were at that time in possession of large main-frame computers. Consequentially many of the initial police computer applications were inaugurated on those local authority computers. The majority of the systems commenced by police forces from the latter end of 1960's, up to the middle of the 1970's, were almost exclusively designed to improve administrative efficiency. Systems such as payroll, accounts, vehicle management, firearms and shotgun licensing, and personnel records were amongst the applications which most forces adopted. In addition, the burden placed on police forces to prepare statistics of criminal and accident events, were met in the main by placing these systems on the local authority computers. It is interesting to note that, in the majority of cases, individual police forces make no great use of these statistics; they are compiled almost solely for digestion by Local and Central Government Departments.

During the middle of the 1970's a number of forces, particularly those with serious urban problems, were troubled by the tactical difficulties of allocating resources on an emergency response basis. This led to the production of a number of tactical policing systems, whose main raison d'etre was the short term allocation of resources to service operational requirements, e.g.the operator in a police control room needs to know what vehicles he has available and where the incidents are in relation to those vehicles, in order that he can make the most efficacious use of the resources at his disposal. In the main, these systems have been termed "Command and Control systems" and most of the major cities have acquired, or are in the course of acquiring some such computer based system. These systems were the first to use in-house police computers although, even then, they were invariably interfaced to local authority machines, which undertook the heavier processing loads.

Soon after the inception of Command and Control systems it became apparent that the sort of information which was being gathered for operational use by such systems could be an invaluable aid to the longer term administration of the police force. Up to that point in time there had been very little factual information on the effects of various management activities. In consequence of these findings a number of sub-systems were added to various command and control schemes, in order to provide ad hoc management statistics. Up until the present time these additions have been of a fairly simple nature, providing information on such aspects as the response times of vehicles and the geographical location of various types of incidents etc. Limited although this information has been, it has proved to be of great use to the managers in those Forces where it has been implemented, although as will be argued later, none of the present management systems are rated by the Home Office as a total success.

Origins of the Devon and Cornwall Constabulary Management Information Project

The Devon and Cornwall Constabulary area covers the jurisdiction of two separate County Council Authorities. Like most other Forces, prior to 1975 it had implemented a number of administrative functions on local authority computers. Due to the fact that it covered two separate Authorities, for political and various administrative reasons, it had shared its allocation of these functions between the two computer departments of the respective Councils.

The allocation of these computer applications were as follows:-

Devon County Council, IBM 370/145 (now 148)

1. Criminal statistics
2. Disposal of offenders (after court or internal process)
3. Shotgun registrations
4. Firearms licensing
5. The Paddy experiment - a major incident data base and search system (Home Office experiment)
6. The personnel system (on line)
7. The housing system (on line)
8. Payroll

Cornwall County Council, ICL 1904

1. Accident statistics
2. A garage and fleet management system

It can be seen that by far the greatest number of applications had been implemented on the Devon County Council machine.

On my return from Aston University to the Force in 1975, I was asked to manage the implementation of the Personnel and Housing on-line systems which the Force had recently purchased, on to the Devon County computer. This project involved the transference of a package designed for the Greater Manchester Police. Having had the opportunity of operating on a few other main-frames, it immediately became apparent to me that the rates charged to the Police Authority by the Devon County Council were extremely high, and this fact had been colouring the Constabulary's view of the viability of various other potential computer projects.

At this time the Devon and Cornwall Constabulary had no comprehensive policy or indeed attitude towards its various computer systems. Each individual application had arisen in an ad hoc manner and there was no integration of the various systems.

During 1975, the Department of Trade and Industry in conjunction with ICL carried out an extensive survey of the policing requirements of the Merseyside Police. The objective was to provide a blue-print for police computer applications. In November of that year a report was received by the Devon and Cornwall Constabulary, (ICL, 1975) and I was requested by the Chief Constable to prepare an evaluation of that report in the light of the Force's requirements. At the same time, during the latter part of 1975, the then Assistant Chief Constable (Operations), Mr. McCartney had been deputed by the Chief Constable to look into the emerging area of Command and Control computer systems, to ascertain whether this concept was likely to be of any use to the Force.

It was obvious that the deliberations of the Working Party set up by the Assistant Chief Constable, and my evaluation of the possibility of a general computing policy, were inexorably linked. I was therefore co-opted on to the Working Party and we worked in conjunction. It soon became apparent that expensive and complex command and control systems were not immediately required in the Devon and Cornwall area. In many Divisions a computer system would add little to the effective knowledge available to an operational controller because of the limited number of resources which he had under his command. It did, however, seem to me that there was a marked requirement in the Constabulary for more general management and operational information, particularly in the areas involving the longer term allocation and use of resources.

The Police Force suffers from the lack of any generally recognised objective criteria of success (or failure). In addition there are few measurements of the cost of its various activities which can consistently be applied. Taken together, these two facets mean that the majority of resource allocation decisions taken within the Police Force are based on what can be best described as 'gut feeling', with a concomitant lack of feed-back, so that even the effectiveness of these guesstimates is not evaluated, unless an obvious disaster occurs.

During my deliberations I found that the majority of decision makers in the Force seem to acknowledge that there was a serious lack of general management information, but they could not foresee any immediate solution, because of the apparently prohibitive costs of either manpower intensive manual information systems or just expensive computer systems.

The reasons for this rather unexpected lack of available information in the police force are many, but it is particularly surprising when one considers that one of the major activities of a police force is the collection and dissemination of information. The root causes are probably the fragmented nature of the various manual and computer information systems which existed at the time when this survey was commenced. Most of these systems had been commenced on an individual basis with very little consideration for their relationship with other information systems within the police force. In addition, the extremely high volumes of data made the collation of records difficult. I think it is reasonable to say without arguing the point at too great a length, that only with the advent of computerised systems could the police force hope to have effective management information available over a wide spectrum of its activities.

It seemed to me that the future developments in the field of micro processors could possibly provide a reasonably priced solution to the data gathering problems of the Force. I therefore set about a learning exercise in that area. Once I was convinced of the viability of micro processors I prepared a plan for a data gathering network. I submitted this plan to the Working Party who agreed with it in principle. We then presented our ideas to the Home Office (Departments of F8, P.N.C. and Telecommunications) who were most enthusiastic. On the 2nd August, 1976, I presented the outline plans to the Chief Constable and his Policy Committee, and it was agreed that it should be used as a discussion basis for the Force's future computer policy.

Basically the plan cannibalised the Force's existing telecommunications networks (telex, telephone etc.) and amalgamated them with two existing computer data bases, the idea being to extract money from existing budgets. The objective was to set up a telecommunications based data gathering and statistical input network using mini computers in Divisional Headquarters. The resulting system would provide efficient operational message switching, with the ability to cull management information. In addition, it would also give Divisional Commanders a local information data base for both operational and management purposes. Preliminary, technical and financial feasibility surveys showed that it should be possible to run the system for less than the annnual expenditure on the facilities that the plan was designed to supercede.

I found (at that time in 1976) it was very difficult to convince people in either the police or the computer world of the (relative) cheapness and at the same time versatility of mini and micro computers. I therefore arranged to purchase some computer components from which I constructed a full working micro computer system. After much learning of digital techniques, soldering and sweating, I was able to demonstrate that for less than £2,000 it was possible to provide a very powerful computer which could be programmed in a high level language and which could access quite large local files at very low cost. This particular machine was used mainly for propaganda purposes in our various lobbyings of the Police Authority and the Home Office to obtain finance for the computer project.

At this time the Force was very fortunate in the appointment as Assistant Chief Constable of Mr. John Brian Morgan who had previously served as the Officer in Charge of the Police Research Services Unit at the Home Office. He quickly accepted the main tenets of the distributed network plan and his contacts proved invaluable in the subsequent negotiations with Central Government. There ensued a period of approximately 15 months of discussions, negotiations, experiments, surveys and lobbying with Government Departments, the Police Authority and various industrial concerns.

During this time the original concept evolved, particularly during discussions between the Police Scientific Development Branch of the Home Office and ourselves. Eventually during September 1977, the Home Office and the Devon and Cornwall Constabulary Police Authority agreed to jointly finance a full-scale computer project in the Constabulary area. A Project Team was inaugurated whose terms of reference were given as follows:-

To develop a computerised management information system which would provide -

i) information to optimise the deployment of resources or at least to provide a more effective deployment of them;
ii) to give information on how tactical use is made of resources and from which future strategic use of resources can be planned;
iii) the system must be flexible to allow changes in the organisation structure and data needs.

'Practical' was defined as the day-to-day deployment of resources in response to calls upon the Force.

'Strategic' was defined as the planning of future use and needs of resources and the providing of information to all levels of managers/supervisory officers to enable them to make good decisions.

In accord with this philosophy the overall objective was defined as - "Exploring the possibilities of using low cost distributed computer technology to provide the Force with management information. The information to be presented in such a form and manner so as to assist in the allocation of resources at all levels". The novel features of this project were therefore -

a) the experimentation of low cost technology and distributed systems;
b) the emphasis to be on the presentation and use of information at management level at the same time not ignoring the tactical requirements;
c) an emphasis on the use of the system by naive (non expert) operators, both in the collection and use of data.

The Team has therefore been set the task of designing a system with the following objectives -

i) to capture management and operational information as near as source as possible;
ii) to provide operational and management personnel with an immediate and invariably interactive source of data to support decision making;
iii) to minimise the constraints imposed upon input format to allow relatively untrained personnel to input data;
iv) to explore the possibilities of using the data base for simulation, modelling etc., and thereby improving the Force's executive and administrative strategies and techniques;
v) to place an emphasis on the organisation/man/machine interfaces and to provide information in appropriate and assimilable form at a time and place where it is needed to support the Force's objectives;
vi) to maintain data bases at Divisional level (as it is considered that the majority of data is raised and used at a relatively local level);

vii) the overall outline configuration to be a mini or micro computer in each Division capable of supporting a number of local and remote terminals within that Division;
viii) the Divisional computer to be linked by line communications to provide a network of small machines;
ix) a larger machine to be sited at the Force Headqurters to control the system to provide back-up facilities, to provide statistical informtion and to run certain Force files;
x) the network to provide -
   a) fast response times for local information
   b) a reduction of unnecessary telecommunications traffic
   c) effective security against either failure or unauthorised entry
   d) the facility for Force-wide message switching

As this was now a Home Office project it meant that the system had to be devised not only with the Devon and Cornwall Constabulary in mind but also with the needs of the Service as a whole, and potentially other over-seas forces, who might become customers of either the Home Office or the Department of Trade and Industry. It means therefore that the principles to be explored must be of a general rather than a parochical nature.

The main terms of reference of the system referred to the nature of the experiment to be carried out, namely that it is intended to evaluate the concept of gathering data using mini or micro computers in a network configuration. The terms of reference did not, however, constrain in any way the types of information which may be considered for implementation on this management data base. The Team therefore quite rightly have considered that any information which they feel may be relevant to the management decisions to be taken by the Force are legitimately part of their investigation. This is a fairly dramatic reversal from previous studies which have tended to look at computing from operational perspectives and then produce management information as a spin-off from these other activities. In this particular project the difficulties of managers and operational officers are being concurrently considered, and systems devised to support them both, as part of a unified organisation. This really means that the project is very much more ambitious than any previously attempted by the British Police Service.

I was extensively involved in the design of the initial strategies of the Project Team which, briefly, were an in-depth survey of certain specific information areas, and a Force-wide review of certain other areas, to assess likely data volumes. This aspect of the work was however taken over by the Team whilst I have concentrated on the research areas, which are the subject matter of the remainder of this thesis.

CHAPTER TWO

The objective of this chapter is to outline the reasons for the choice of the investigation of human factors in control room message acquisition as the locus for this research effort.

POTENTIAL HUMAN FACTORS PROBLEMS

Any project as large as the one outlined is bound to have many potential human factors problems. For convenience the have.been considered under three main headings:-

1. Societal fears
2. Management of change
3. Man/machine communication

The main focus of the present research comes under Section 3 - man/machine communication. This area was selected for important reasons associated with the current operational issues. However brief consideration is given to those other topics which were potential research areas, but which were set on one side for pragmatic reasons.

Societal Fears

There can be very little doubt that a system which is designed to gather information comprehensively for a police force will concentrate quite a considerable amount of power in certain hands. This is particularly true of the collators' records, which in many cases contain a great deal of either incriminating or unsubstantiated facts about persons suspected of being involved in criminal activities. In any computer system the spectre of 1984 is never far from us, but in police computer systems this is particularly true. This is a social-human factors problem which is likely to be most potent. However, we have chosen not to examine this problem in the present research.

Management of Change

The second human factors area which immediately presents itself when any wide-ranging changes are to be considered, is the management of that change. There is no doubt that a very large number of jobs within this Constabulary are going to be dramatically altered by the advent of a computer network. This fact is well illustrated when one considers the flow charts that are presently being developed by the Team's O and M surveys. Invariably, the pre-computer chart of activities is three or four times the length of that expected, post computer. In addition to gross changes in working procedures the speed with which information will be available, and also the fact that it will be generally, rather than simply locally available, could well be very unsettling for persons who have developed their careers in an environment where such information did not exist at all. The potential difficulties in this area have been stressed to the Management Project Team and it is an area in which they hope to obtain professional advice.

Man/Machine Communications

The two major problem areas under this heading seem to be:-

1. Information at the managerial level (mainly output and the use of complex data)
2. Information at the operations level (which will be largely input of raw data)

Management Level

There is no doubt that managers who have been unused to receiving any form of feed-back on their decisions are going to require very careful consideration, in both the presentation of management information for their use, and also in their training to understand and use that information. It is obviously an extremely important area, and I have urged that the Team and the Home Office pay great attention to this issue, as ultimately the acceptability of the system will depend upon the response of police management to the information provided by the computer system.

Chapter Two cont.

Operations Level

The use of the system at the operations level also has two significant problem areas. First is the design of the system to accommodate the almost totally naive operator. Because it is intended to capture data as near as source as possible, many people will come into contact with the computer who cannot be regarded as expert operators. Indeed it would probably be prohibitive in terms of time and money to train them to become experts. Procedures must therefore be designed which can be used by non technical persons - a classic human factors problem.

The second anticipated problem in the operational interface area is one of information bottlenecks. Quite simply, there are fears that certain sections of the organisation will be so pressed, due to their operational commitments, that the essential information will never reliably reach the data base. If the whole data base were to be suspect, then all of the subsequent clever computer operations would be a waste of time and energy. For this reason, the major locus of the present research effort was directed towards the evaluation of these anticipated information bottlenecks, and the police control room is an area wherein major bottleneck problems might be expected.

CHAPTER THREE

REASONS FOR CONTROL ROOM STUDY

The decision to study control rooms derives from a major premise concerning the data capture, coupled with some current speculations about the reliability and effectiveness of control room operations in general.

It was believed that, not only was a large percentage of information for the data base first received in control rooms, but also the most important information tended to enter the police force in this way. Thus a serious failure to capture any of this data effectively, could have repercussions for the validity of the data base as a whole. If information was missed altogether, then none of the consequent actions could take place; if information was inefficiently captured, it would necessitate wasteful checking procedures at a later stage. If this premise was proved to be correct, then it would suggest in turn that there was a potential bottleneck for information in these control rooms, which would need to be carefully considered in the design of any computer information system for the police.

Secondly, within the Devon and Cornwall Constabulary there were also a number of speculations concerning inherent problems in the present control room operation. These speculations within the Force fell into three areas and will be enumerated in greater detail below, they are:-

i) The efficiency of data capture.

ii) Resource control problems, particularly concerning the allocation of resources to attend incidents.

iii) The quality of control room staff, particularly in the employment of civilian personnel as controllers of police resources and their ability to effectively capture relevant data.

Suspect data entry

It was generally felt by members of the Project Team that the recording of information from 999 and telephone calls from the public tended to break down under certain pressure conditions.

There was anecdotal evidence that control room staff were unable to complete the message logs on-line to a caller, and therefore made cryptic notes, which often resulted in a back-log of scrap notes, many of which were deficient in certain important aspects of information.

There had also been complaints in certain areas from patrols that they were being allocated to resources with insufficient information, and being expected to gather information from the scene of an incident, which could have been quite valuably and usefully obtained from the caller.

If it was found that a significant percentage of data entered by control rooms was inaccurate, then that finding would have serious implications regarding the validity of any proposed M.I. System.

Resource Control Problems

The argument here is that the majority of Divisional Commanders had put in requests for additional staff on ground cover. At the same time police personnel have complained that they have been sent to incidents which did not warrant their attention, whilst serious incidents were written off as 'no resources available to attend'. This was occurring particularly in the urban areas during periods of high incident load.

Complaints about the quality of control room staff

Here the Police Federation (which is the nearest the Force has to a union), had aired a number of complaints concerning the fact that experienced police officers were directed to incidents by inexperienced civilian control operators. It was felt that it could be inefficient and potentially dangerous if a control room operator failed to note certain important signs in the incoming information and allocated insuffient resources.

It must be said that there was always considerable resistance to civilianisation by the police, and any minor perturbations in the system are prone to exaggeration.

DESCRIPTION OF OPERATIONAL CONTROL SYSTEMS

The Devon and Cornwall Constabulary operate a three tier Command and Control system. As previously stated the Divisions within the Force are fairly autonomous both in aspects of administration and also operational control, the main responsibility for control therefore rests within the Division. Each of the eight Divisions has its own control room (at the commencement of this study there were nine Divisions. This contracted to eight during the course of the research. A further reorganisation is impending which will reduce the Force to a total of six divisions). At present, however, there are five major Divisions which have superior control room facilities, and a more general level of control. They do not supervise the vehicles outside of their Divisional area, but they do have certain facililties such as the Police National Computer terminals etc., and they are able to take over the adjacent minor divisions at times of emergency, or low availability of operators in the smaller satellite control rooms.

'A' Division - Camborne (Major) Control Room

Operator in 'K' Division - Paignton Control Room

The Headquarters Information Room operates a listening watch over the Divisional Stations, the objective being to maintain continuity between the various Divisions for incidents which straddle boundaries, and also to supply support facilities in the event of serious incidents.

Each of the Divisions has VHF radio contact with the majority of its mobile vehicles, and UHF pocket phones to most foot patrols. The characteristics of these systems are that VHF radios tend to be larger and bulkier, but have the advantage of a much greater range, while the UHF systems are practically all localised in areas of four to five miles radius from an urban centre. In many cases vehicles will carry both VHF and UHF radios. In addition certain other mobiles are equipped with a hybrid system consisting of a VHF transmitter, and a UHF relay. This system allows an officer to leave his car and go into a remote area, whereupon his vehicle operates as a local relay station. Superimposed on these systems are a number of ad hoc walky-talky networks, command and control vehicles, and special radio facilities which will not be discussed in detail at this point.

All the mobiles within the police area which are on a radio network, come under the direct control of either a Divisional control Room or the Force Headquarters. Those control rooms are responsible for the allocation of all police resources to any incidents which are reported. At any time when a vehicle is not under direct orders from the control room to proceed to an incident, it is available to carry out routine work which is generally under guidance from its base Station, or in the absence of such instructions carry out a normal preventive patrol.

All the vehicles within the Force are allocated a geographical area which is their responsibility. In the case of most panda cars this is called a Unit and only one vehicle is allocated to each such geographical area. Incident and traffic cars may have an area of responsibility which is either superimposed on each other's areas or over the areas of a unit beat panda car (or both). In general the traffic vehicles are only responsible for patrolling major routes. The incident cars are invariably situated within urban areas.

In addition to their responsibilities for the Force, the Communications Rooms also maintain close co-ordination with the fire, ambulance and coast guard services. The police service is automatically the senior controlling service at the scene of any major incident.

All of the 999 systems within the two counties are routed into the local divisional control rooms. In addition, a great number of general telephone calls from the public are routed through these rooms, as are the Police Advisory Telephone (PAT) systems.

Message Logs

The information which is received by an operator during any communication to him is noted down on a special form which in the Devon and Cornwall Constabulary is called a "Message Log". This document forms the major source of information concerning incidents and actions by the Police Force. In other forces it is invariably referred to as a message form or an incident log. Figures 3.3 and 3.4 show message logs for the Devon and Cornwall Constabulary and the West Midlands Police.

Fig. 3.3

DEVON AND CORNWALL CONSTABULARY

STATION C'Hill **MESSAGE FORM**

Personal	
Telephone	
"999"	✓
Wireless	
Robophone	
Telex	

Tick if applicable

SUBJECT FIGHT - Disturbance (GBH) + BURGLARY

TIME: 0015 DATE: 28-12-80 MESSAGE No.: 12764

FROM: Mrs Kane Frith
197 North Road
Penny-cum-Quick
Plymouth Tel. No. 543397

TO: Comms
Crownhill
Tel. No.

Received/Sent by: CW PC 1148

References to other Messages: 12760 - 12769

"Can you send a policeman to Vallefort Road Millbridge, A group of youths have been fighting. One appears to be badly injured. Two or three of them have run off. I think that the window of the second hand dealers has been smashed"

Cont. overleaf

Time	ACTION TAKEN	Action endorsed by
0016	H35 Pc Wilson & Greenaway	
0019	Unit 6/7 Pc Wellings & Quest	
0023	Ambulance requested by H35	0036
0035	[illegible] to [illegible] track to Stoke Village	
0120	9 PERSONS ARRESTED O/C Pc GREENAWAY 3. GBH. 4 Public Order & 1 Burglary. 2 persons to FREEDOM FIELDS HOSPITAL (1 Head Injuries)	J Hurley Insp. 0315

Fig. 3.4

WEST MIDLANDS POLICE

WG 501
(amended 9.75)

Message Form

Control Rooms and Sub-Divisions 'A' to 'F'

Sub-Division

Received Via:-	Initial Classification		Serial No.
Phone	RTA	ALARM	
Radio	CRIME	MISC.	
Other	DISORDER		Date
'999'	Final Classification (Sub-Division only)		
Fire or Amb.			Time
Alarm			

LOCATION

INFORMANT

MESSAGE

ACTION

RECEIVED BY

TRANSMITTED TO TIME

RESULT & REF.

It can be seen that although the layout is slightly different the content is almost identical. A form of this general type is universally used by all of the police forces within the United Kingdom.

The purposes of the message log are:-

1. To note salient details for the purpose of assisting initial actions concerning resource allocation etc.
2. As a control document and a record of any action taken. (Usually taken within the first few hours of message receipt.)
3. As a description of any incident or information. The log is usually written so to be comprehensible by various third parties. The logs are frequently used to brief both patrolling officers and supervisors.
4. As a source of statistical information.

A message log will be made out in nearly all cases where incidents are reported to the police. In many cases, subsequent forms such as crime reports or accident reports are later produced, but the message log is the first record of the incident. In many cases involving minor incidents the message log is the only record within the police service of the incident. It can therefore be seen that the message log has a pre-eminent place as a source of operational and management data concerning the running of the Force. For this reason it is a major focus of the present research.

Evaluation of premises concerning control room working

Most of the fears concerning control room working, including the premise concerning the volume of data, were of an anecdotal nature and unproved at the commencement of this research effort. It was therefore decided as a matter of urgency to investigate these suppositions early in the project to ascertain what substance there was in those assertions.

SUMMARY PART I

The Devon and Cornwall Constabulary is a sizable police force, covering both urban and rural communities. The management of the Force identified a number of operational and management information problems which they decided could be assisted by the provision of computer facilities.

The major source of management and operational information, in both a manual and a computer system, is based upon incident reports. The majority of these reports are communicated to the police at their police control rooms. In the Devon and Cornwall Constabulary there are eight of these rooms situated at the divisional headquarters. In addition to their task of receiving information from members of the public, these control rooms also have a number of other responsibilities, including the controlling of police resources and the provision of backup information to both police resources and members of the public.

There were reasons to believe that the reliable capture of incident data at these control rooms for a computer based management information system might be difficult under normal operational circumstances. The timely and accurate capture of incident data was considered to be essential for the viability of a computer based project as a whole, and therefore the investigation of any potential data capture difficulties in this area was designated as the focus of the present research project.

THESIS PLAN

PART 1: INTRODUCTION

PART 2: PRELIMINARY INVESTIGATIONS - PERCEIVED PROBLEMS

PART 3: IN DEPTH INVESTIGATION OF PROBLEM AREAS

PART 4: SOLUTION EXPLORATION

PART 5: CONCLUDING SUMMARY

PART 6: BIBLIOGRAPHY

CHAPTER FOUR

EXPLORATION OF CONTROL ROOM IMPORTANCE PREMISE

Initial Ground Work

One of the first things to ascertain before any in-depth research was carried out was whether or not the premise that the control rooms undertook a major share of the incident based work load of the Force could be supported by any quantative evidence.

In order to test that premise (along with other objectives) a record survey was undertaken.

Message Recording

When information is received in the police force concerning an incident, a written message is made of the details. There is a. Force instruction that a message log should be made out for any telephone call which requires police action. (See Fig. 3.3) This instruction is not followed to the letter owing to the large volume of telephone calls received by the police force, and in general, only those incidents which are regarded by the police officers as being relatively serious are recorded. It is, however, believed that a reasonably uniform standard of severity is maintained by the various officers receiving telephone calls in judging those calls requiring logs.

The Force has 126 police stations and offices which might be expected to receive information from members of the public and therefore with the potential to initiate message logs. Of these, 10 were designated as either an Information Room, a first rank Communications Room or a second rank Communications Room.

Method

The survey was conducted by randomly selecting 31 days from the year of 1977. All of the message logs from each station and office throughout the Force were obtained for those days, and salient details coded onto computer data input forms.

Results

A total of 50,439 messages were checked for the 31 day period. Of these messages, 23,908 were received by one or other of the information or Communications Rooms. Approximately 47.5% therefore of all messages received by the Devon and Cornwall Constabulary during the period under survey were received in Communications or Information Rooms. In addition all 999 calls are routed into the Divisional Communications Rooms.

Discussion

These figures probably understate the true work load passing through the Communications Rooms, because many messages received by a normal patrol station are then passed by telephone for action by the Commuications Rooms, the log being retained by the patrol station and only a radio log being made out by the Communications Rooms.

It would seem that there is sufficient quantative evidence to suggest that a major proportion of incident and data collection work is carried out by the Control Rooms within the service, and further comprehensive research is therefore justified.

CHAPTER FIVE

OBJECTIVES OF THE CONTROL ROOMS

Having decided to investigate police Control Rooms in depth it seemed a reasonable starting point to ascertain what were the Control Room objectives. This was approached on two fronts.

1. Command objectives, that is some formal statement of what the police service expects of its communications department and its communications rooms, presumably epitomised in an official document or an official pronouncement by a very senior officer (H.Q. staff level).
2. The informal objectives as perceived by those actually running the system.

It seemed potentially instructive to compare these two sources of operational objectives to ascertain any disparities or even potential conflict in aims and objectives.

Command Objectives

It was assumed that any formal objectives, being the statement of official policy concerning the operations of communications within the Force, would be available as a fairly widely disseminated document, and therefore easily available for investigation. This proved to be an incorrect assumption. I have carried out a diligent search of the major official policy making documents of the Devon and Cornwall Constabulary and, in addition, a number of reports which refer specifically to re-organisations and reviews of the control rooms. In none of these have I been able to discern what one could describe as an unequivocal statement of the objectives of either the Communications Department, or individual Communications Rooms.

In many police forces the tenets by which the service organises itself are enshrined in a document known as General Orders. The General Order which refers to Communications in the Devon and Cornwall Constabulary is entitled 'A.110' (Devon and Cornwall Constabulary 1979). This document deals in the main with the mechanical operation of telecommunications and certain organisational aspects thereto. It does include a slightly fuzzy statement of the 'objectives of telecommunications' (namely VHF, radio, pocket phones, telex and robophones etc.) and these are set out as -

"a) Providing a rapid service to the public and to inform members of the Force of all operational matters.
b) Allowing the speedy despatch of administrative business. This will take second place to operational matters and telecommunications will not be used where the matter can be efficiently dealt with by post. Administrative matters must not be dealt with by radio."

The Information Room seems to fare slightly better in the statement of objectives. There are the following statements of its role:-

"a) Control the main radio schemes
b) Disseminate operational messages
c) Give a service both to the public and police personnel (particularly as a central source of information)
d) Co-ordinate those incidents which require action on a larger scale than can be dealt with by Divisions."

The objectives such as they are, seem to be written in operational terms, at a fairly detailed low level, i.e. the Information Room will be responsible for this, or responsible for that, rather than attempting to state what the system as a whole is trying to achieve.

These operational statements are of course necessary, but presumably only to support an overall philosophy of the organisation. It may seem that I am being unduly critical of this lack of objectives, but considerable problems for day to day planning and organisation derive from the vacuum.

In order to ascertain whether any relatively formal objectives had been laid down in verbal form, I interviewed the two senior communications officers in the Force. They informed me that they found their position extremely difficult because there seemed to be no discernible policy over communications systems. They felt that they were a small technical group who were left on their own, as far as planning was concerned, and yet they had the operational efficiency of the Force very much in their hands. I was informed that there were no explicit direct objectives laid down in either written or verbal form for any aspect of a Communications Department, (i.e. neither for the Department as a whole for the Headquarters Information Room nor the Control Rooms). The Communications officers say that in particular they are desperately trying to understand the role of the Information Room, but at the time of the presently reported investigation (early 1979) changes just seem to happen rather than be planned.

Informal objectives

I interviewed 41 communications officers, approximately 25% of the actual staff employed on communications duties. (The word 'actual' is emphasised because the authorised establishment is considerably less, and is often supplemented by people drafted into Communications Rooms on an unofficial local basis.)

I asked each of these officers "what they were trying to achieve", " what they thought were the objectives of their particular job" and "the control room as a whole". Without exception all of my respondents found this question very difficult to answer and it was quite apparent that it was not a subject to which they had given much thought. To some extent it was an unfair approach for me to make. Most people who get immersed in the day to day running of their lives and jobs find it a problem to raise their heads above the milieu to enunciate their goals and objectives. In a job where the day to day running can be as absorbing as that in a

Control Room this is probably particularly true. In addition, the control rooms play a vital but supporting role to other police activities. In this Police Force in particular, the overall objectives of the Force have been thrown into question, quite deliberately, by the present Chief Constable who espouses a radically new, socially orientated role for the Police Force. This means that the whole Force is at the present time finding it difficult to ascertain its overall objectives and therefore individual sections of the Force, such as the Control Room operators under study, find it difficult to discern their own supportive sub-goals.

In the main the answers of officers outlined three main categories:-

1. Servicing emergency calls from members of the public.
2. Relaying and allocating police resources to deal with incidents.
3. Providing an information service to members of the Police Force within their geographical area.

In addition a few of the officers mentioned that with the police advisory telephone system they had a duty to provide information and advisory support to members of the public.

Areas of authority

Most of the replies that I received from communications officers in response to the question about objectives were in fairly mechanistic terms, i.e. "I am responsible for operating the telex", "I listen on the radio", or "I answer 999 calls" etc. However, in response to other questions, many officers referred to difficulties which on occasions occurred, and which could be directly attributable to a lack of well understood objectives or role of the communications department. This was particularly notable with respect to the delineation of their authority and responsibilities over resources.

The question effectively is, are control rooms responsible for controlling vehicles in the same mode that a General might control his forces from his radio control room, or are they merely centres for the reception and transmission of information concerning incidents, and the allocation of vehicles only in the micro sense of sending a vehicle to an individual and specific incident?

There have been a number of competing 'centres of authority' within the police force, all concerned with the control of the man on the beat. These are the Headquarters Information Room, the Control Rooms and the ground supervisory cover officers. The situation vis a vis the Headquarters Information Room and the Control Rooms is gradually being resolved 'defacto' by the curtailment of the Information Room facilities. Up until this point there had been a duplicity of control, in so far as certain vehicles were 'legally' controlled from the Information Room, but effectively controlled by the Control Rooms. It is understood that the Information Room will now relinquish all control over Traffic vehicles, with the exception of those on the Force channel which will be patrolling the motorway. This duplication of control should therefore be gradually abated.

A more serious and continuing area of conflict is between the Control Rooms and supervisory ground cover. Control Rooms are responsible for sending units to incidents, and presumably for maintaining adequate allocation of resources to service any potential future incidents which they may receive. The ground cover officers are responsible (one must presume) for the less immediate policing of their locality. This leads to difficulty because the ground cover officer may be employing a long term policing plan for his area and therefore allocate his patrols to various areas to cover the contingencies about which he is aware. Unfortunately, immediately his patrols leave the station they come under the radio control of the Control Rooms and may then be legitimately despatched to deal with incidents. Most communications officers interviewed indicated that on occasions conflict does arise in this area.

This is an area which has been discussed by this Police Force for some considerable time but to date no general decision upon it has been made. Therefore in the absence of a policy statement the individual officers have had to decide their own particular job objectives and degree of authority. Naturally these have differed from individual to individual.

Although there is this considerable variation, the consensus seems to be that the ground supervisory officers are responsible for the overall allocation of vehicles and other police resources. When an isolated incident occurs the Control Room is responsible for selecting from those resources and despatching the relevant officer(s). If an incident requiring a number of resources arises, or during periods of intense emergency activity, as at certain times of the week, then the authority to control resources is generally taken more firmly by the Communications Rooms. In this case they may, in addition to the resources that they are despatching to specific incidents, also move other resources away from their normal areas of patrol into certain "back up" positions.

In the case of incidents which require a number of resources to attend, the Control Room remains in overall command of the situation until a ground cover officer arrives at the scene. At the scene of the incident the ground cover officer will take command of the situation immediately in his vicinity, and will relieve the Communications Room of the responsibility of controlling that particular incident. He will, however, normally relay his requests for additional support through the Control Room in order that they can co-ordinate the allocation of resources in the wider sphere.

In the case of very serious incidents it is possible that a ground cover officer of senior rank will be called in to the Control Rooms to take over control. At the present time the most senior rank in the Control Room is a Sergeant and it is likely that ranks of at least Inspector but quite possibly up to Superintendent will be brought in dependent upon the seriousness of the incident.

It must be understood that these descriptions of a communications role and objectives in these varying conditions are in no sense formal and merely seem to be the operating mode suggested by the concensus of officers within the control rooms. As previously stated, not all officers have the same views concerning delineation of authority or the objectives of the various parties involved and therefore on occasions some friction does occur. This is normally evidenced when the Control Room tends to exert more authority over a ground cover resource than the ground cover supervisory officer thinks is necessary or "legal".

CHAPTER SIX

TASKS WITHIN A CONTROL ROOM

Observations were carried out in all of the Communications Rooms within the Devon and Cornwall Force and the Information Room at Police Headquarters and also the Information Rooms in a number of other Forces, namely the Metropolitan Police, Glasgow, Derby, the West Midlands and Dorset Police Forces. These observations produced the following categorisation of functional tasks carried out in police control rooms.

1. Emergency telephone operators
2. Non emergency telephone operator
3. Police advisory telephone operator
4. W.T. operators
5. Police National Computer (Network) operators (PNC)
6. Telex and/or teleprinter operators
7. Ancillary information staff

Naturally in any one control room it is not necessary that one task will be allocated to just one officer. Each officer may have an amalgam of these tasks or there may be more than one operator dealing with each or a number of these category areas. A number of Forces have their own computer operational and information services operators, but the facilities provided on these are so diverse, dependent upon the systems being considered, that I have not included them in this categorisation, preferring to concentrate in this research on the type of facilities which are likely to be provided by the network being developed within the Devon and Cornwall Constabulary. This will be elaborated under the ancillary information aspects of the tasks.

Emergency Telephone Operators

This task consists of servicing the 999 emergency telephone calls received from members of the public. The arrangement in the Devon and Cornwall Constabulary is that such calls are routed to the Divisional Communications Rooms. They are first intercepted by a G.P.O. operator who ascertains the service required and,in cases of ambiguity, will normally default to the police who then become responsible for further action and the activation of other services should they be required. There is a general view in the Police Service that the 999 calls should be serviced by police officers but the policy of staffing the various Communications Rooms is somewhat variable, and certainly not all calls are dealt with by a police officer. Later in this report there will be considerable and detailed discussion of the role and responsibilities of the operator receiving a 999 call, but briefly his task is to ascertain salient details from the caller, and to decide on and initate a course of action appropriate to the type of incident being reported.

Non-emergency telephone operators

There are basically two types of non-emergency telephone calls received in the Control Room. One is from members of the Police Force or other Police Forces usually asking for information of one type or other, or details of current operational activities. The second, are calls routed to the Communications Room from members of the public. Attempts are made to ensure that the majority of non-urgent telephone calls are routed direct to patrol stations rather than to a Control Room, but on occasions there are non-urgent telephone calls from the public which can only be answered by the communications officers.

Police Advisory Telephone

This is a new system which has been inaugurated within the Devon and Cornwall Constabulary. It is a free phone system open to any member of the public, allowing them to contact their local Control Room (they do not know that it is their local Control Room), in order to obtain advice, or to talk in an informal manner to a member of the Police Force. Names and addresses are not required of the member of the public although they will be accepted if volunteered. The objectives of the call may either be to assist the member of the public by providing him with certain types of information, or to assist the police by giving information etc. about happenings within the area. The whole emphasis of this type of call is that it is relaxed, with none of the discipline and air of urgency of an emergency 999 call.

Telephone switchboard

Most Control Rooms are sited close to the major telephone switchboard in their area and frequently the control room operators have the supervision of the switchboard as part of their activities. In addition, in some stations at night there is no regular switchboard operator and calls are routed through to the Control Room radio consoles.

Police National Computer

The Police National Computer is a network of terminals throughout the United Kingdom all of which access a central data base at Hendon. Information in this central computer covers the areas of lost and stolen vehicles, wanted or suspected criminals (brief details), disqualified drivers, details concerning the owners of vehicles. A great deal of use of this information is made by patrolling officers, and at certain times of the day these operators are under a heavy work load. The response time and reliability of the computer service are generally good.

Telex and/or teleprinter operators

All Control Rooms, have, either within their room or close by, facilities for telex and/or teleprinter. In the main this is used to communicate to other stations within the Force area, or other police forces. The equipment can of course operate on the normal telex net but a survey which I carried out showed that most telex communications are internal.

Ancillary information

A great deal of ancillary information is kept within the Control Rooms or in their immediate vicinity. The type of information which is maintained in a Control Room covers areas such as keyholders registers, voters registers, details of vulnerable premises, call out lists, and a whole host of miscellaneous information of both a permanent and a transient nature, concerning the locality which is being policed by that Control Room.

In addition most of the Control Rooms are situated close to (or have access to) the collators offices which carry criminal intelligence information about areas and persons within that Division, (or in the case of Devon and Cornwall Constabulary, probably the adjacent divisions as well).

A considerable amount of time is spent by communications officers servicing requests for information from operational beat personnel, and members of the public.

Details of operational modes specific to Devon and Cornwall Constabulary will be found in Chapter 7.

CHAPTER SEVEN

PRELIMINARY INVESTIGATION

I decided to try and set the scene on the workings of the control rooms and their potential problems by carrying out a preliminary investigation. This investigation was comprised of two parts.

1. Interviews covering approximately 25% of the communications officers in the Force, using a structured interview system.
2. A series of naturalistic observations in the Divisional Communications Rooms, and the Headquarters Information Room.

The objectives of this preliminary investigation were not to come up with any concrete proposals, but merely to map the problem space. In the main the threads found in this investigation were then used as pointers towards more quantitative and empirical research into specific areas of the Control Room situation. Basically I was interested in obtaining information to give sufficient insight into the communications area, to enable the generation of some useful, relevant and testable hypotheses concerning the prevalent interface problems. The approach in this chapter is both qualitative and quantitative

In the main I have concentrated on the incoming 999 calls and the subsequent actions. To an extent this of necessity involves consideration of the allocation problems of W.T. operators, especially when there are circumstances where the emergency telephone operator and the W.T. operator are the same person. However, in the main no in-depth evaluation has been undertaken concerning normal allocation problems, other than to mention it where relevant.

INTERVIEWS OF COMMUNICATIONS OFFICERS

The objectives of these interviews were three-fold:

1. to ascertain in detail the difficulties that officers felt that they experienced in the gathering of information from 999 and other emergency telephone calls;
2. to ascertain the type of information that they would require in a computer system for communications rooms, and
3. to be aware of any other difficulties which may affect the efficiency of communication room operation both with the present manual, and the future computer systems.

The interviews broadly followed an interview schedule, a copy of which is reproduced in Appendix 1. The questions were aimed at covering all of the areas mentioned in the preceding paragraphs, although the emphasis in this chapter is on objective No. 1.

I interviewed a total of 41 communications officers who were either sergeants, constables or civilians. The sample was stratified in so far as 25% of each individual Control Room establishment were interviewed. This was done in order to obtain a sample which was representative of any possible differences between the various levels of Control Room within the Force.

Two questions related to matters which are central to this thesis; and these were questions 3 and 4 in the section on "incoming calls".

Question 3

Question 3 asked "of those (telephone calls) which are recorded, what percentage are started on scrap notes and transferred?" This question was asked in such a way that the reply was limited to emergency telephone calls received from members of the public.

The answers to this question fell into four major areas which are set out in table 7.1 below.

TABLE 7.1

INTERVIEW SCHEDULE - HOW OPERATORS LOG INITIAL INFORMATION RE. EMERGENCY CALLS

	Responses	%
All messages initially on scrap paper	34	82.9
Most messages initially on scrap paper	3	7.3
50:50 messages initially on scrap paper	0	0.0
Most messages initially on message log	3	7.3
All messages initially on message log	1	2.4

It can immediately be seen that approximately 83% of respondents stated that they placed the majority of their initial notes on scrap paper, and then later transferred them to the message log. Just over 7% (3 respondents) stated that they placed certain types of call onto the message log directly although they used scrap for the majority of messages. These three officers all mention automatic alarms as the type of message that they would attempt to capture directly onto a message log.

A similar number (three officers) stated that they placed most of the information directly onto the message logs and one officer stated that he put all information directly onto message logs and never used scrap paper at all.

There has been a general directive within the Force that information should be captured directly onto message logs from 999 calls. It is therefore of considerable interest that the majority of police officers engaged in communications work do not follow this directive.

Question 4

In question 4, I asked the officers why they found it difficult to input the information directly onto a message form. The replies that I received were ranged over a number of subject areas which are categorised in Table 7.2.

TABLE 7.2

INTERVIEW SCHEDULE RESPONSES CONCERNING PROBLEMS IN DEALING WITH POLICE EMERGENCY TELEPHONE CALLS.

	No. of Responses	% of Total
A CONTROL OF TRANSACTION		
1. Calm and/or reassure caller	7	4.3
2. Sequence and format information	22	13.5
3. Keep caller on the line	4	2.5
Sub-Total	33	20.3
B INFORMATION EXTRACTION		
1. Need to edit irrelevant information	5	3.1
2. Insufficient necessary information	12	7.4
3. Problematic types of information		
a) Names	2	1.2
b) Addresses	2	1.2
c) Telephone Numbers	2	1.2
d) Locations	11	6.8
e) Descriptions (of persons, places)	3	1.9
Sub-Total	37	22.8
C COHERENCE		
1. Caller		
a) Transient conditions (anger, panic, confusion, fear)	9	5.6
Permanent conditions		
i) mental disorder, age etc.	4	2.5
ii) dialects	2	1.2
2. Background Noise		
a) On telephone line	5	3.1
b) In control room	9	5.6
c) At scene of call	3	1.9
Sub-Total	32	20.1

Table 7.2 cont.

D DECISION ACTIVITIES		
1. Comprehension of situation during call (i.e. change of understanding as more information supplied)	8	4.9
2. Set pattern for some incidents (i.e. some incidents easier to deal with)	9	5.6
3. Deciding on subject of incident	6	3.7
4. Deciding on action	5	3.1
5. Concentrating upon the call	7	4.3
6. Remembering to ask necessary questions	1	0.6
Sub-Total	36	22.2
E PRESSURE		
1. Of other calls and events	5	3.1
2. Urgency of action related to call	2	1.2
3. Writing speed (and legibility)	7	4.3
Sub-Total	14	8.6
F PROCEDURAL		
1. Misdirected 999 calls	2	1.2
2. Equipment or materials problems	1	0.6
Sub-Total	3	1.9
G CONFUSIONS		
1. Expectations of public re. location of the Communications Rooms (i.e. they expect local knowledge)	6	3.7
2. Need for local knowledge	3	1.9
Sub-Total	9	5.6
GENERAL COMMENTS		
1. Advantages of 2 man mode of telephone answering, explained later in this chapter	8	4.9
2. Different emphasis by different operators	1	0.6

The major headings are:-

1. problems concerning an operator's ability to control the transaction;

2. difficulties with the information content, either the volume of it, or certain types of information being difficult to obtain;

3. the coherence of the caller, either due to certain transient conditions, such as panic, anger, etc., or more permanent considerations (stuttering, accents) or possibly technical problems such as the noise on the line;

4. the amount of concentration required to comprehend the transaction, to make a decision and/or the miscellany of pressures caused by the effect of other events which go on contemporaneously within a control room; or finally,

5. procedural difficulties.

Conclusions on interviews

The major finding in the interviews is the substantiation of the belief that the majority of police officers do not input information directly onto the message logs. It must obviously be supposed that they had very good reasons for failing to do this and the second question in the interview schedule attempted to ascertain some of the reasons why they believe that they were unable to complete the task in the decreed manner. The results in Table 7.2 do not suggest that the problem of writing speed was one of the major difficulties in collecting information from the call. This is not to say that it is not a problem, but it certainly was not uppermost in the operators' minds when responding to this question. Difficulties mainly concern their ability to abstract certain types of information, the control of the call and in particular the sequencing of information into an order which would be useful to them. Their comprehension of the information and subsequent decision upon that information, were all regarded as major difficulties in the recording of information during police emergency operations.

It is significant that a very large number of the responses referred to matters which are of a mental or cognitive nature rather than the process or mechanical limitation of writing speed. This seems to be counter-intuitive to the views of most senior police officers, who when questioned during my visits felt that a training programme in high speed typing would ameliorate the situation being experienced by the Control Room operators in this aspect of their work.

OBSERVATIONS

The objective of the observations was largely to supplement and support the more specific information which was obtained from the interviews.

The observations were carried out by my sitting in the various Control Rooms and making general notes of any event or situation which I thought might be of interest. These activities were carried out at the beginning of the project and were an eclectic exercise aimed at providing some qualitative flesh to the problem area.

Most of the observations were carried out at times which were estimated by the communications officers to be their busiest periods. Invariably, (and also unfortunately for the investigator), these periods turned out to be Friday and Saturday nights between 1800 and 0300 hours. Observations were also conducted in various Control Rooms for shorter periods at other times of the day.

I have outlined the findings under the major subject headings, and also included various informal comments made to me by operators, as some anecdotal accounts of incidents tend to exemplify certain specific points quite well.

I found that experienced operators had great difficulty in recalling how they carried out their tasks, specifically when asked how they dealt with 999 calls. I presumed that this is due in main to the fact that this has become a skilled activity and therefore is less accessible to conscious mediation. The less experienced officers tended to be better able to describe the problems that they encountered when message taking. This of course does not necessarily mean that experienced operators do not experience such problems but merely they have difficulty in providing a verbal description.

Main Modes of Operation

I found that there were basically three different methods by which the various control tasks were organised within the Constabulary's Control Rooms.

Mode 1. A single operator covers the tasks of telephone operator, W.T. operator, and is also responsible for the completion of the message logs.

Mode 2. One operator receives a telephone call and makes out the message log whilst a second operator controls the W.T. operations, including the despatch and control of resources. This is the most commonly used mode of operation.

Mode 3. One operator receives the telephone call, a second operator monitors the call and makes out the log, and finally a third operator controls the W.T. and subsequent activity. This mode is frequently employed when the control room is under pressure from a large number of incidents.

Generally every communications officer is expected to be capable of undertaking all tasks within the Control Room. The policy of interchangeability however varies throughout the Force area. In some Control Rooms operators have fixed tasks and only interchange in emergencies, in other Divisions a round-robin schedule is maintained.

The experience of the communications officers varies from a few weeks up to 15 years. Invariably it is the civilian operators who have the longest in-job experience as they are recruited as 'communications officers' and remain in that post for all of their employment. The police officers, however, are all 'general' police officers and rarely have more than three years' continuous experience of control room working (the average is 2.7 years). The police officers are officially in charge of the Control Rooms. They are usually the only communications officers with direct knowledge of practical police work.

Call Taking

I found that without exception all of the operators whom I observed did not record the information they received in the "emergency call" directly onto the message logs. They all made out scrap notes on various pieces of paper and later transcribed them. The reasons that they gave for this activity were various but could be categorised under the following seven headings:-

1. The format of the incoming information and the message log were not the same.
2. The form of log depended upon the type of incident which often could not be correctly classified until the end of the call.
3. Problems with sorting out the relevant details from irrelevant floss.
4. Need to concentrate on controlling the caller and the information flow.
5. Problems with understanding the caller due to panic, noise, dialect, incoherence through drink etc., and therefore need to concentrate on speech understanding.
6. Need to get 'things moving' in response to call.
7. Need to write quickly, cryptic scrap notes can be briefer, less neat, i.e. using this mode the operator has less need

to consider the presentation of the document during the course of the call, being able to leave this until a later time.

These findings closely mirror those of the interviews although the sample was quite different.

Some of the operators informed me that they had to be "careful" when writing up message logs to ensure that the right impression was given. There seemed to be a tendency only to enter into the data base (the manual message log system in this case) those facts which accorded with the plan of action which was finally selected by the operator. I noted that on a number of occasions details entered into the message log tended to be tailored to suit some template or a specific incident type. Presumably the operator would have categorised the incident and the template chosen would be an appropriate one. In one specific case a woman alleged that she had been assaulted by her common law husband during a domestic dispute. Her allegation of being assaulted was omitted from the telephone message log. The reason given by the operator for this is that frequently during such domestic incidents an allegation of assault is made which is invariably subsequently withdrawn. The operator in this case felt that it was better to report just the bare details and leave it for the patrol officer to add any allegations of assault if they persisted after the initial enquiry.

It is not of course possible to ascertain the degree to which message logs are consciously influenced in this manner, but obviously a certain percentage of the information entering the Force is filtered by the operator before it reaches the message log data base.

During the course of my visits to the various control rooms I took the opportunity of interviewing the various senior officers in the Force concerning the mode of operation of the various Control Rooms for which they were responsible. The major points that I noted was that there was generally a lack of detailed knowledge concerning the actual allocation activities of the various Control Rooms.

In addition the majority of senior officers were under the impression that in the main the official policy of making out message logs directly from a call was being adhered to by Control Room staff. Many of the Control Rooms have become technically quite complex and it seemed that on a number of occasions this had caused some distancing between the senior police officers who were ostensibly responsible for the administration of the Control Room and the officers who actually worked within the Control Room. This is a point to which I shall return later in the thesis when commenting upon the results of the subsequent simulation exercise.

Decision making

I paid particular interest to the various decision making elements of the operators' tasks and this aspect was particularly underlined by a specific incident which occurred late one Saturday night.

'On this occasion a control room received a number of 999 calls from different locations all alleging that a bomb had been placed in the bar of a drinking club which might be expected to be crowded at that time of night.

The policy regarding bomb hoaxes which the Force has gradually evolved is that in the main the police take no direct action themselves other than contacting the manager of any private premises within which the bomb is alleged to be residing and inform him of the call. If he wishes to take any action the police force will provide the proprietor with as much support as possible, normally to evacuate clients from the premises. This policy is designed to reduce the disproportionate use of resources which was occurring with frequent bomb hoaxes, but it is of course a policy with inherent dangers. The call on this particular occasion had certain indications that it was not a normal hoax.

I monitored the call in parallel with the police operator and on the conclusion of the call he literally took no action for approximately fifty seconds. The officer then made attempts to find the telephone number of the club but gave up before he had completed the task. He then made attempts to radio the night duty Inspector. It seemed from my observations that none of these actions were particularly purposeful. (Anecdotally he seemed to be trying to form a plan of action). Eventually he ascertained that the night duty inspector was on the air in an area which usually has good radio reception. The operator managed to contact the night duty Inspector and clearly outlined the circumstances of the incident. Thereupon an almost identical situation occurred with the Inspector asking for repeat transmissions of the message. It seemed that because of the unusual circumstances, and presumably because of the potentially serious consequences both of these officers were literally "stopped in their tracks" until they had formulated some coherent plan of action, production of which took a measurable period of time'.

A number of other similar incidents of a less dramatic fashion were noted during these observations, usually occurring when the incident was unusual and particularly when it had serious implications. The displacement activity of looking for the telephone number or some other similar action seems to frequently occur under these circumstances. In one other incident, where a man was reported drowning offshore, the operator spent some fruitless minutes making enquiries concerning the location of a unit within the station.

A major difficulty for decision making by the Control Room staff is that frequently their information is incomplete or of suspect quality. Often callers don't know the location from which they are calling and,if the incident is a fast moving one, frequently only small snippets of information will come in about one particular facet, leaving the Control Room staff to piece together an incomplete jigsaw. The fact that they become adept at evaluating information is in itself a source of danger. On one particular occasion a call was received on a Friday night from a person calling himself John Smith who gave an address which officers in the Control Room thought to be false. Mr. Smith reported a serious disturbance in Torridge Way, Plymouth. The initial inclination by officers in the Control Room was that this was a hoax and no resource was despatched. However, the Voters' Register was checked as a matter of course, whereupon it was found the name and address was in fact genuine. Units were then somewhat belatedly despatched to what transpired to be a very serious incident.

Even when the information has been properly received and evaluated the following allocation decisions can themselves be remarkably subtle and complex. During one incident which I noted a police patrol car was stopped and given information by a member of the public to the effect that an intruder had just broken into some business premises. The building was large and isolated and the officer who arrived at the scene prudently requested the assistance of a backup unit.

The Control Room sergeant had another single crewed vehicle quite close to the scene but declined to send it.

I asked him the reasons for his action and he informed me that he felt that a dog handler would be a more appropriate resource to send to the scene. He said that if he had sent the second police officer to the incident, then once the two officers were together at the scene they would feel it encumbent upon themselves to commence entry into the premises in an attempt to apprehend the offender. However, with just one officer at the scene he would be more likely to hold back until the dog handler, who was some distance away, arrived.

The sergeant's reasoning was that a single man would not feel there was any dishonour in failing to enter the premises alone, whereas two men together might be imprudent enough to make the attempt. Whether this view was correct or not, it does demonstrate a fair degree of subtlety in his evaluation of human behaviour.

The co-ordination of resources at the scene of incidents can in themselves be quite complex. It is often necessary to seal off operational areas, in which cases resources have to be taken from other places and on occasions even from other incidents. In these circumstances the comparative importance of the various incidents has to be evaluated. At the same time the supervisor has to be aware of the capabilities of each of his units, his duty to provide backup information and to contact other services such as hospital, local authorities, ambulance, fire brigades etc. In addition he may need to initiate action independently in other geographical locations, e.g. by sending officers to an escaped offender's home address.

All of these actions require a very firm grasp of the events which are occurring and a lively ability to solve simultaneously many different equations concerning incident needs and resource capabilities.

Operator Overloads

There are obviously capacity limitations in the tasks of both operators and supervisors which will have ramifications concerning the amount of work that they are able to undertake. I noticed that on a number of occasions, when operators had multiple incidents occurring within their area of responsibility, that they seemed to become bogged down and unable to adequately cope with any more incidents.

On one occasion the supervisory sergeant started to ask a W.T. operator for details of her current situuation viz: a serious hit and run accident. It became immediately obvious that she could not service his request for information, whilst at the same time dealing with the control of three incidents which were proceeding under her direction. This led to some interesting interpersonal difficulties in so far as the operator was obviously overloaded and therefore unable to properly control at least one of those incidents. The sergeant who was, ostensibly at least, supervising incidents throughout the city unfortunately did not have the benefit of a radio system. He therefore had a good police ability, but incomplete knowledge of the situation. On the other hand the operator was unable to update him because she was already fully committed. The result was that he would issue instructions which made very little sense because of his incomplete knowledge of the very dynamic movements of the police units.

I would not like to suggest that the situation occurs frequently. Under normal load conditions the control systems seem to be quite adequate, it is only under exceptional conditions that this sort of breakdown occurs.

The overloading of operators also produced other manifestations in the operational sphere. In particular I noted that frequently the operators were unable to service routine requests for information from beat officers, because of their workload in the allocation and control of more serious incidents. This meant that the information requests both from within the Force and from outside were deferred until quieter periods.

Similarly, under conditions of high workload control room tasks which are considered to be less important are often deferred. On a number of occasions I made snap checks of the message logs during periods of high incident load. In all cases they were behind the current time. The degree of lag in the completion ranged between fifteen minutes and two hours.

There were also a number of occasions when the high workload on operators caused them to make mistakes concerning the number of resources at their disposal. This is despite the fact that in most cases Control Rooms do not have a large resource pool to maintain. I did however notice that during a number of busy periods it was quite possible for a vehicle to be forgotten and not used although it was a viable available resource. This has two dangers:-

1. the vehicle is obviously being under utilised and other vehicles given an unnecessary workload, and
2. the normal safety monitoring of officers is relaxed with inherent dangers.

Effect of new Force policies

The new Force policies which have been briefly described elsewhere in this thesis will tend to displace resources from response vehicles towards community constables etc. This will mean that the Control Rooms will inevitably have less emergency resources available to deal with the various incidents. Even if the community constables are on the air, they are likely to be less mobile, and therefore less versatile. This means that allocation decisions will have to be made on a much more careful basis and inevitably this will complicate the already difficult decision making processes within the Control Rooms.

Operators' knowledge

The operators bring to the job a wealth of world knowledge and accumulated experience which they frequently use to augment the data received from more formal resources such as 999 calls etc.

My observations during the course of a number of evenings indicated incidents which adequately demonstrated the usefulness of a police officer's contextural knowledge of the area. On one occasion a telephone operator was having great difficulty in understanding the caller. A police officer monitored the call and recognised that the caller was a well known 'nutter' and although a name had not been given, terminated the call and sent an appropriate unit. This saved a great deal of unncecessary telephone time and also the potential desptach of inappropriate resources. The mentally disturbed caller at this time was alleging a very much more serious incident than eventually transpired to have occurred.

In another area, a vehicle which was having difficulty locating certain premises, was directed to a source of information about which the police officer in the Control Room was aware. On other occasions the police officer was able to augment the information coming from the caller with previous information that he had about both the area and similar types of incidents which had occurred within the last few nights. All of this contextual knowledge must aid the gathering of accurate information.

Communications models

In addition to this factual information many of the communications officers seem to hold views about their job at a more general and abstract level. A number of operators gave quite elaborate models of how they considered action took place within the area they were covering.

One operator described what he considered to be waves of action on a Friday and Saturday night in so far as he expected a high point of drunks, vehicular accidents, pedestrian problems etc., perhaps broken windows and damage immediately after 10.30 in the evening. Just prior to that time there would be a slow build up from about half past seven to eight o'clock. Just before 11 pm he describes a lull followed by a fair number of domestic incidents. He suggested that this was because the drunks had by this time arrived home. Around about midnight until 1 o'clock there would be a reasonable number of opportunist burglaries, usually involving young men climbing into yards, etc. From 1 o'clock to 2 o'clock there would be further trouble caused by clubs turning out and during the whole of this period there would be drunken driving offences. Thereafter the situation would quieten down and any incident which occurred afte 2 o'clock in the morning was likely to be a serious burglary or attack on property.

Other operators had less detailed models of whether Friday nights were busier than Saturday nights, or whether Sunday night was in fact getting busier than it used to be.

The fact that operators have elaborate mental models about their job does not of course mean that their views are necessarily accurate in every detail. This subject will be looked at in a little more detail in Chapter 13.

Allocation strategies

I have some grave doubts about some of the currently used allocation procedures. In this respect some interesting replies were received from operators concerning the use of 'C' calls. A number of them stated that a broadcast call to cars was frequently more efficient than the more laborious process of specifically allocating a single vehicle. There were two reasons for this -

1. It was much faster for them to output that information, e.g. "any car Torquay Town Centre" rather than looking up a list and ascertaining which vehicles and/or patrols were on duty in that particular area (although to be quite honest most of them would be known to the operators, perhaps with the exception of the foot patrols).

2. Perhaps a more valid point, accurate location updating procedures tend to be somewhat sporadic and therefore operators are not always in possession of accurate data regarding the location of vehicles.

It may be that they are mistaking the effect of the speed with which they can get an incident off of <u>their</u> hands, with the overall elapsed time for the dealing with that incident. If they ask for volunteers all the time they effectively lose control of resources and in the long term it is likely that response times to incidents could rise particularly if the 'volunteer system' causes some imbalance in the locations of committed vehicles. On the other hand, they have a valid point regarding the current location of incidents and certainly at times of low work load the general 'volunteer call' may be a more efficient device, but at times of high workload this abrogation of a control function could have serious allocation cosequences. Paradoxically, however, it is at times of low incident occurrence that a specific vehicle is named and at times of pressure when general calls are more likely to be made. The Management Information System evaluation in Chapter Fifteen gives some quantitative support to the existence of these control problems.

CHAPTER EIGHT

LITERATURE REVIEW OF POLICE CONTROL ROOM STUDIES

POLICE SYSTEMS (GENERAL)

The focus of this research is on the task of recording information concerning incidents which are reported to the police by members of the public. This is generally referred to in police circles as 'incident logging'. The importance of this type of information was underscored by O'NEILL(1977) when he puts forward the common sense point of view, that police forces cannot be everywhere at once, and therefore rely on the public to provide them with information concerning crimes and other incidents for which they are responsible. Ian WYLIE (PACTEL 1976) in a survey carried out for the Winnipeg Police Department in Canada suggests that approximately 75% of all calls for police service arrive via a telepohone system to a police control. He also suggests that at certain times of the day nearly 100% of communication with the police from members of the public is initiated by telephone.

The data which is collected by the Communications Officer when incident logging, forms the basis of the information used in all the management information computer systems which are currently being developed. The Dorset Police (1978) in a recent LAMSAC seminar stated that incident logging was the basis of their command and control computer system, and similar statements concerning the importance of accurately collected data for both the immediate operational response and also the longer term strategic reports have been made in a number of papers, e.g. MORGAN (1978), COMRIE and KING (1975) and FARR (1974) of the Police Scientific Development Branch. The last of these was probably one of the most detailed design evaluations to be carried out on the current wave of computer systems in the British Police Service. The author Tom FARR specifically refers to the quality of logged incident information as a major aspect of the performance criteria. The central role of incident logging in both command and control and the basic nature of both the command and control sub-system (as it is now called), and the incident logging component are exemplified in a recent report by the Police Scientific Development Branch rationalising its approach to independent police computer systems, BLESSED (1977).

Sue NOAKES (née BLESSED) has developed for the P.S.D.B. a model of management information systems which operates on three levels. The first level being the command and control sub-system whose essential components are an incident logging facility and some form of resource (policeman and vehicles) allocation. The report sees police computing as progressing up through the three levels.

Level 1 is a relatively tactical use of information and has been entitled the 'What is' stage, at level 2 the information obtained is used to develop some idea of trends both from a time and also a geographical vantage. This level has been tagged the 'What will' phase. Finally the last level involves what will obviously be a form of simulation, but also provide very detailed question and answer data bases and has been tagged the 'What if' phase.

Essentially all of the projected stages of computer development sit on the same basic information, but make a gradually more sophisticated use of it. As Miss BLESSED states in her report the concepts of command and control and M.I.S. are very new to the police service, and most forces are either on the first level, or tentatively exploring the possibilities of the second.

All of the command and control computer installations so far produced have been carried out under the direct auspices, or with the guidance and advice of the Police Scientific and Development Branch of the Home Office. Naturally therefore, that body has been in the forefront of commissioning research into the problems encountered in changing manual command and control systems, into those assisted by a computer facility. A lot of work has been aimed at ascertaining the type of incidents that occur, as in the studies of urban work loads by COMRIE and KINGS (1975), and ARKEL and KNIGHT (1975). Other studies have concentrated on equipment design in control rooms, some of which will be described later in the section on ergonomics. The job of the control room operator has been considered in three major reports, FARR (1974) who investigated the Strathclyde (Glasgow) computer system with an attempt to evaluate the relative costs of a manual versus a computer information and control system. PEACE (PEACE et al 1974) who in 1974 conducted what was scheduled to be stage 1 of a work study on the jobs of the operators in the then new Glasgow police system. The whole project was intended to cover three stages, the first one to be the analysis of the current work load of the controllers, stage 2 was the development and evaluation of alternative job designs dealing with the organisational, operational and procedure aspects of a controller's duties, and stage 3 was a modification of the stage 2 recommendations to meet the anticipated requirements of the computerised system. So far only stage 1 seems to have been published. Finally a two-phase investigation was carried out on the control room work loads for the Dorset Police by T.R. IZZETT (IZZETT 1976a, 1976b).

FARR in his report is mainly interested in the time taken to deal with the various task elements of the operator's job. In his section on the quantitative description of performance he isolates three elements (in respect of 999 emergency telephone operators) namely (a) duration of the call, (b) writing and checking time, and (c) delay. From his observations he noted that when a controller had finished listening to a telephone call he had not necessarily finished recording the message on the occurrence form. However, for his purposes he did not attempt to investigate the individual task elements or the skills required to deal with individual callers. He described the job of a controller in extracting information from a telephone caller by saying, 'An incoming emergency (999) call is taken by a controller in the telephone room, who may be a police constable (C), or a Communications Assistant (CA). The controller writes the date, time and incident details on an occurrence form."

FARR therefore infers that the manual system an operator listens to the telephone call and transcribes the details immediately, or at least directly, onto a written message pad.

In his comparison of a hypothesised computer system, and the then manual system, FARR used the data obtained from the manual system as an input into a computer simulation of the new computer system (HOCUS Computer Simulation). He was therefore implying that the same sort of time would be taken for the various task elements in the new computer system as were presently being experienced in the then manual system. This is, however, not a view shared by IZZETT in his later report (IZZETT 1976a page 18), where he says, 'Experience from the Birmingham and Glasgow projects suggest that typing incident logs (on a V.D.U.) takes significantly longer than writing on a note pad.'

The problems of taking a telephone call, and at the same time attempting to make a permanent log of the information being obtained, was noted in the first paragraph of the report by PEACE et al. (PEACE 1974). His major objective in this particular stage of the report was to look at overall work loads and in doing so he made the following comments:

"There are other reasons why careful consideration must be given to the levels of work associated with the controller's job. In recent times there has been a move towards the introduction of computer based command and control systems into the Police Service. Unfortunately this has had the effect of increasing the controller's work load further, since a computer based command and control system requires him to enter details of incidents into the computer as they become available. Experience in the Birmingham computerised command and control system has shown that at busy times such as late on Friday and Saturday evenings the controllers frequently cannot deal with the number of incidents occurring and concurrently record them on the computer. Thus manual records - brief notes on message pads - have to be kept and the information entered later when the incident work load diminishes. This practice, which does not record the true situation at such times, degrades the integrity of the information in the system. For example, details of times of occurrence and deployment are not always accurate and some incidents are never entered into the system."

The view taken by PEACE in this report, is that in the move from a manual to a computer based command and control system, increases the amount of work that an operator has to do concerning any one incident, and therefore, at times of peak load the increased burden becomes too much and he resorts to other procedures. There still remains however, the implicit assumption, that at times other than under peak load conditions, it is quite possible to make out either a manual or a computer log directly from, and concurrently with, an emergency telephone call.

PEACE, in what is probably one of the more perceptive Home Office Reports, however, was well aware of the difficulties in a controller's job which he describes in the following manner.

"The controller receives his information by various means of communication from different sources, e.g. telepohone, from within the division, and the general public, U.H.F. radio from patrolling officers and V.H.F. from the control room. The reliability which can be placed on the information varies significantly depending on its source and the quality of the communication's link. The controller is therefore operating under conditions of uncertainty which result in a high risk of error. In this way a stressable environemnt is likely to be generated which is then exacerbated by the unpredictability of the incident work load. The study has shown that general patterns of work exist, including the obvious heavy work load periods on Friday and Saturday evenings. There remain, however, periods of high activity which are difficult to predict.

In view of these problems the controller's job must be so designed that he has sufficient time to elicit the maximum detail from his source of information, including time for elucidation when the communication is unintelligible.

Additionally, a provision should be made as far as is possible to enable him to function efficiently when an unexpected influx of incidents occur."

PEACE et al noted that controllers changed their method of dealing with calls dependent upon the amount of pressure that they were currently experiencing. He carried out some experimentation and was eventually able to produce a formula which fitted the observed data,

His equation suggested that the time taken to deal with any particular incident is inversely proportional to the number of incidents handled by the controller. It also suggested that there is a minimum handling time of about 2.3 minutes. BISSERET (1971) noted similar changes of operator strategies under load in a review of Air Traffic Controllers.

IZZETT in his survey of the Dorset system was given the brief to evaluate the job of control room operatives, to decide whether or not to amalgamate the telephone answering task with the radio control task. He carried out an extensive survey using activity analysis, observation, self recording booklets and ran further simulations using the Hocus package. Once again the orientation was mainly towards operations research, and no psychological or ergonomic work was carried out. Incidentally he did make the following observations regarding the tasks of a control room operator. Quoting a personal communication with FARR, of the Police Scientific Development Branch, he said that a typing speed of approximately 10 to 12 words per minute (using the formated screens of the Glasgow system) had been observed. He also stated that, 'It was arbitrarily assumed that for half the time taken to answer a telephone call the operator would simultaneously be typing an incident log. This seemed intuitively reasonable, and no data was available from any other source.' These parameters of typing speed and writing time were used as the input to the simulation system using the Hocus package.

Some reports indicate doubts about the accuracy of the data entered on the message logs. There seems to be certain reservations concerning the efficacy of present manual systems. HARRISON (1979b) in a survey of a sub division in the Devon and Cornwall area, found that an attempt to carry out a survey, using a historial review of incidents recorded on the message log, had to be abandoned in its original form due to inaccuracies in the message logs. He was able to accurately cross-check the attendance of personnel at the incidents. He found that this information was highly suspect and therefore threw doubts on the efficacy of the information in other parts of the message log, (i.e. description of the incident, etc.) (Personal communication G. HARRISON). PEACE, FARR and IZZETT (Ibid) all independently refer to the probability that numbers of messages are never recorded.

The official position, nonetheless, still seems to be that in any new command and control system, it is quite practicable for a telephone operator to listen to a telephone call and simultaneously type the details of the caller, and sufficient description of the incident onto a computer display. This assumption is made in the following reports. WYLIE (1976), WYLIE (1978), McNEIL (1978), ADAMS, FLEET AND O'BRIEN (undated), O'BRIEN (1973), IZZETT (1976). and FARR (1974). This view is made explicit in the first bulletin issued by the Suffolk Constabulary at the inception of their command and control system in 1976 (Suffolk Constabulary 1976). They described the activities upon the receipt of a message in the following terms:

> What does command control mean? The prime task of any police force is to protect life and property, preserve law and order, prevent and detect crime. In the majority of incidents involving any of these activities, members of the public report to the police station details of the occurrence. This is received by the control room officer who in turn directs some police resource to the incident. He must also make a written record of the occurrence and eventually note the result of police action, index it and then file it away for future reference. A command and control computer is there to help streamline this procedure. In a Force with divisions the size of ours, it is impossible for any controller to know exactly what resources are available, where they are and their state of availability. Again, the computer will help. Every time a report of an incident is received, the controller will be able to start a log on a visual display unit (V.D.U.). A pro forma

> will be displayed for the controller to complete. Together with this he will be shown a full list of all resources within striking distance of the incident and the state of their availability. The incident, once recorded by the controller, will never be lost and can be recalled almost immediately regardless of whether it happened today, yesterday, weeks or years ago. By specifying one or more of a number of details of the incident, the controller can quickly recall the log even if he is not sure of every detail. The computer will also ensure that each log is completed correctly.
>
> All of this! - and the controller has not been required to make any written message and there has been no indexing and no filing.

The originators of this publicity leaflet for the Suffolk Constabulary were very sure of their facts when they stated that it would be possible to input messages into the computer system without resorting to any paper system. A similar information bulletin produced in October 1975 for another police project, (Staffordshire Police 1975), made a similar claim.

> The present system of message recording is to write out the message on a form or pad. The computerised system will be similar in as much as the message will be written on the V.D.U. screen. A message form will be presented on the screen and the operator will <u>simply fill in the headings</u>. This message will then be stored in the computer until it is required. (The underscoring is mine.)

Staffordshire Police, however, have gone a little further than their contemporaries. In their third bulletin (Staffordshire Police 1977), they produced the following artist's impression of the new control room consoles. These have been specifically designed to ensure that there is no surface which can be used for writing. The system has been designed to Home Office specifications by the industrial design firm of Murdock and Gibbs Limited. (Fig. 8.1)

Fig. 8.1 - Design Sketch for Staffordshire Police

Communication Officer's Console

Ergonomics

The rise of the computer and the need to consider human interaction with it, means that the number of human attributes which must be studied by the Ergonomist is expanding to include not only physiological characteristics but also psychological ones (NICKERSON 1969, SHACKEL 1969 and ASHTON 1973). The psychological considerations can of course cover the full gamut of that subject from the attitudes of users to various types of terminal, to the cognitive requirements of a human being trying to work with a computer system.

The mental capabilities of human beings attempting to interact with a computer system is an area which we will need to consider carefully as such systems proliferate. A term, 'Cognitive Ergonomics', became popular during 1978 in the Information Display Unit of the Department of Applied Psychology at Aston University. This rather apt term is a major focus of this thesis, and it will therefore be used to describe attempts to apply the growing knowledge being acquired by cognitive psychology and similar disciplines. In some ways it may be considered to be an applied branch of cognitive psychology.

Although there is a growing awareness of the need to consider man's cognitive ability when designing computer (man/machine) interfaces, most of the ergonomic work in this area still concentrates on the physical aspects of the interface.

Chapter Eight cont.

Police - Ergonomic Research

Certainly the most significant and celebrated use of ergonomics in the Police Service has been the collaboration between the human factors group of the Police Scientific Development Branch at the Home Office, and the Department of Design and Research at the Royal College of Art , London. Under the Project leadership of John WOOD (R.C.A.) and Denis O'BRIEN (Home Office) a series of studies has been carried out into the design of console, mainly in the Glasgow and Strathclyde area, but also including the West Midlands and Dorset Police systems. The resultant systems have been the subject of a large number of articles and papers, (WOOD 1974 - 1978), (WOOD et al 1974 - 1978), (COMBES 1976/7), (NORTHEDGE 1977), (Strathclyde Police 1977 A 1977 B). The Strathclyde Control Room is certainly the show piece Information Room of the Service, and it is frequently demonstrated to hundreds of senior police officers from the U.K. and throughout the world.

Most of these papers describe a methodology which was put together by the R.C.A. team and has been succinctly detailed in the number of papers presented by John WOOD , (1976 A, 1976 B, 1976 C). WOOD effectively evaluated the specification which he was given concerning the job of a control room operator, and used a whole battery of ergonomic and related techniques to provide himself with a model of the activities of a control room, emphasizing in particular the physiological capabilities of the operators. These techniques included systems analysis, the use of models, ergonomic rigs (mock ups), sketches, tick lists, link analyses of physical activities, photographs and full scale prototype trials.

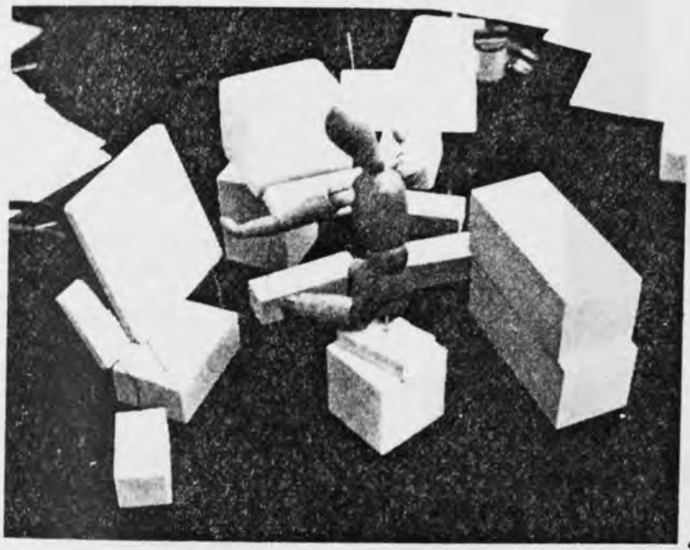
The original system at Strathclyde was designed to cater for 22 radio channels, 60 telephone terminations, and two computer display systems per console, together with a miscellany of ancillary equipment.

Exhaustive measurements were made of the physical characteristics of that somewhat specific portion of the population which is selected to enter the Police Service, (in fact using service personnel of the required height rather than actual policemen), and the equipment was all designed to cater for these anthropometric measurements. Extensive work was aimed at ensuring that displays and controls were grouped according to use and function, and that the legends both the VDU's and controls were easily used. Meticulous attention was also paid to the environment, illumination and general physical comfort of the controllers. Control rooms had previously been designed in a rather ad hoc manner by local policemen, or sometimes never designed in total at any one time, but rather grown in a topsy like manner. The approach undertaken by the Home Office and their contractors was fundamentally different. This is certainly the view held by both the Home Office and the R.C.A. In the introduction to his paper presented to the 6th Congress of the International Ergonomics Association 1976, John WOOD (Ibid) states that with an industrial designer and ergonomist making up the design team, the incorporation of ergonomic principles at the outset was ensured and ergonomics was the dominant theme throughout the design programme.

Clearly all these studies made dramatic visual improvements to the consoles. Figure 8.2 shows some of these improvements, together with some of the mock-ups used in the design process. Figure 8.3 illustrates some of the experimental keyboards used during rig testing.

1

3



2

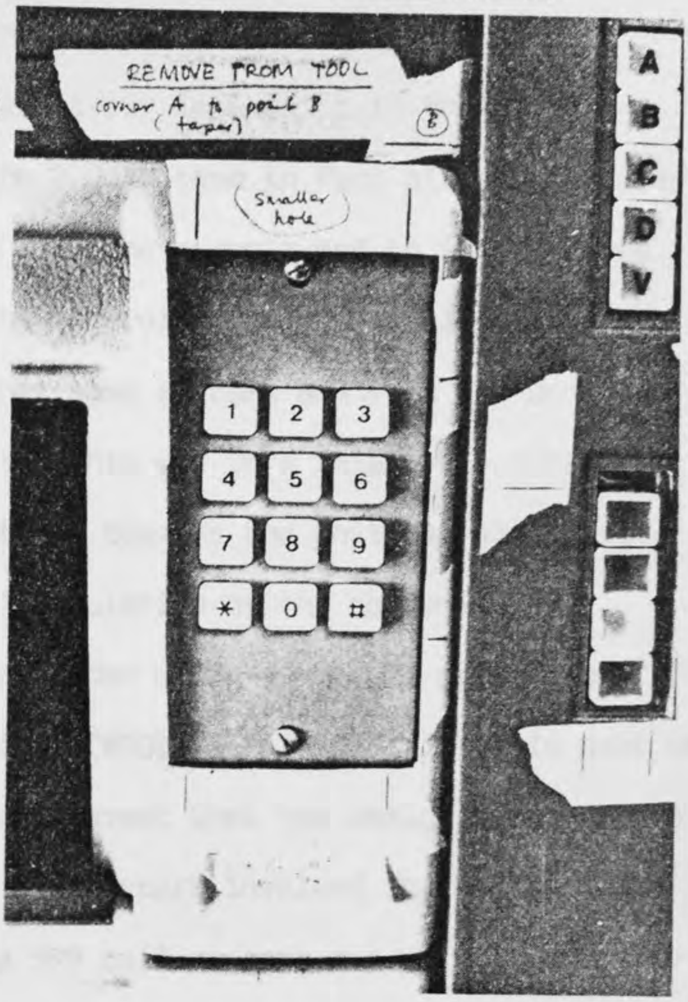
4

1. Old control room, Glasgow City Police. 2. Ergonomic model. 3/4. Officer trying out two test rigs. 5. The eight consoles grouped in a semi-circle: note how layout helps minimise bulk of left hand visual display unit.

Fig. 8.3 - Elements of Ergonomic Technique on Console Design

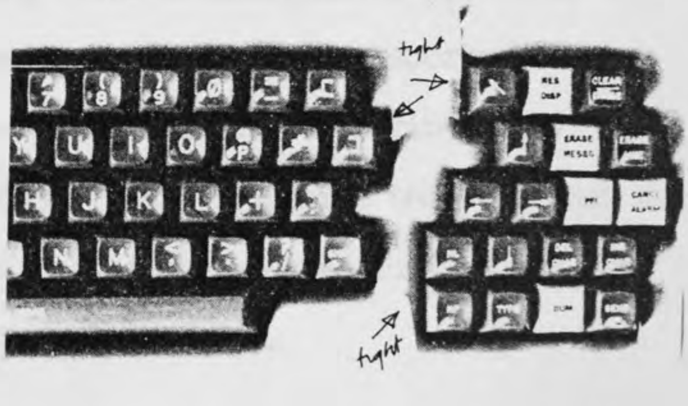
Telephone Key Board

All key boards set in moulded abs facia panels



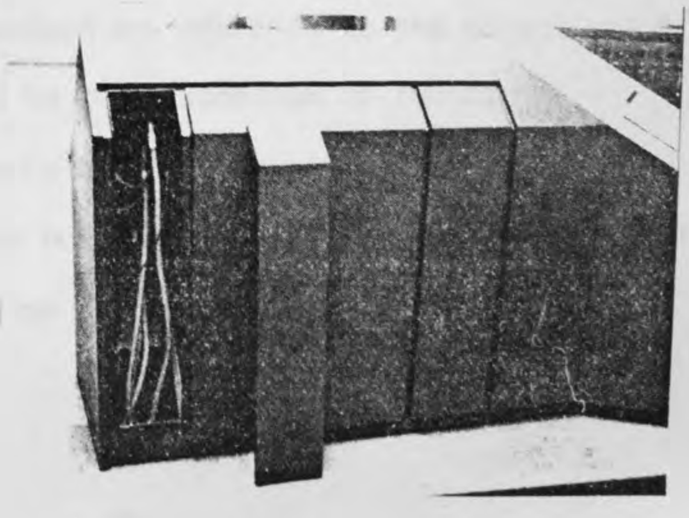
V.D.U. Key Board

Notes indicating design comments on the rig



Rear of Consoles

Showing attention to servicing requirements



A major drawback to the effect does seem to be the fact that the application of ergonomic principles was, contrary to WOODS' statement, brought in at a relatively late point in the design stage. The brief given to the R.C.A. team in fact already detailed the hardware which was to go into the console and to a very large extent the task content of the controller's job was already predetermined. It is true that some systems analysis was done of the controller's activities but this was in a relatively cursory manner which was again orientated towards the physical aspects of his movements and actions. A simulation of the controller's activities was carried out in London using a mock-up of a number of potential console configurations (WOOD et al 1976 f). This part of the research was certainly the nearest that the design team came to evaluating the capabilities of operators involved in the jobs of information collection from a 999 call or resource allocation. The team, at various stages during their investigation, did carry out observations in control rooms, but no comment is reported of information overload or input difficulties as described previously in PEACE (1976) and FARR (1974). This is despite the fact that the two projects were apparently running contemporaneously under the auspices of the same Home Office Department.

None of these reports contain any reference to the objectives of the Control Room operator or to the allocation of functions. Similarly there are no comments upon the cognitive aspects of an operator's abilities to carry out the tasks he has been given. The orientation of the research has been toward the physical environment, and the Home Office contracts which have been awarded have in the main been aimed at either 'knobs and dials' ergonomics, (R.C.A. Reports etc.) or at the physical environment (COX and SCHIRO 1978).

SUMMARY TO PART II - PRELIMINARY INVESTIGATIONS

The importance of the incident log data as the major precursor to both the operational and management information systems within the Police is ably supported by the published views in most of the reports mentioned, in addition to the comments from Devon and Cornwall senior officers and the Project Team. The position of the control rooms as the major gateways through which this information enters the organisation is further supported by the results of Force-wide message survey. These are relatively unexceptional findings and reinforce what most senior officers would have supposed. More surprising indications arise from an examination of the efficacy of the data which enters the Database, particularly the accuracy of the manual systems and the effect of any changes in technology.

There are few reports which attempt to evaluate the accuracy of information passed to police officers over the emergency system. The qualitative indication by Harrison is that there may be considerable inaccuracies in the message logs reports; there is no quantitative evidence to support this statement at the present time and it must therefore be considered an important area for me to investigate.

The further question to be asked is does a change in technology in the control rooms in any way effect the ability of an operator to effectively collect the information. The major design premise in this area which underlies both the present manual system and all of the existing and proposed computer systems is that it is quite possible for an operator to effectively collect information from a telephone call and transcribe it concurrently onto either a manual or a visual display format. FARR certainly considered that this could be done and implied stated that no design changes were required concerning the operators' task in a transferrence from a manual to a computer system. IZZETT did notice some activity differences, but presumed that the effect of these was in no way sufficient to throw in doubt the major design foundations upon which the whole system in Dorset was based. The major doubts from an official source come from the reports by PEACE et al who openly state that at certain times operators were unable to cope with the message input format. PEACE's view was that this was probably mainly during busy periods and was due to a cumulative overload brought about by a large number of incidents occurring simultaneously. The preliminary investigation which I have carried out tend to suggest that all operators within the Devon and Cornwall Constabulary do not use message logs even in a manual system. This must be considered odd as it is unlikely that they are going to find a computer system format more easy to use than the relatively simple manual message log, in fact this point is made by IZZETT. In addition the fact that they do not only employ the scrap note mode of operation at busy times may throw some doubts on PEACE's view that the overload solely occurs at busy periods. It could well be that the sub tasks of an operator's job in answering a single telephone call are sufficient to cause him overload if he also has to take on board a message log format. There are however other possible explanations of the Devon and Cornwall operator's behaviour. It may be that they have simply got into a habit of taking messages in this way. In any event, the fact that this mode of message taking is so wide spread strongly suggests that there should be serious doubts about the ability of operators to collect information on line. These doubts are strong enough to warrant further in depth investigation. The findings of the preliminary investigation substantially support the suppositions of the Project Team members concerning the usual operation in the Control Rooms.

The major emphasis of the Home Office reports has been on the physical aspects of both the Control Room environment and also the message taking task. The work which has been carried out has been generally of a high quality and very necessary. However the possibility that Control Room tasks involve a high cognitive load has been ignored. In addition, the Devon and Cornwall operators emphasised the mental aspects of their tasks during their responses to the interview schedules. They mentioned these problems more frequently than any reference to the physical difficulties of the job. The qualitative statements made in the section of chapter seven under "Observations" further emphasises the considerable mental input that an operator brings to his task. The idea that operators simply transcribe information from a telephone call onto a formatted log seems to be a considerable over simplification. This simplified view of the operators' task has very serious ramifications now that it has been implemented as a major design principle into multi million pound computer systems. It would be relatively inexpensive to change the mode of operation of the present manual systems, but to attempt to change a computer system is likely to be very much more costly and disruptive. It is therefore essential that this area be adequately researched in depth, before the proposed Devon and Cornwall computer system is designed. Such an investigation is the major objective of the next six chapters which form the in depth section of this thesis.

The following is a provisional list of the activities which an operator carries out during and immediately following the reception of an emergency call.

Suggested Operator Activities During Call

1. CONTROL CALL	Control the flow of information during the course of the control call and try to impose a structure on the communication.

2. UNDERSTAND INFORMATION	Understand the information being supplied (often under conditions of high acoustic noise due both to poor equipment and on occasions to environmental conditions at <u>both ends of the line</u>). (Also the semantic content of a message may be difficult to discern because of stress, lack of time, or poor education of the caller.
3. CLASSIFY	Make a classification decision concerning the type of incident, its urgency and the appropriate initial action.
4. DEVELOP STRATEGY	Take appropriate initial action (or consider taking such action before the end of the call). (In these circumstances the operator will often despatch a vehicle in the general direction of the incident and then later follow up with more detailed information).
5. NOTES	Make a note of appropriate salient information. (These are the scrap pad notes).

Part II summary cont.

6. HELP CALLER	The operator also has a duty to reassure the caller and on occasions to cause them to take appropriate action under his direction.
7. WRITE REPORT (LOG)	Make out a full description of the incident as initially described. (The target audience for this paper is mainly third party officers).
8. DESPATCH	Despatch resources or confirm initial action.
9. BACKUP INFORMATION	Supply backup information and support where necessary.
10. CONTROL	Supervise the running of the incident and the close down of the initial action phase.
11. LOG RESULTS	Log results of initial action.

Items 1 to 6 are carried out during the course of the call.

Items 7 to 10 usually immediately or soon after its completion.

The uses of the Message Logs are:-

1. A note of salient details (for the purposes of initial actions - resource allocation etc.)

2. A control document and a record of initial action (usually taken within the first few hours of message receipt).

3. A description of the incident written so as to be comprehensible by a third party (briefing of other officers and supervision by senior officers).

4. A source of statistical information.

THESIS PLAN

PART 1: INTRODUCTION

PART 2: PRELIMINARY INVESTIGATIONS - PERCEIVED PROBLEMS

PART 3: IN DEPTH INVESTIGATION OF PROBLEM AREAS

PART 4: SOLUTION EXPLORATION

PART 5: CONCLUDING SUMMARY

PART 6: BIBLIOGRAPHY

POLICE ENTER COMPUTER AGE

Brum.

CHAPTER NINE

ACTIVITY ANALYSIS

The objective of the investigation in this chapter was to ascertain the type of activities undertaken by an operator whilst dealing with a 999 call. The emphasis is therefore on an analysis of the physical characteristics of the task, particularly the time taken to complete various processes.

I have also included at the end of the chapter some brief details of a more general survey of overall workloads.

Method - first investigation

An initial investigation was mounted in which I observed the actions of operators immediately following their reception of a 999 call. The actions were coded and timed according to a set of protocols which I developed. The timings were then tabulated and graphed. The observations were carried out on a randomly selected number of days during March 1979, on a series of shifts designed to give a reasonable coverage of all times of the day.

A number of difficulties were discovered with this particular exercise, the main one being that because emergency calls tend to be relatively sparsely distributed throughout the day, there were many periods which yielded little observational data. However, when a large number of emergency calls occurred in a relatively short time, a single observer was only able to deal with one or two of them. It was plainly of no use timing a call sequence unless it could be timed from beginning to end.

Method - Second Investigation

In order to overcome the above difficulties a second system was set up in which the Plymouth Control Room was observed using CCTV cameras supplied by the Police Technical Support Unit from Almondsbury.

The method used was to focus the CCTV camera on a 999 operator for a number of pre-selected periods during September and October 1979. The CCTV camera was provided with an extremely accurate time/date insert and the films were analysed using the previously protocols mentioned. This new procedure enabled extremely accurate measurement of time as the actions of an operator could be frozen and moved along at single frame intervals.

At the same time, a general sample of the operator's activities over a complete 80 hour period was taken and coded at intervals of five minutes. (It had been intended to cover it for two complete 80 hour periods but the cameras were removed as they were required for a major crime.)

The initial settings of the camera had been intended to provide a fish eye of the complete room, with a focus on one particular operator. The rationale behind this was that if he should leave his console to go to some other part of the room it would be possible to specifically code his movements in that respect. Unfortunately this was not possible due to the fact that it would have involved a number of civilian operators, and it was intimated that there might be Union objection. In view of this possibility and as that particular facet was only peripheral to the investigation, the focus of the camera was maintained on the police officer who was the 999 operator. (There was no objection from the Police Federation in this respect, after consultation with the Local and Force Representatives.)

Using these facilities a total of fifty-six calls were analysed, rather less than had been hoped. Twenty-nine calls using the manual method and twenty-seven calls using the television observation. There was good agreement between the results of the two methods, despite the fact that the timing of the television system was very much more accurate. The results are in line with the relationships noted during the overall activity sampling (see next section).

Analysis

A summary of the findings of the post-call analysis using the second method can be seen in Table No. 9.1 and a graphical representation of the same data is shown in Figure 9.3. Figure 9.2 shows an example of a single call.

Table 9.1

Summary of Operators' activities during initial phase of 999 call receipt

Type of activity	Average time for activity over all calls (seconds)
999 call	67.00
Calls	23.81
Write notes	52.78
Write logs	168.33
Read notes	1.04
Read logs	9.74
Communicate to PS	20.56
Communicate to W/T op	26.52
Communicate to other	0.19
Access log file	41.19
File logs	20.48
Access other file	2.30
Leave console	11.63
Eat	0.26
Other action	14.15
Time taken to answer 999 call	8.33
Elapsed time until end of initial phase	507.44
Average time per word	3.84

Table 9.2

Example of the process coding of a single 999 call (from PRINT PROGRAM)

Type of activity	Time in seconds	Call No. 13	Disturbance - 38 Words
999 call	38		
Write notes	52		
Write logs	161		
Communicate to PS	38		
Communicate to W/T op	27		
Access log file	8		
File logs	4		
Leave console	15		
Other action	66		
Time taken to answer 999 call	3		
Elapsed time until end of initial phase	461		
Average time per word	4.23		

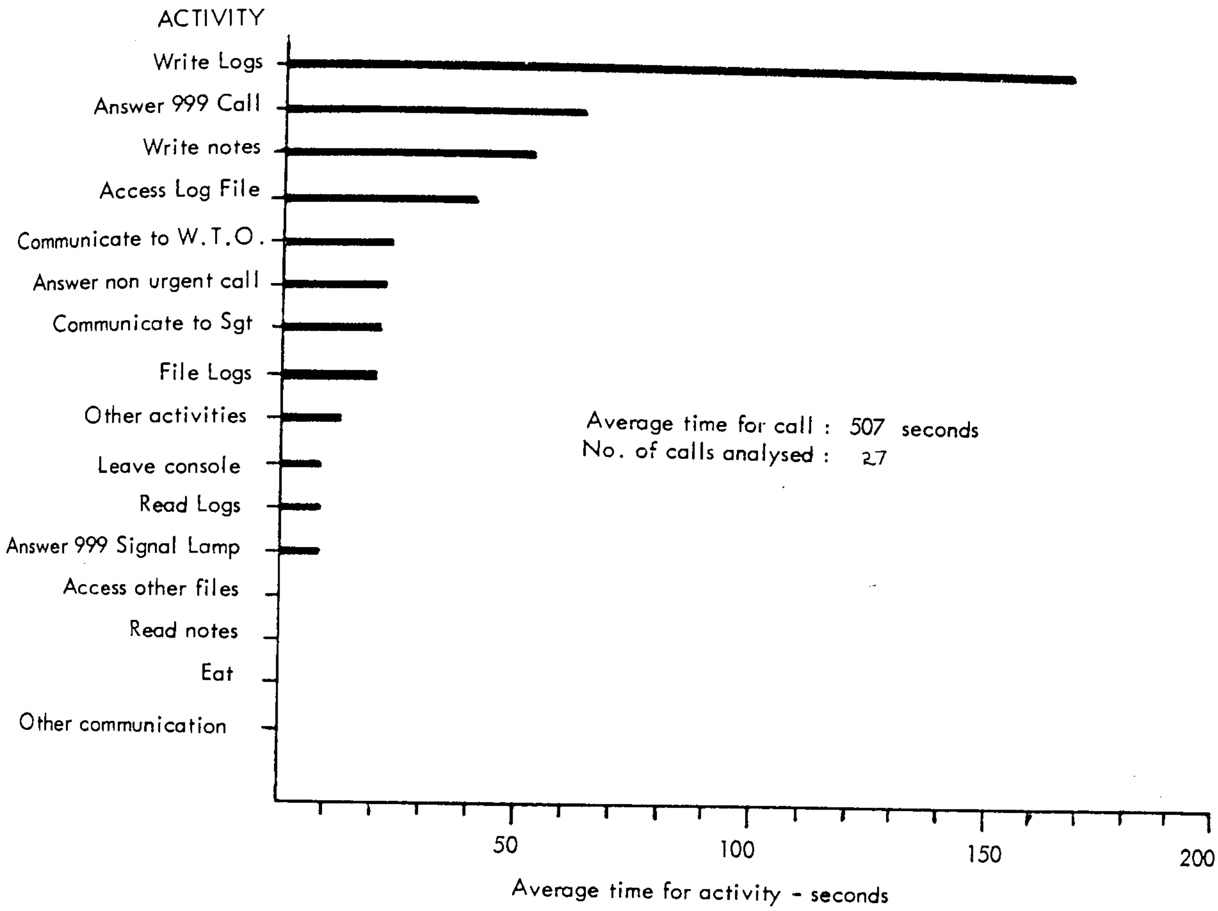


Fig. 9.3 Operators activities during initial phase of 999 call.

Discussion

It can be seen from these results that time taken to answer and deal with the immediate aftermath of a 999 call is in the order of nine minutes. Of this, just over a minute is taken up with the actual call itself, and nearly three minutes with the writing of the log. The writing of notes and the taking of the call are in most cases parallel activities whereas all other activities take place in serial order. In this particular analysis the average time to write a word on the log was found to be 3.8 seconds and this seems to be consistent with other findings in this thesis. (This is approximately sixteen words per minute for this manual system).

Relatively little time seems to be spent reading either the notes or the logs, although this particular finding may be subject to some reservation as it is rarely easy for an observer (under these conditions) to be certain that an operator is not actually glancing at his notes if no head movement takes place.

A note of caution also should be introduced with respect to the overall times. One of the difficulties which was noted during this investigation was that as calls came in during heavy periods it frequently transpired that the writing up of even the initial phase of the log was delayed whilst a second or subsequent 999 call was taken. It then became very difficult to distinguish to which of the calls an operator's subsequent actions should be related. This was particularly true of the CCTV analysis where it was not possible for the observers to alter their position in response to any moves within the control room. Consequently, calls during busy periods where operators were dealing with multiple calls were excluded from this analysis. It may be possible that such calls have characteristics which are somewhat different from calls which are accepted in singular fashion. Casual observations of the operators did not suggest that there was any significant difference but it remains a possibility.

Conclusion

It can be seen that on average the operators take 168 seconds to write their logs against approximately only 67 seconds to accept and deal with the call. This would seem to contradict the suggestion that it was possible for an operator to complete a log concurrently with a call. It is likely if he were forced to follow that course of action, log writing activities would be even slower, as it would then be necessary to interpolate them with his other task of interacting with the caller. It seems a reasonable hypothesis that the reason why most operators adopt the strategy of taking notes during the call and subsequently producing a written log message in a serial fashion, is that this is likely to be the most efficient mode of action, certainly when making a written record.

Overall Activities

The more general analysis of operators' activities throughout his working period can be   by the 960 observations which were taken over an 80 hour period using the CCTV camera.

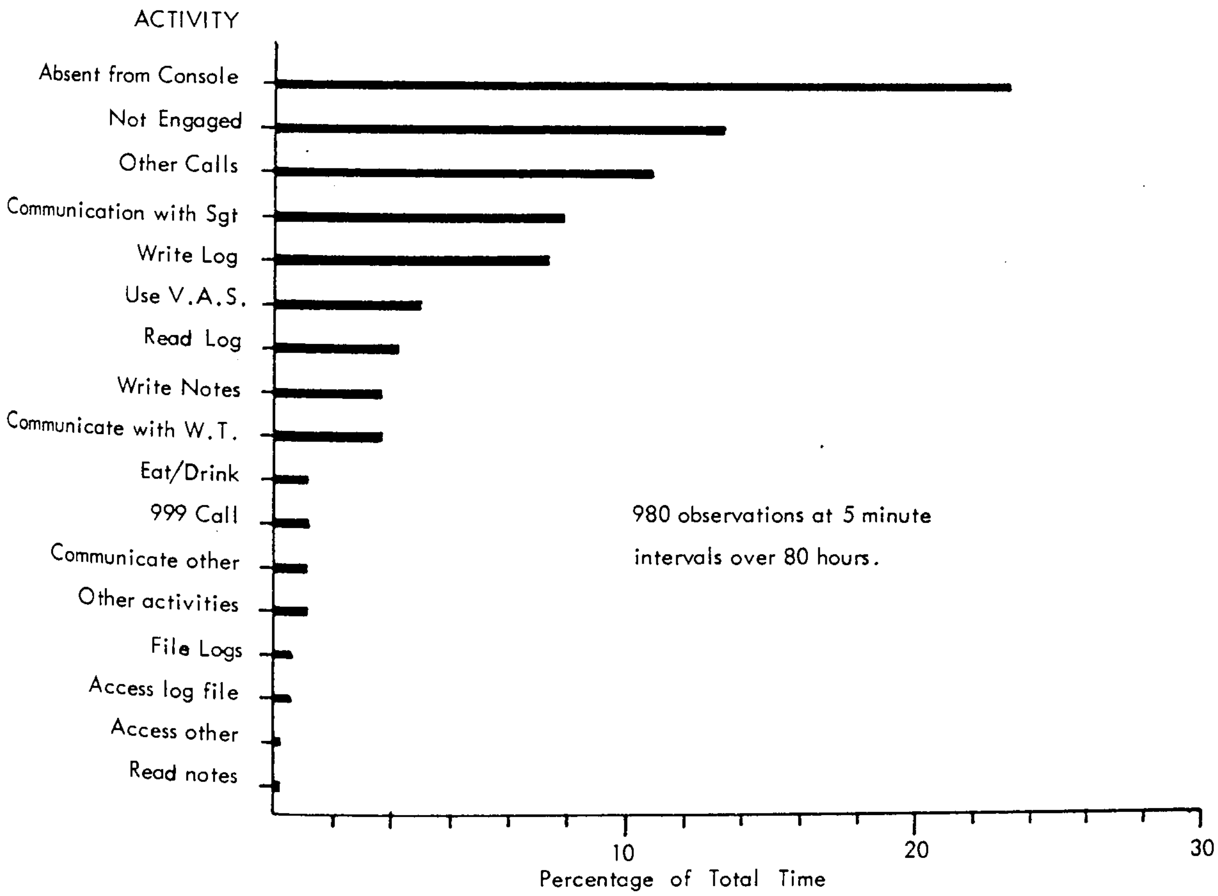


Fig. 9.4 Analysis of operators overall activities

Figure 9.4 shows a distressingly high percentage of the operator's time is spent absent from his console. This is obviously an unsatisfactory situation in so far as whilst he is absent, emergency calls will necessarily have to be taken by another, probably less skilled operator away from the main 999 console. It is felt that this finding tends to suggest poor design of this particular control room (Plymouth).

The other major finding is the relatively short amount of time which is actually spent dealing with 999 calls, although the period during which the operator was present in his console and not engaged in any particular activity was rather lower than was expected at something like 14%. The findings suggest that the administration of calls tends to take up the major part of the operators' active time.

Workload Analysis

The major emphasis of this chapter is naturally on ascertaining the specific task elements of an operators' job. However, the overall variations of workload which characteristically appear in the control room situation are of interest as background information. These fluctuations were investigated using two different methods.

Force Survey

The survey which was directed at telephone calls received by various stations throughout the Force (referred to in Chapter 4), also contain the necessary data to produce an indication of the fluctuations in workload which occur over time. In a Force area such as Devon and Cornwall there are three major components of such fluctations. A variation by time of the day, which is by far the largest, a variation by day of the week, and finally changes which occur on a seasonal basis. Figure 9.5 is a histogram illustrating the fluctuations in workload as described by the number of calls received in a control room. The profiles for the other control rooms were all very similar.

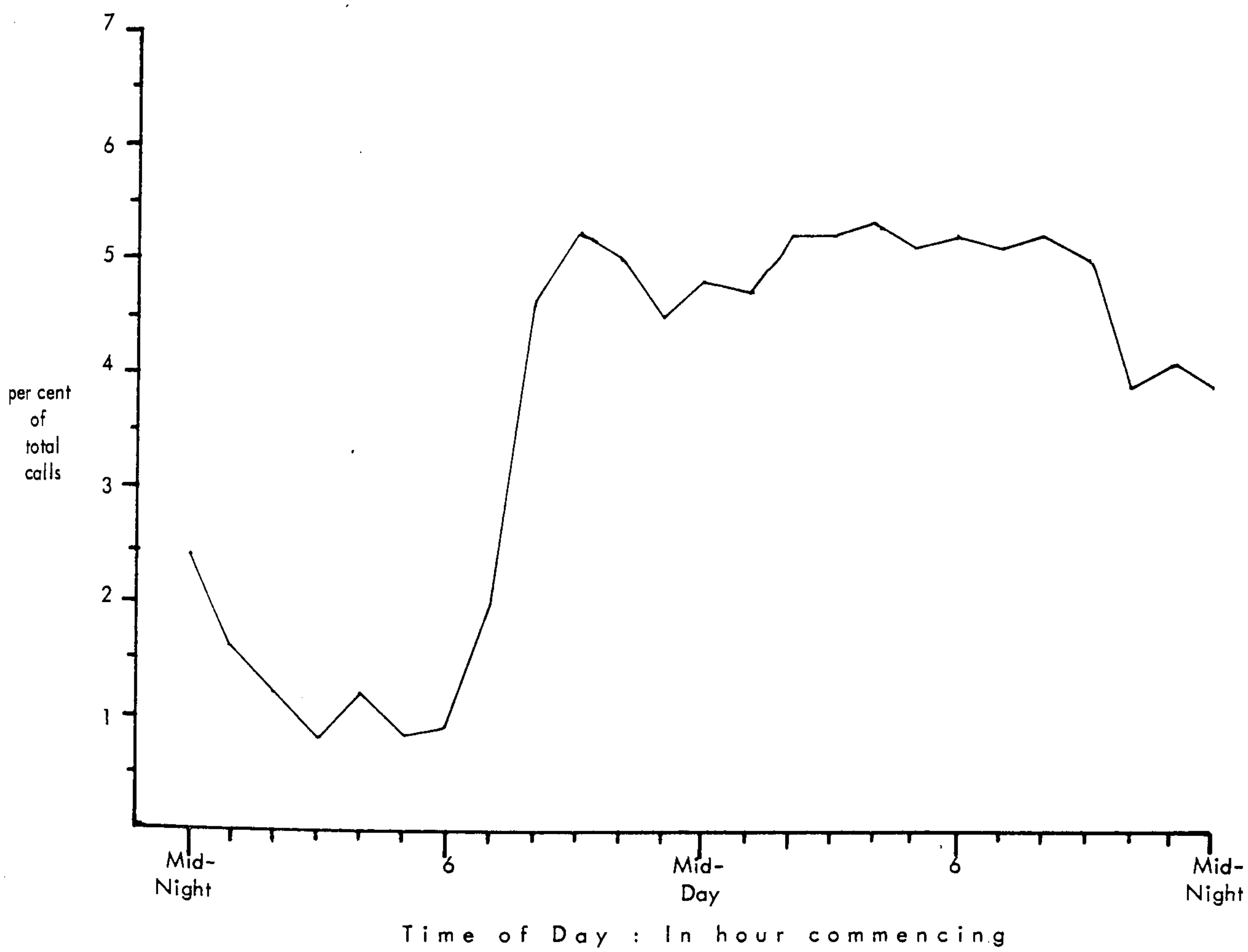


Fig 9.5 Distribution of emergency calls received during a 24-hour period.

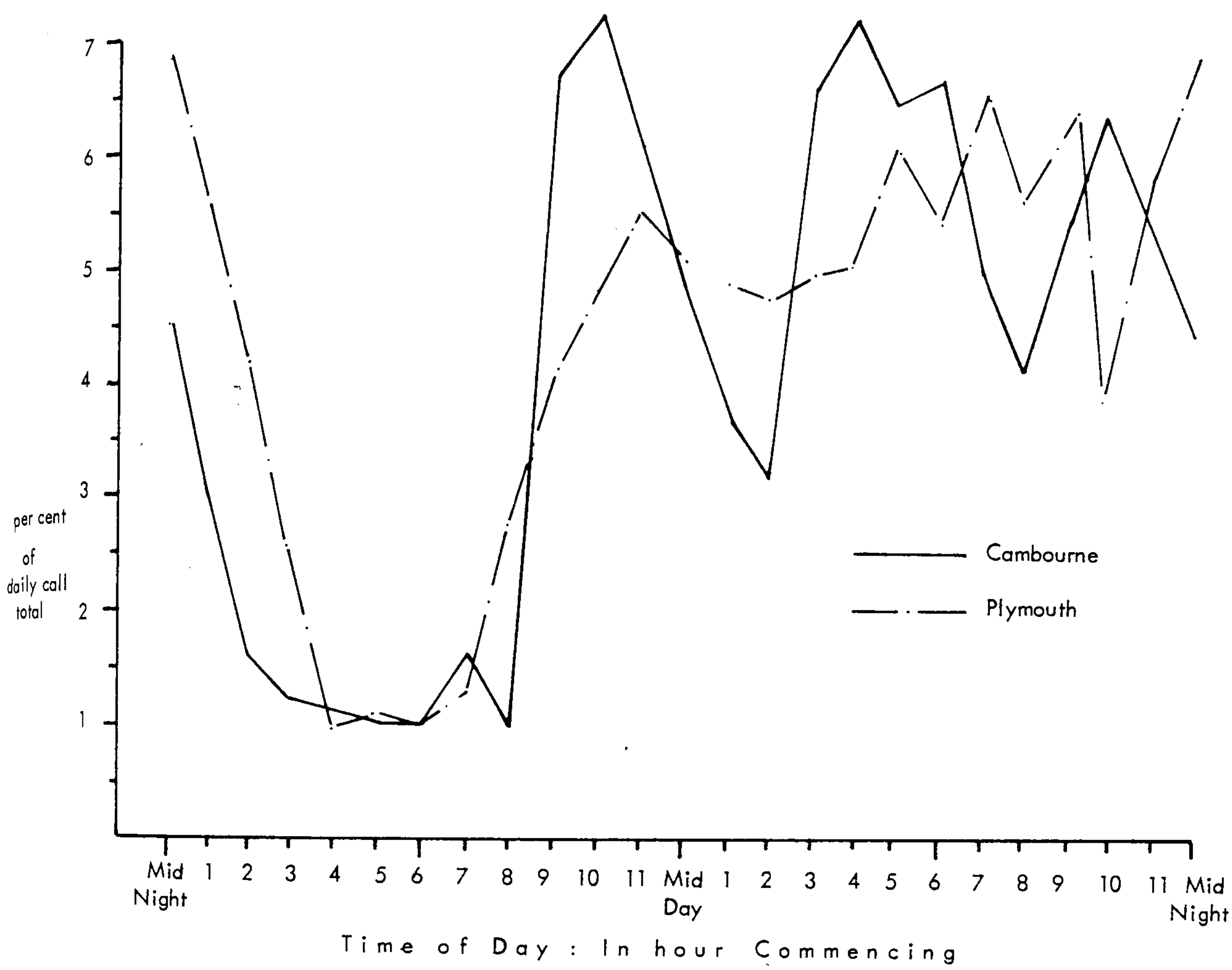


Fig 9.6 Fluctuations in Call workload during a 24-hour period

Manpower - Incident Surveys

Calls which require some form of police response in terms of the despatch of a vehicle etc. (that is mainly 999 calls but includes other emergency telephone calls) tend to show related but somewhat wilder fluctuations. This area was investigated by analysing a large number of incidents in the Camborne and Plymouth Control Rooms. The main objectives of these particular surveys which were carried out during 1976 and 1979 were to ascertain the efficiency of certain shift working systems.

Using a survey system designed by the author the data was collected by Superintendent Harrison of the Research and Development Department with assistance of officers in the Divisions. I undertook the computer and graphic analyses. The data for these two surveys was captured using somewhat different samples. However, the curves are so similar that they suggest very stable factors. The Camborne data consisted of 28 days collected during May 1976, whereas the Plymouth data comprised of 28 days collected from random weeks out of each of the four quarters of the year.

It can be seen that there are considerable fluctuations based on time of day with peaks during the morning, mid-afternoon, and during the evening. As all of these incidents would require action by the operators, it can be seen that there is considerable fluctuation in the rate of call for their services during the course of a day.

Multiplicative Problem

In addition, there may be what I call a multiplicative problem in so far that not only will there be more incidents at certain times of the day, but circumstances may prevail which makes the decision making component of their work slightly more difficult. One of the main tasks of the operator is to match incidents to resources. Owing to the fact that the availability of resources cannot on humanitarian grounds (because of various shift working systems) accurately follow the fluctuations of incidents, the ratio of resources to incidents varies more than the simple periodicy of emergency calls alone. I have called this a workload quotient and it is simply calculated by dividing the number of incidents which occur on average in any hour, by the average resources which are available. This information for the workload quotient is displayed graphically in Figure 9.7.

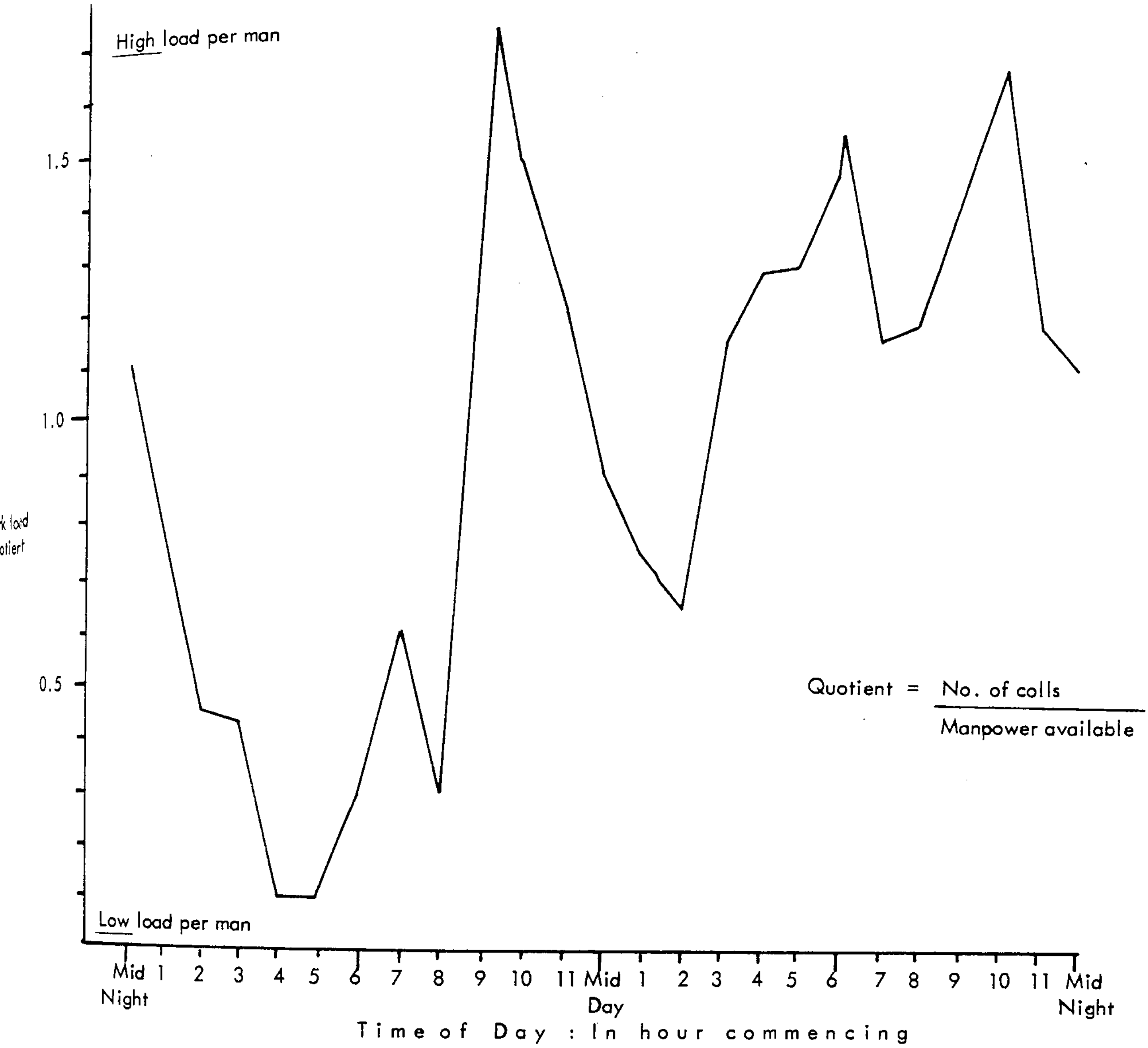


Fig 9.7 Work load quotient as a function of time of day.

It can be seen that the workload quotient is even more peaked than the straight workload graph. This suggests that the allocation problems at, say, 8 o'clock in the morning are considerably more difficult than they are between 3 and 4 o'clock or even between 12 noon and 1 pm.

CHAPTER TEN

EMERGENCY TELEPHONE TRANSACTION ANALYSIS

I decided that an early requirement should be to understand the dynamic processes which might be going on during an emergency telephone call. I was particularly interested to obtain:-

(1) some measure of the complexity of the communication,

(2) an indication concerning the type of information upon which the operator concentrated his main attentions, and

(3) the circumstances and information types which represented the major difficulties as far as information collection were concerned.

I was unable to find any relevant empirical work on police emergency telephone transactions. DEININGER (1963) has carried out a content analysis of telephone calls at Bell Labs. His INNADS system was specifically aimed at the tasks of directing enquiry operator and his coding was task specific.

I therefore devised a system to analyse police calls.

Description of ETTA Instrument

The analysis of the calls was divided into two separate sections,

(a) an evaluation of the whole of each call under various headings (Call Analysis), and

(b) the breakdown of the individual transactions (definition and discussion later), which occur during each call (Transaction Analysis).

A. Call Analysis

Each call was rated under a number of headings:

1. Subject

This concerned the type of incident which was being described by the call. The subject classification is based on a system which has been used for surveys within this Police Force for a number of years, and that survey categorisation was originally based on the actual subject headings used by operators when describing their calls. (The top of each message log has a subject description line.) There was a total of 45 categories in the classification used during this analysis.

2. Coherence

The coherence of the call was rated under two headings. The acoustic coherence and the logical coherence.

(a) The acoustic coherence referred to the strength of the signal which was received by the police operator. It was related to the amount of noise at both ends of this communication line, that is in the control room and also at the scene of the call. The latter situation can often be one of considerable disturbance. In addition it reflected the clarity of the connection.

(b) The logical coherence referred totally to the ability of the caller to explain the reasons why he rang the emergency operator. Naturally certain categories of caller are likely to be less coherent than others. Certainly persons who are under the influence of alcohol, the mentally sub-normal and the emotionally affected, are all likely to have a less than optimum ability to logically explain their difficulties.

Both these coherence measures were rated on an 0 to 7 scale. 0 being the low end of the scale and meaning that the communication was totally unreadable. Naturally the ratings in both cases are subjective assessments by the researcher. (However sub samples were rated by three independent judges and the coefficient of concordance was good).

3. Urgency

The urgency of the call was rated on a similar scale. The urgency relates to the requirement for the police force to take some action on the information being passed. For instance, it is likely that a bank robbery in progress is likely to have a very high rating, whereas a burglary which has occurred at some time over the last three months will have a relatively low rating. If no police action is required then a 0 rating was given.

Two other aspects of the call which it was thought might be relevant to the type of communication and the amount of transactions which went on were:

4. An indication of whether the caller was involved in the incident being reported. The assumption being that a caller who is involved in the incident is likely to have more information than a person who has merely witnessed some aspects of it, and

5. A repeat call. Certain events give rise to a large number of repeat calls, particularly if they occur in a public place, when witnesses will often call the police being unaware that other persons have already reported the incident. In these circumstances the initial presumption was that the police officer would have much less difficulty understanding the conversation, as he would already have had some warning. Also his information requirements would be less, or possibly zero.

TRANSACTION Analysis

I listened to a very large number of telephone calls and slowly refined a system which seemed to usefully define a transaction and also the components within a transaction. The result was a methodology which is as follows.

A transaction was defined as either a change in speaker or a change in the subject.

Each transaction was broken down into five descriptive areas:

(1) the actor engaged in the transaction

(2) the direction of the communication

(3) the type of component

(4) the subject category which is the main topic of that component

(5) the subject details

Table 10.1 shows a lay-out of these classifications including the contents of each descriptive component type.

Table 10.1

Emergency Telephone Transaction Analysis
Call and Transaction Classifications

Overall Call Analysis

Details		Scale
Subject		01 - 99
Coherence	Acoustic	0 - 7
	Logical	0 - 7
Urgency		0 - 7
Details	Caller involved	0 = No 1 = Yes
	Repeat call	0 = No 1 = Yes

Transaction Analysis

Actor	Communication Direction	Component Type	Subject	
			Topic	Details
1 Police	1 Give	1 Information	1 Caller	1 Name
2 Caller	2 Request	2 Elaboration	2 Offender	2 Address (Present/ Near future)
3 GPO	3 Broke off call	3 Positive Feedback	3 Victim	3 Location/ Direction
4 Automatic System		4 Negative Feedback	4 Police	4 Present Tel. No.
		5 Repeat/Confirm	5 Incident	5 Personal Details
		6 Instruction/ Demand	6 Call/ Transaction	6 Time
		7 Pleasantry/ Greeting/ Exit	7 Third Party	7 Description
		8 Non-Informative Emotive Utterance	8 GPO	8 Category/isation
		9 Refusal		9 Action/knowledge
		10 Comfort/support		10 Advice

Actor

The two main persons involved in a telephone communication to a police emergency service are obviously the caller and the police operator. However, other persons or systems do occasionally intrude, the main one being the GPO operator who is often responsible for making the initial connection, and on occasions for explaining to the police officer any unusual circumstances surrounding the connection. The other major actor is in fact a sub-category of the caller, namely automatic alarm systems which produce a pre-recorded voice. It is fairly obvious that the police operator's reaction to a recorded voice is going to be very different from that with a normal caller, (although I have listened to an entertaining conversation between an operator and an automatic system); in the main I have excluded automatic systems from this analysis.

Communications Direction

Only two communications directions were considered, that is giving and requesting. Essentially giving was the volunteering or responding to a reqeust for information. It indicated that the person who was producing that particular transaction component was in fact the source of the information. Requesting is self explanatory in so far as the person using that particular component was requesting information. Naturally in terms of police 999 calls this was invariably the police officer. During the course of the analysis it became necessary to include another category to explain certain perturbations in these calls and therefore a communications direction component entitled "Broke off call" was included.

Component Type

The components type fell into ten main areas. There were initially seven but these once again were gradually augmented during the analysis and the preceding calls were then recoded.

1. Information
   That is a relatively normal transaction of either giving or requesting information.

2. Information elaboration
   This component was used when the information had been previously given and it was necessary to request for the information to be elaborated.

3. Positive feed-back
   This component, which turned out to be very important, was merely some indication that the person at the other end was actually following the conversation.

4. Negative feed-back
   This was an indication that he was not following the conversation.

5. Repeat/Confirm
   This was either a request that the information that had previously been given should be repeated or confirmed in order to ascertain that it had been obtained correctly; or alternatively many operators would repeat information which had been given to them, on the understanding that the caller would interrupt if their repetition turned out to be incorrect.

6. Instruction/Demand
   This is self explanatory.

7. Pleasantry/Greeting/Exit
   This was a component which was intended merely to cover those categories of pleasantries which are frequently used in verbal communication.

8. A non-informative emotive utterance
   This rather long winded definition was intended to include all of those exclamations which occasionally punctuate this type of communication, e.g. 'Oh my God', or 'For heaven's sake', or on occasions somewhat stronger language.

9. Refusal
   This is merely a refusal to supply information.

10. Comfort/Support
This was a category which was included to cater for the police officer's actions in attempting to console and comfort certain callers, in order that he could get them to a state of coherence which was sufficient for him to gather certain necessary information.

Subject Topic

This will obviously vary according to the main discourse which is being considered. In the area of police 999 and emergency telephone calls the topic can be broadly divided into two areas:

(1) describing the persons involved in the various incidents which are taking place, and

(2) concerning the situations which are being considered or described.

The persons fall into the following categories:

1. The caller
2. The offender
3. The victim
4. The Police
5. A third party (usually a witness)
6. The G.P.O.

The situations under discussion are usually:

(a) The incident
(b) The call-transaction.

Subject Details

Each subject topic can have appended to it a number of subject details which are described as follows.

1. Name
2. Address
3. Location/direction (present or near future)
4. Present telephone number
5. Personal details
6. Time
7. Description
8. Subject category - this category was employed to explain the fact that callers will often start a call by stating a type of quasi-legal definition which they consider encompasses the incident, e.g. 'There has been a house breaking', or a 'murder', or a 'bank robbery'. Their definitions do not always coincide accurately with any legal or police operational definition.
9. Action/knowledge.
10. Advice

Transaction Coding

The methodology used is that one item from each of these five columns can be used to describe a particular transaction. Invariably at least one item from each column is used although on occasions only items from 1. and 2. are necessary. This is particularly true in the case of feed-back requests. Therefore, for instance, the transaction involving a police officer who asked of a caller,

'Where did the accident happen?',

would be described using the transaction classification as

Police-Request-Information- Incident-Location.

It can therefore be seen that there are a great many potential combinations available to describe the transaction components (about 13,000). However, not all such combinations would constitute a sensible sequence.

The first three columns of the classification focus on the dynamics of the communication, and the last two are specifically orientated towards the information content of that particular transaction. The first three components could be used for any similar communications analyses, whereas the subject dependent items at the end of the transaction analysis would vary greatly depending on the subject area being considered.

Fig. 10.2 shows an example of a coded call:

Fig. 10.2 - Example of a coded call using the ETTA system (from PRINT PROGRAM)

CALL SUMMARY CALL NO. 20

SUSPICIOUS CONDUCT	3
ACOUSTIC COHERENCE	5
LOGICAL COHERENCE	4
URGENCY	6
CALLER INVOLVED	NO
REPEAT CALL	NO
THE CALL LASTED	88 SECONDS

TRANSACTION NO.				TRANSACTION DETAILS		
1	POLICE	GIVE	INFORMATION		POLICE	NAME
2	CALLER	GIVE	INFORMATION	RE	INCIDENT	DESCRIPTION
3	POLICE	REQUEST	INFORMATION	RE	INCIDENT	LOCATION/DIRECTION
4	CALLER	GIVE	INFORMATION	RE	INCIDENT	LOCATION/DIRECTION
5	POLICE	REQUEST	INFORMATION	RE	INCIDENT	LOCATION/DIRECTION
6	CALLER	GIVE	POSITIVE FEEDBACK			
7	POLICE	GIVE	REPEAT/CONFIRM	RE	INCIDENT	DESCRIPTION
8	CALLER	GIVE	POSITIVE FEEDBACK			
9	POLICE	GIVE	POSITIVE FEEDBACK			
10	POLICE	REQUEST	INFORMATION	RE	CALLER	NAME
11	CALLER	GIVE	INFORMATION	RE	CALLER	NAME
12	POLICE	REQUEST	INFORMATION	RE	CALLER	ADDRESS
13	CALLER	GIVE	INFORMATION	RE	CALLER	ADDRESS
14	POLICE	GIVE	POSITIVE FEEDBACK			
15	POLICE	REQUEST	INFORMATION	RE	CALLER	PERSONAL DETAILS
16	CALLER	GIVE	INFORMATION	RE	CALLER	PERSONAL DETAILS
17	POLICE	GIVE	REPEAT/CONFIRM	RE	CALLER	PERSONAL DETAILS
18	CALLER	GIVE	POSITIVE FEEDBACK			
19	POLICE	REQUEST	INFORMATION	RE	OFFENDER	PERSONAL DETAILS
20	CALLER	GIVE	POSITIVE FEEDBACK			
21	POLICE	REQUEST	INFORMATION	RE	OFFENDER	NAME
22	CALLER	GIVE	INFORMATION	RE	OFFENDER	NAME
23	POLICE	GIVE	NEGATIVE FEEDBACK			
24	CALLER	GIVE	INFORMATION	RE	OFFENDER	NAME
25	POLICE	GIVE	REPEAT/CONFIRM	RE	OFFENDER	NAME
26	CALLER	GIVE	POSITIVE FEEDBACK			
27	POLICE	REQUEST	INFORMATION	RE	OFFENDER	ADDRESS
28	CALLER	GIVE	INFORMATION	RE	OFFENDER	ADDRESS
29	POLICE	GIVE	REPEAT/CONFIRM	RE	OFFENDER	ADDRESS
30	POLICE	GIVE	POSITIVE FEEDBACK			
31	POLICE	REQUEST	INFORMATION	RE	OFFENDER	ACTION/KNOWLEDGE
32	CALLER	GIVE	NEGATIVE FEEDBACK			
33	POLICE	REQUEST	INFORMATION	RE	OFFENDER	ACTION/KNOWLEDGE
34	CALLER	GIVE	POSITIVE FEEDBACK			
35	POLICE	GIVE	POSITIVE FEEDBACK			
36	POLICE	GIVE	INSTRUCTION/DEMAND	RE	CALLER	ACTION/KNOWLEDGE
37	POLICE	GIVE	PLEASANTRY/GREETING/EXIT			
38	CALLER	GIVE	POSITIVE FEEDBACK			
39	POLICE	GIVE	PLEASANTRY/GREETING/EXIT			
40	CALLER	GIVE	PLEASANTRY/GREETING/EXIT			

METHOD

Recording equipment was installed in the Crownhill Control Room and attached to the 999 operator's 'key and lamp' console (similar to Fig 2.1) to enable the recording of both sides of the conversation during a 999 call. Using this apparatus a large number of calls were recorded during the early part of 1978. A random sample of calls was selected from these recordings and I then listened to each individual call and manually coded the transactions. This invariably meant that each call was listened to on approximately five occasions to ensure that the various transactions were adequately understood. Many of the transactions occur in such a short space of time that only by repeated play-back is it possible to distinguish them from the preceding and subsequent transactions. Finally the calls were then played through and timed and rated on the scales of acoustic and logical coherence and urgency etc.

A total of 208 calls were treated in this manner.

RESULTS

A number of programs were produced to input the data and perform certain analyses, tabulations etc. on it. These were then used to place the data into a computer data base which consisted of two separate files, one for calls and one for transactions there being as previously stated 208 calls and a total of 6,047 transactions.

A number of tabulations were performed; one a complete listing of the entire file giving a call summary and then a run-down of the transactions which transpired in that call. This listing was used for a sight analysis of the data to ascertain whether any peculiarly overt manifestations could be distinguished. Next the listing of every type of transaction was produced together with the number of hits that that transaction type received and its relative percentage of the total number of transactions. This particular list was sorted in a number of ways based on subject matter and frequency. It was found that of the potentially very large number of transactions in fact only 340 were ever used.

A simple run of frequencies found for each of the various components of the transaction analysis was tabulated and this can be seen in Figure 10.3.

Table 10.3 - Summary of all transaction components (etta system)

Overall Components	Component Type	Number of Transactions	Percentages
	Participants		
	Police	3141	51.94
	Caller	2756	45.58
	GPO	122	2.02
	Automatic system	28	0.56
			100.00
	Direction of Communication		
	Give	4987	82.47
	Request	1044	17.26
	Broke off call	16	0.26
			100.00
	Type of Communication		
	Information	2876	47.56
	Elaboration	218	3.61
	Positive feedback	1377	22.77
	Negative feedback	166	2.75
	Repeat/confirm	809	13.38
	Instruction/demand	112	1.85
	Pleasantry/greeting/exit	435	7.19
	Non-informative emotive utterance	29	0.48
	Refusal	6	0.10
			100.00
	Subject		
	Caller	1520	25.14
	Offender	225	3.72
	Victim	166	2.75
	Police	633	10.47
	Incident	1285	21.25
	Call/transaction	90	1.49
	Third party	71	1.17
	GPO	29	0.48
			100.00

Table 10.3 cont.

Information Details		
Name	835	13.81
Address	618	10.22
Location/direction	437	7.23
Present telephone number	121	2.00
Personal details	124	2.05
Time	44	0.73
Description	911	15.07
Incident category	67	1.11
Action/knowledge	788	13.03
Advice	52	0.86
		100.00
Total transactions	6047	
Average number of transactions per call	29	

A TOTAL OF 208 EMERGENCY CALLS WERE ANALYSED IN THIS RUN

A slightly more detailed look at the subject aspects of the transaction analysis was tabluated and this is shown in Figure 10.4.

Table 10.4 - Subject emphasis of call transactions (Percentages)

	Subject Description										
	Name	Address	Location/Direction	Telephone No.	Personal	Time	Destination	Category	Action/Knowledge	Advice	Total
Subject Topic											
Caller	12.52	11.31	2.56	2.76	1.28		.50	.05	6.77	.15	37.90
Offender	.53	.23	1.13		1.05		1.83		.83		5.60
Victim	1.33	.90	.43	.03	.65		.48		.30		4.12
Police	6.02		.05	.18	.05		.08		9.51		15.89
Incident	.08	2.93	6.47		.03	1.08	19.04	1.18	.18	1.08	32.07
Call/Transaction		.05	.13	.03		.03	.70	.45	.78	.05	2.22
Third Party	.35	.08	.20	.05	.03		.10		.98		1.79
GPO	.13				.03		.13		.42	.03	.74
TOTAL	20.96	15.50	10.97	3.05	3.12	1.11	22.86	1.68	19.77	1.31	100.00

Notes: (i) See Table 10.1 for description of ETTA System
(ii) Feedback and similar transactions which do not have a specific subject are not included in this table

A detailed look at the characteristics of the call overall, that is the subject matter, the logical and acoustic coherence etc., was tabulated and can be seen in Figures 10.5 and 10.9. The details of Fig. 10.6 are also shown in graphical form in Fig. 10.10.

Table 10.5 - Effect of Subject Matter on Call Parameters

Subject of Call	Call Parameters			
	Hits (N)	Duration of Call (Secs)	Average Number of Transactions	Logical Coherence
Crime	49	64.65	34.00	4.90
Other Offence (not Traffic or Crime)	8	67.50	36.25	4.85
Suspicious Conduct	14	61.21	26.36	5.21
Vandalism	12	49.92	27.67	4.67
Crime Prevention	5	50.80	29.80	5.60
Useful info re Crime/Offence	7	71.29	30.00	5.43
Public Order	16	35.44	24.31	5.13
Road Traffic Accident	25	43.00	26.49	5.76
Floods/Fallen Trees/Obstructions etc	3	30.33	18.00	5.00
Traffic Offence Report	1	90.00	48.00	5.00
Vehicle Destruction/Breakdown	2	108.50	37.50	4.00
Advice on Law/Crime	5	30.80	20.60	4.40
Advice on General Matters	2	19.50	12.00	5.50
Directions/Locations/Local Knowledge	3	73.67	20.67	3.33
Results of Cases &/or Earlier Reports	1	20.00	10.00	6.00
Sudden Death	1	42.00	29.00	6.00
Missing Persons	3	83.00	45.33	4.67
Mental Health	2	58.00	30.00	4.00
Welfare/Social Service Matters	1	94.00	48.00	3.00
Fears for Person's Safety	3	83.67	49.67	5.33
Domestic	6	73.00	40.00	3.50
Civil Matters (usually legal)	1	51.00	20.00	6.00
Illness/Injury	1	32.00	20.00	5.00
Non-Road Traffic Accidents	1	44.00	30.00	5.00
Lost/Found Property	3	33.00	27.33	4.67
Animals/Lost - Found - Straying	1	23.00	11.00	4.00
Burglar Alarms	7	36.14	17.86	5.57
General Nuisance Complaints	9	55.89	29.00	4.44
Fire or Bomb Report	2	46.50	25.50	5.00
Hoax or no Reply	6	33.00	23.17	5.50
Other	4	389.75	32.00	3.40
TOTAL	207			

Table 10.6 - Effect of urgency upon call parameters

Urgency Rating	Hits	Time (Secs)	Average Transactions	Logical Coherence
0 Non-Urgent	11	46.64	23.91	4.27
1	13	69.38	31.69	4.08
2	10	85.40	06.60	5.10
3	26	59.58	29.12	4.77
4	24	57.46	31.25	5.19
5	32	58.44	33.44	5.19
6	49	48.53	28.12	5.00
7 Very Urgent	42	42.98	25.67	5.36
TOTAL	207			

Table 10.7 - Difference between repeated and non-repeated calls

Repeated Call	Hits	Time (Secs)	Average Transactions	Logical Coherence
No	193	55.90	30.03	4.95
Yes	14	33.00	19.36	5.36
TOTAL	207			

Table 10.8 - Effect of acoustic coherence upon call parameters

Acoustic Coherence Rating	Hits	Time (Secs)	Average Transactions	Logical Coherence
0 Poor	1	86.00	39.00	0.00
2	7	82.43	35.43	4.29
3	8	32.63	33.13	3.63
4	32	57.44	32.63	4.22
5	89	54.91	28.21	4.84
6	68	47.41	28.60	5.76
7 Good	2	36.00	11.00	8.50
TOTAL	207			

Table 10.9 - Effect of logical coherence upon call parameter

Logical Coherence Rating		Hits	Time (Secs)	Average Transactions
0	Poor	1	86.00	39.00
1		2	132.00	54.00
2		7	73.57	36.86
3		18	71.67	36.56
4		26	65.00	32.27
5		71	49.51	27.65
6		73	48.62	27.51
7	Good	9	47.44	22.33
	TOTAL	207		

Fig. 10.10

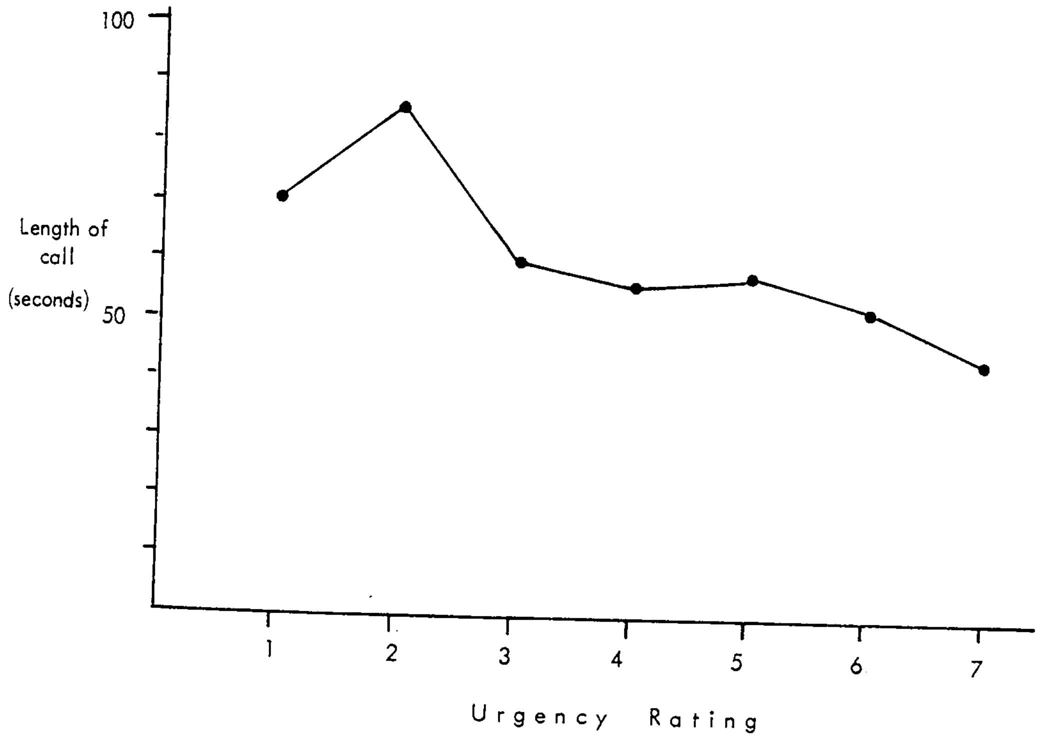


Fig 10.10 Effect of Urgency on Length of Call

DISCUSSION

The first thing to be noted in the Figure 10.3 is that the number of transactions is relatively high for what is supposed to be a relatively simple call. The average number is 29 transactions per call and this varies between a high of 89 and a low of 3 with a standard deviation of 14.1.

The standard deviation seems to be quite large and certainly as will be discussed later there seemed to be some significant differences between the number of transactions and the time spent on various calls based on a number of other parameters which affect the call, such as subject and acoustic coherence etc.

The police officer is apparently responsible for slightly more transactions than the caller. A large number of both the police officer and the caller's responses were simply positive feed-back transactions, the police officer providing nearly twice as many of these as the caller (833 to 478). The single category of positive feed-back in fact accounts for 23% of the call transactions.

The direction of communication provides some surprises in so far as only a very small percentage of the conversation involves any questioning. This would suggest a relatively passive role for the police officer, or at the very least, a sifting, sorting strategy rather than an intervening and directing one. These findings are very much in line with the comments made by judges in the Semantic Analysis investigation (Chapter 12), where they complained about the inadequate level of interrogation. The evidence from the real (live situation) logs in this chapter and Chapter 12 is supported by the results of the Simulation Experiment (Chapter 17) where poor interrogation and low information content in the resultant logs was noted in an experimental setting.

As might be expected the majority of requests were in fact made by the police officer. Of the 17% of total transactions which constitute requests for information 2% came from the caller and the remaining 15% from the police officer. The majority of caller requests were for advice or directions of various kinds.

The main finding with regard to the type of communication, are the relatively low percentage of communications both from the caller and the police officer which is directly concerned with the passage of information. A surprisingly high number of the transactions referred to pleasantries and greetings rather than the gathering of information.

A purposive element which does have a fairly high rating is the 'Request to repeat and confirm information' which takes up approximately 13% of transactions. Requests to elaborate on information which has already been given are fairly low at just over 3%.

Topic

The major topic in the conversation is in fact the caller rather than the incident itself. This reflects what might be suggested to be an orientation of the police officer to obtain identification details rather than detailed information concerning the incident being reported. The incident however follows fairly closely taking up 21% of the transactions.

Information concerning the police themselves is the next highest category with all other topics being very low on the list of priorities. The topic of 'police' is probably artificially boosted by the fact that on most calls the police officer will report details of the emergency service immediately after the initial connection in order to reassure the caller that he is speaking to the correct service. This activity accounts for nearly 4% of the 10% of 'police' transactions.

The actual subject details within the topic categories seem to break down into three areas. The first is information which has some form of identifying criteria, e.g. name, address, or location etc., and the second is some indication of the type of incident which is being discussed and finally there are various peripheral matters such as the imparting of advice or knowledge etc.

The largest single category is in fact the one of 'Description' which makes up 15% of all transactions. Of this 15% over 12½% is entirely concerned with a description of the incident, which is as may be expected.

The identifying criteria whose main objective is presumably to locate the incident in order that a resource can attend are made up of the categories of 'Name', 'Address', 'Telephone Number' and in most cases location direction and personal details. These categories together account for 34% of all transactions.

Difficulty in Extracting Information

I looked closely at the categories of 'Repeat', 'Confirm' and 'Request for elaboration', to provide some indication as to that information which was difficult to obtain, or perhaps alternatively which the operator considered to be so important that he had to obtain it to a high degree of reliability. Of the 'Repeat/confirm' transactions approximately 410 related to identifying criteria such as names and addresses or locations, against only 98 referring to the description of the incident. The requests for elaboration concerning identifying criteria were very low indeed with approximately 41 requests for elaboration concerning the identifying criteria, and 31 requests for elaboration concerning descriptions of the incident (out of a total of 6,047 transactions).

Overall Call Characteristics

Figures 10.5 to 10.9 refer to the call characteristics overall. Figure 10.5 shows a tabulation of the call subject categories against the total number of calls of that nature, together with average length of the call, numbers of transactions and the logical coherence. The average times vary quite considerably as do the number of transactions.

Acoustic Coherence Rating

The acoustic environment appears to have an effect on the duration of the call. The average time reduces from approximately 82 seconds for incidents with a poor acoustic coherence rating to less than half that period for calls with a good rating on coherence. The effect on the number of transactions is slightly less marked. The correlation between the amount of time taken and the acoustic coherence rating was carried out and Pearsons r for the correspondence between acoustic coherence and time $= -.18 (P < .014)$. Pearsons r for correlation between acoustic coherence rating and the number of transactions was $-.15, (P < 0.05)$. Weak negative effects which are statistically significant.

Repeat Calls

The tabulation in Figure 10.7 on the subject of repeat calls shows a fairly obvious effect in respect of both reduction in time and number of transactions with respect to repeat calls. This would tend to support the hypothesis that the operator is more able to quickly orientate himself when he already has some prior knowledge about the subject of the call. In all probability he also requires less information.

There is small relationship between repeat calls and logical coherence. This may indicate that an officer who is in full possession of the facts is less likely to cause confusion in the call by asking irrelevant questions.

Urgency Rating

The urgency rating is tabulated in Table 10.6 and also graphed in Figure 10.10. It can be seen that there is a modal distribution of the 'time taken to deal with a call', over the range of incident urgency. The moderately urgent calls are dealt with at a relatively leisurely pace compared with the calls of high or low urgency, which are completed expeditiously.

I would suggest this is due to two separate effects. At the very low end of the urgency rating the time taken to deal with the call is relatively short. I felt that in the main this was due to calls which were not essentially of an emergency nature and operators were tending to tell the caller to terminate the call, perhaps to reconnect on a non-emergency line. The reason for this reaction is that there is only a limited number of emergency lines into the police control rooms and unnecessary usage of them could potentially delay a genuine call. I investigated this hypothesis by checking those calls with an urgency rating of 1 or below and I found that for ten of them the call was curtailed by the operator taking this form of action (two of the remaining 14 calls were abusive).

The calls with an urgency rating of 2 to 7 show a linear drop from 85 seconds to an average of 42.9 seconds as the message becomes more urgent. Initially this seems to be very reasonable, however, when one considered the position of the operator there is no objective reason why he should deal more quickly with an urgent rather than a non-urgent call. There is no reason to suppose that urgent calls require him to obtain less information concerning the incident than less urgent calls. He can normally despatch resources to an incident before the call is terminated and therefore it should not be a question of him having to complete the call before he can start to take responsive action (although in some control rooms this is not as easy as it should be).

It would seem that the operator is being affected by the obvious expectation of the caller, that matters be dealt with expeditiously. Although there seems to be no objective reason why the call itself should be dealt with more quickly, this effect on the operator may be causing him to fall into the habit of quickly curtailing such calls. My investigations of the raw messages in a number of cases involving urgent calls suggest that the collection of useful information was often neglected in these instances.

Logical Coherence Rating

Many of the operators when being interviewed (Chapter 7) gave examples of the callers who were agitated and excited, and therefore whose coherence was generally poor. They seemed to have the impression that this was one of the major reasons why it was difficult to collect 999 calls on line.

An investigation of the logical coherence ratings of the 207 calls so far analysed suggest that this is probably not a major contributory factor to the difficulty of obtaining 999 calls. Only 13% of the coherence ratings were below 3 (on a 0 to 7 scale) and only 5% were rated below a value of 2. There does however seem to be an interesting relationship between the coherence rating and various subject matters, e.g. domestic disputes tend to have a low coherence rating on the part of the caller. This is presumably because it is often the wife who is reporting the fact that she has just been assaulted by her husband and therefore naturally her ability to logically state her problem is impaired by emotion and shock etc. Three may also be relationships between the coherence rating and the acoustic rating, (see Figure 10.8), suggesting that people's ability to logically order facts can be affected by poor communication links. The average transaction time seems to vary very little over the range of logical coherence ratings.

Difficulty in Retrieving Information

The level of difficulty in retrieving different aspects of information, may to an extent be inferred by the number of communications which concentrate on that particular subject matter. In this respect previous comments concerning the preponderance of transactions pertaining to the caller's name and address etc., are relevant. The two elements of the analysis which were specifically aimed at this problem, namely 'Request for the elaboration of information' and the transactions which repeated, confirmed or requested a repetition or confirmation of particular items of information, should indicate where the major difficulties lie.

The gross number of transactions involving elaboration were very low, about 3.6% of the total conversation; the number of transactions involving requests for repetition or confirmation of information were somewhat higher at 13.4%. This once again indicates a relatively passive role on the part of the operator in so far as he is repeating or confirming information already given, rather than requesting elaboration or probing for new information which has not been supplied.

A break down of the transactions involving the police officer and repeat/confirmation activities shows that the majority of them involved him giving a repeat/confirm transaction. In this case it would be something like, 'Did you say 2 to 6 Lansdowne Place, love?", rather than a question such as, "Could you repeat that address, love".

The number of requests for information which concerned location or other identifying intelligence was more than four times the number of transactions which involved the description of the incident.

When one considers the transaction involving elaboration, quite naturally there were hardly any in which the police officer gave elaboration of the information. The number of requests were very low and were spread relatively evenly between elaboration of the details concerning identification (as above) and descriptions of the incident.

Observational Notes

During the course of attending to these calls I maintained a record of any particular event which seemed to be relevant and which might throw light on the more empirical findings. Some of these are appended below.

Strategies

One police section seemed to deal with the calls faster than the others. A cursory analysis of their work suggested that they neglected to obtain as much information as some of the other operators and they tended to despatch a vehicle to all incidents. This cut down the amount of interrogation required of the caller, but of course meant that the resources of the organisation were more regularly committed. On one of the series of tapes, the operators of this section had to repeatedly inform callers that there were no vehicles available to respond. As I was not in the control room at the time of these incidents I was not in a position to say whether or not their lack of resources was due to bad management on that particular occasion, but such a suspicion must be there, given the general strategy.

Early Information

Whilst monitoring the taped calls for this investigation, I noted that frequently when a caller gave his name and address early in the conversation, the operator ignored that information until he had ascertained the gist of the call. He would then ask the caller for those details again. I decided to investigate the hypothesis that these actions might comprise a coherent strategy. The results of that enquiry are recorded later in this chapter.

Terminations of the Call

As stated previously, it seemed that many operators were positively affected by the emotion and urgency of particular calls. This was evident to an extent where in certain calls they neglected to gather quite important information concerning the location of the incident or the nature of an offender, despite the fact that as far as could be judged this information could have been obtained from the caller. In addition, when officers seemed to be under pressure they tend to make a greater use of devices to reduce the amount of information that they have to collect, such as writing 'anon' on the caller's address, despite once again the probability that the caller would have supplied a name and address if requested.

It was noted that on a number of occasions when the police officer made a serious hash of his interrogation of the caller, in the main because the caller was agitated and the operator then terminated the call with only sufficient information to despatch a vehicle despite once again the probability that more information could have been obtained, had not an emotional conflict arisen between the operator and the caller.

Feed-Back

I noted that some operators failed to provide feed back to callers and this seemed to have an effect on the caller's efforts to pass the information. It was natural to assume that if a caller was unsure whether the operator was following his story, he might increase his efforts to pass his information. I decided to investigate this further by comparing the total number of transactions in a call with the number of feed back plus confirmatory transactions.

The results of this analysis indicated that there was a positive linear relationship between the number of ordinary transactions to the number of feed back transactions. This effectively negates the hyothesis which would require a negative correlation, to suggest that calls which have less than the average number of feed back transactions should be longer than those in which feed back was more generously given. The correlation between the two scores Pearsons r of Total Transactions with Feedback Transactions was 0.856, $p < .001$.

Decision Process

The police officers invariably completed calls with details of the police action to be carried out. This suggests that they had at least partially made up their minds concerning the action, possibly including the categorisation of the call. The majority of the calls included some indication from the police officer of the action that the police would take.

Call Maintenance Procedures

As discussed elsewhere in this chapter, call maintenance transactions such as greetings and exits seemed a very high proportion of the call. Nearly all calls had a larger than anticipated exit routine with both the police officer and the caller saying 'goodbye' or indicating that they were about to terminate a number of times. In quite a large number of calls it was noted that this exit routine was entered and to all intents and purposes the call was about to terminate, then either the police officer remembered some question that he had not asked, or more often decided that he wanted to re-affirm information which he had already obtained. In addition, on a few occasions the caller suddenly brought up some new information when he realised that the call was about to be terminated. In each of these cases the call once again started with a further question and answer sequence, often going over the same ground as that previously covered in the main body of the call.

To some extent this suggests that the control of the call had not been particularly well planned. It also says something about the degree of ambiguity of the information which the police officer was trying to collect. I would suggest that it points to possible utility of improved training methods and operator aids which will be discussed in later sections of this thesis.

Local Knowledge

The local knowledge of the police officer is important in a number of ways. Quite often a police officer, because of prior knowledge concerning a particular type of incident or a particular caller, is able to short circuit the question and answer routine.

In some ways his strategy can then be similar to an officer who has received a repeat call in so far as he has prior knowledge of the type of incident which is being reported, and therefore can go immediately to the salient aspects of the incident.

On the negative side of police knowledge there seems to be a caller expectation that most communication rooms are local and therefore they often give information, particularly about locations and also about persons and offenders etc., on the presumption that the police officer has a fairly detailed knowledge of the locality. Unfortunately in this day of centralisation, most of the control rooms are often many miles away from the caller, for instance the Camborne control room covers from Penzance to a position east of

Truro, that is over half the whole county of Cornwall. It is therefore unlikely that any officer has detailed local knowledge of the whole area. This is another area where control room aids may be of assistance.

ADDITIONAL ANALYSES

The initial analyses threw up a number of questions against which I then mounted some additional lines of enquiry.

Operator Strategies

I was interested in ascertaining whether any particular strategies were adopted by the police officers in their attempts to deal with a call, and also whether callers followed any trends in giving information to the police.

Method

I decided to have a close look at the first interchanges which occurred during a telephone call, in particular the first items of information which were volunteered by the caller and the first request for information made by the police officer. I therefore visually checked each call, and coded whether the first request by the police officer concerned information regarding the caller, the incident or some other details. The same procedure was followed for the first information volunteered by the caller. A note was also made of whether the first volunteered information, was produced temporally before or after the first request for information by the police operator. A file was then produced which included in addition to these items a flag indicating whether or not the caller was involved in the actual incident, the urgency rating of the call and the call subject categorisation.

Results

A small program was then written which carried out a number of tabulations of these various factors. These can be seen in Tables 10.11 to 10.15.

Table 10.11 - Order of first transactions in 999 call

Nature of First Information Transaction	Hits (N)		Percentage of calls (%)
Caller Gave Information First	191	-	97.45%
Operator Requested Information First	5	-	2.55%
TOTAL CALLS CHECKED	196		

Table 10.12 - Subject of initial information volunteered by caller Related to caller involvement in incident

		Subject of information volunteered by caller (Percentages)			
		Caller	Incident	Other	Totals
Caller involved	Yes	26.18	34.03	8.90	69.11
	No	11.51	17.28	2.09	30.89
		37.70	51.31	10.99	100

Note: Analysis confined to calls wherein information was volunteered by the caller before any police questioning (i.e. 97.45% of total calls)

Table 10.13 - Subject of initial information volunteered by caller Related to urgency of incident

		Subject of information volunteered by caller (Percentages)			
		Caller	Incident	Other	Totals
Urgency	Low 0	1.57	1.05	1.57	4.19
	1	2.09	3.66	.52	6.28
	2	3.14	1.57	.00	4.71
	3	7.85	3.14	.52	11.52
	4	5.24	6.28	1.05	12.57
	5	3.66	10.47	2.61	16.75
	6	7.33	15.18	2.09	24.61
	High 7	6.81	9.95	2.62	19.37
TOTALS		37.70	51.30	10.99	100

Note: Analysis confined to calls wherein information was volunteered by the caller before any police questioning i.e. (97.45% of total calls)

Table 10.14 - Subject of initial information volunteered by caller related to subject matter of call

Subject of Call	Caller Involved	Caller not Involved	Totals
	Subject of information volunteered by caller (Percentages)		
Crime	11.52	13.61	25.13
Other Offence (not Traffic or Crime)	3.14	1.05	4.19
Suspicious Conduct	6.28	1.05	7.33
Vandalism	4.71	1.57	6.28
Crime Prevention	2.09	.00	2.09
Useful info re Crime/Offence	2.62	1.05	3.66
Public Order	7.33	1.05	8.38
Road Traffic Accident	11.52	1.57	13.09
Floods/Fallen Trees/Obstructions etc	1.05	.00	1.05
Vehicle Obstruction/Breakdown	.52	.52	1.05
Advice on Law/Crime	2.09	.52	2.62
Advice on General Matters	.00	1.05	1.05
Directions/Locations/Local Knowledge	1.05	.00	1.05
Missing Persons	1.05	.52	1.57
Fears for Person's Safety	1.05	.52	1.57
Domestic	1.57	1.05	2.62
	1.05	.00	1.05
Lost/Found Property	.00	1.57	1.57
Burglar Alarms	2.09	.00	2.09
General Nuisance Complaints	3.14	1.05	4.19
Fire or Bomb Alert	1.05	.00	1.05
Other	1.05	.52	1.57
TOTALS	69.11	30.89	100

Note: Analysis confined to calls wherein information was volunteered by the caller before any police questioning i.e. (97.45% of total calls)

Table 10.15 - Subject of Police Officers' first question related to subject of previously volunteered information

Percentages		Caller	Incident	Other	Total
Subject of	None	4.85	3.66	3.14	14.65
Police Officers	Caller	15.71	25.65	2.09	43.46
Subsequent	Incident	9.95	17.28	3.66	30.89
Questions	Other	4.19	4.71	2.09	10.99
	TOTALS	37.70	51.30	10.99	100

Note: Analysis confined to calls wherein information was volunteered by the caller before any police questioning i.e. (97.45% of total calls)

Discussion

The first thing of note is that after the introductory (and generally non-informative) transactions concerning greetings etc., which effectively established that the correct connection has been made, the first transaction nearly always involves the caller providing an item of information. On 97.5% of all occasions the first such transaction was caller initiated and involved him giving information.

Caller's Stragegy

When one considers those calls where the caller volunteered information before being questioned, the type of information which was volunteered predominantly concerned the incident. On 51% of occasions the subject was the incident, on 38% of occasions it was the caller, and on 11% of occasions it was some other matter.

During my previous analyses I produced a hypothesis suggesting that the probability of different types of information being presented by the caller would change dependent upon the urgency of the call. Primarily, I suggested that there was a greater likelihood that information concerning the incident would be produced as a first transaction for urgent calls, whereas for non-urgent calls there would probably be little difference.

This hypothesis seems to be substantiated by the data in Figure 10.13 where the urgency has been tabulated against the subject matter of the first information given by the caller. At the lower end of the scale there is some fluctuation between the two although in the main the caller information predominates (some care should be taken with urgency ratings 0, 1 and 2 as the cell count is low). At the higher end of the scale, however, it can be seen that at an urgency rating of 6 the incident details are given on nearly twice as many occasions as caller information. Even for a rating of 7, where it dropped slightly, the percentage is still 51% for incident information versus 35% for caller information. It would seem that with increasing urgency the probability of the first exchanges relating to the incident increase. In other words, if the call is urgent the first exchanges are likely to be about the incident. If it is less urgent they are likely to be about the caller. This tentative finding has considerable implications for VDU format design.

The fact that the caller volunteers information before any request is made may seem natural until one considers other operators who might superficially be considered to be employed in similar jobs. In this respect if one thinks of a GPO telephone operator or the operator on the Access credit control desk, then in those circumstances on almost 100% of occasions the first purposeful transactions involve the operator asking a question, followed by the caller responding (hopefully) with the requisite information. The operator in those circumstances is able to adopt this strategy because there is a relatively small domain of discourse with which he is likely to be involved. In the case of the GPO operator somebody is obviously attempting to get a connection and therefore the operator is really only interested in the number that they require. In the situation of credit control, persons only ring the credit control checking agency in order to check credit, therefore it is quite proper for them to ask questions about that very limited domain. The police officer is in nowhere near such a fortunate situation, as although he has presumably in the main only to answer questions concerning police responses to certain incidents, the variability of those incidents is so great that there is no easy introductory question with which he may commence the communication. This serves to emphasise the very much more difficult task that faces a police operator compared with some of the other well known examples of telecommunications operator.

Police Strategy

The second tabulation in the Figure 10.15 looks at the subject of the first request for information compared with the first volunteered information by the caller. In this case it can be seen that the majority of requests by the police officer involve information concerning the caller (43%), whereas information concerning the incident is only 30%. In addition, in those circumstances where the caller information has already been volunteered, the subject of the first police questions frequently covers the same 'caller information'. This would suggest that there is a tendency for the police officer to concentrate his early requests on caller information, irrespective of the subject matter of the previously volunteered information.

Caller's Involvement in the Incident

A final tabulation was made which analysed calls by subject matter dependent upon whether the caller was actually involved in the incident or not. Surprisingly enough the majority of calls were reported by persons who were involved in the incident. 69% of cases were reported by persons so involved, with 31% by persons who were in no way associated with the incident. This is somewhat surprising as the initial view of the researcher would have been that incidents such as public order, and road traffic which occur in public places have the probability of a large number of non-involved witnesses, and would be very frequently reported by persons who were not involved in the incident. This turns out not to be the case; in fact in road traffic accidents 88% of all reports are made by persons who are directly involved in the incident. Crime seems to be the only subject (with a sufficient sample size to discern) wherein calls are reported more by persons not involved in the incident. This finding is of interest because it may be presumed that a person who has been involved in the incident will have more information to impart than a person who has merely witnessed it. This may be reflected in the difficulty of the operator's job.

Information Hierarchy

It may be worthwhile considering the call in terms of a hierarchy of importance for the various items of information.

If one considers the police operator's activities from the position that he is dealing with an extremely fragile communication which may be terminated or degraded at any moment, then one of his major considerations should be the security of the information which he is likely to obtain. In order to do this one would expect him to attempt to obtain the most salient information first. This leades one directly to the consideration of what information is most important to the organisation and which information would be most difficult to recover if the communication line was lost.

This would suggest a hierarchy of information based on both its utility and ability to be recovered.

Obviously the most important piece of information that the officer requires initially, is the location or address of the incident. If this is the only piece of information that he obtains, then he still has the ability to send a resource to that area with a fair chance of recovering evidence concerning the incident. Therefore, a message which merely said, 'Come quick, there is trouble here at Elliot Road,' would give the officer sufficient information to at least send a resource to investigate the general area of Elliot Road.

His next most important acitivity would be to refine the address to enable the vehicle to go directly to the incident. Thereafter information such as the name of the caller (and potential witness), details of the incident, information concerning any movement away from the scene of offenders, or dangerous circumstances, are then useful in order to be able to:

1. decide whether a resource is necessary or what type of resource should be sent
2. properly brief the officers who are being sent to the scene
3. decide on any alternative or additional action that he should take.

It is likely that the less urgent information may vary from subject to subject and to some degree from incident to incident.

This approach suggests that the police officer should impose a discipline on the conversation, which would enable him to obtain the information that he required in a descending order of importance. However, it seems from my observations, and also from the analyses produced in this chapter that many witnesses want to get off their chest, certain information which they consider to be important. It may be more effective to allow them to pass that information in their own way, and then to impose an interrogative discipline, rather than attempting to control the conversation, from the outset. It is likely that operator aids could be designed to assist the officer in imposing a degree of structure on the call. In view of the preceding findings, such aids should allow sufficient flexibility to input information which comes to the operator out of the intended sequence.

CHAPTER ELEVEN

ANALYSIS OF SCRAP NOTES

In this investigation I have found that 999 operators normally use a scrap notepad which they supply for themselves, from various sources. They invariably make their notes onto this paper during the course of an emergency telephone call and later transfer certain of the information on to an official message log. I decided to investigate the nature of these notes in order to ascertain why they formed such a firm part of the unofficial call answering strategy.

Method

In this investigation I replaced all of the "private" scrap pads with some experimental pads. These were essentually similar to the pads normally used, with the exception that they had a light pink hue, to enable me to recover them from the welter of paper which is frequently in evidence in the control rooms.

The operators were asked to make out their 'scrap' notes on the new pads in the normal manner. At the end of each shift the notes were collected, and a photocopy taken of each message log which had been completed during the course of the shift. I later matched the scrap notes to these message logs.

I initially carried out a pilot experiment in Plymouth on four consecutive days in March. Slight modifications were then made to the pad and the procedure which I adopted, following which a longer run covering a complete week was carried out in the Paignton (Torbay) Control Room, during the month of May, 1979.

A total of 170 messages were collected and matched with the appropriate logs.

Method - Data Analysis

I first scanned the notes to try and ascertain whether the information they contained fell into any particular catagories.

It seemed that nominal categories such as -

1. Telephone numbers
2. Names
3. Addresses
4. Times
5. Incident descriptions etc.

were quite prominent and this being the case it seemed appropriate to use the analytic categories which had previously been developed for the ETTA telephone analysis. (Described in Chapter Ten).

Certain parts of the ETTA system are redundant when applied to scrap notes, because there is only one "actor" or writer of the notes and therefore only a single communications direction. In this case it was only necessary to use the last two components of the ETTA system, namely "subject" and "subject details". (See Table 10.1).

The ETTA system required further minor modifications in order to cope with note taking, as I wished to look in somewhat greater detail at the incident description categories of information. Most of the categories refer to factual information of a type which is usually called non-redundant, (e.g. names, addresses, telephone numbers etc.). The category of incident description, or "story" of the incident, and was, in the main, highly redundant in nature. There were, however, certain other descriptions of persons, vehicles, houses, etc., which although forming part of the story were of a non-redundant character. I therefore split these two aspects of description into separate categories to embody this redundant - non redundant dichotomy.

Table 11.1 - Analysis of 999 operators' notes

Information Category of Notes		Percentage of Notes (Calls) which contained information Category
Caller's	Name	90
	Address	85
	Description	1
	Location	5
	Telephone number	60
Offender's	Name	1
	Address	2
	Description	5
Victim's	Name	5
	Address	1
	Description	2
Police Resource	Name	9
"	Time	4
Incident	Address	16
	Location	20
	Time	1
	Description	79
Call	Time	84
	Type	26
Car/Object	Description	2

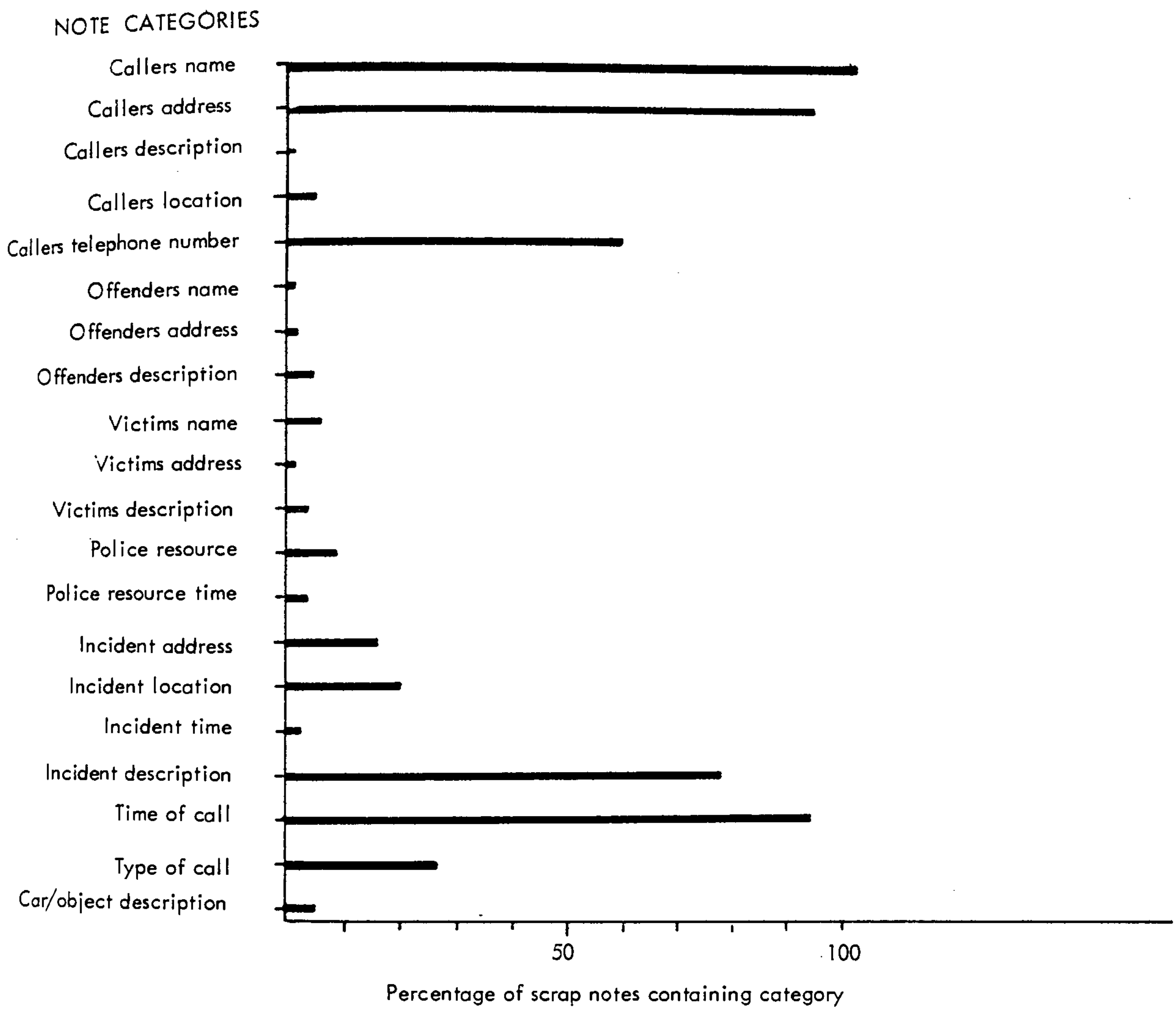


Fig 11.2 Analysis of operators notes

Categories of Information

Once I had devised this analytic tool I then checked each scrap note and carefully itemised the categories of information that it contained. I then developed a computer program which summated the number of messages which contained each category type and also produced a graphical representation of the same information. Table 11.1 shows the results and Figure 11.2 is the graphic representation of the same information.

There seems to be two fairly distinct groupings:

a) Information categories which are used for nearly every telephone call,

b) Information categories which are only infrequently noted.

The former groups contain the caller's name, which is noted nearly on 90% of occasions, address, the time of the call, a description of the incident and the caller's telephone number.

The second group may be further sub-divided into two sub-groups. Those which occur at around about the 20% mark, and the rest which occur infrequently or never.

If one considers the two categories, incident address, and incident location to be related, incident location being a slightly less precise form of incident address then this produces an additional item which occurs on about 36% of the logs.

Comparison of categories by subject

A histogram was produced showing the number of scrap notes which contained each type of information category, for each of the 23 message subject categories which were represented in this sample. The graphs were identical in format to that in Figure 11.2 with the exception that they only covered one individual subject category, e.g. crime, road traffic accidents etc. No differences in the relative representation of different information categories could be found which could be stated to be significant. There were a number of minor differences noted but each of these were in incident categories which only occur infrequently. For instance, there were naturally no names or addresses in hoax calls. There seemed to be a much greater emphasis on the transaction call time in fire and bomb calls, and the information categories of victim description and victim address was more uniformally represented in the subject category of missing person. All of these are effects which one would have predicted given the knowledge of the type of processes going on in a telephone call involved in these circumstances. Unfortunately, these type of calls represent a very small percentage of the total workload, and therefore it was not felt necessary to specifically aim any further investigation at these potential effects. It might, however, be an interesting study for some future research.

Redundant v. non-redundant information

It seemed from my overview of the scrap notes that the operators were dealing with redundant information in a different way from non-redundant information. I therefore decided to categorise the words used in both the scrap notes and the logs according to this dichotomy.

I designated information such as telephone numbers, times, names, addresses, personal or object descriptions, registered numbers and location descriptions as being non-redundant information. The incident description or story I designated as redundant information. Essentially this dichotomous categorisation is related to that used in the previous section insofar as the incident description is identical to redundant information, and all of the other categories fall into the subject of non-redundant information.

Each note sheet and every related message log was checked and the individual words on both documents designated as either being redundant or non-redundant. The results were totalled and entered into a computer program.

Table 11.3 - Comparison of redundant versus non-redundant words in the scrap notes and message logs

		AVERAGE NUMBER OF WORDS PER CALL SEQUENCE				
		Word Categories				
		Redundant		Non-Redundant		Overall
		Mean	SD	Mean	SD	
Document Type	Notes	3.9	3.8	9.0	4.0	12.9
	Log	17.7	10.7	11.1	4.8	28.8
	Expansion Ratio	1:4.54		1:1.23		1:2.23

Table 11.4 - Comparison of transition from notes to logs by call subject category

Call subject	Non-Redundant			Redundant			Total Words in Notes	Total Vocabulary	Number in Sample	Number W/O Red Notes	% W/O Red Notes
	Nr Notes	Log	Ratio	Red Notes	Log	Ratio					
Crime	8.9	12.1	1.36	4.1	16.2	3.92	101	85	24	2	8.3
Other Offence	9.17	11.33	1.24	5.0	23.7	4.73	31	27	6	1	16.7
Suspicious Conduct	9.6	11.9	1.24	3.6	22.5	7.32	79	61	20	8	40.0
Crime Prevention	9.3	9.0	0.96	4.3	12.0	2.77	14	14	3	1	33.0
Useful Information	7.0	18.0	2.57	5.0	15.0	3.0	5	5	1	0	0
Public Order	7.2	9.4	1.28	4.3	14.8	3.42	149	110	33	6	18.18
R.T.A.	8.9	10.6	1.19	2.8	16.7	5.96	60	40	20	4	20.0
Traffic Offence	5.5	8.0	1.45	3.5	40.0	11.43	7	7	2	0	0
Vehicle Obstruction	12	10	0.83	1	14	14.0	1	1	1	0	0
Mental Health	9	12	1.33	4.33	26.33	6.08	13	12	3	0	0
Welfare	10	10	1.0	3.33	22.0	6.6	11	11	3	1	33
Fears for P/Safety	7	6	1.14	2	16	8.0	2	2	1	0	0
Domestic	7	10	1.43	1.88	15.13	8.1	18	15	8	2	37.5
Illness Injury	7	8	1.14	5	18	3.7	5	5	1	0	0
Lost & Found Property	8.5	11	1.29	4.5	15.0	3.33	9	9	2	0	0
Animals	11.3	15.3	1.35	3.7	13.7	3.7	11	11	3	0	0
Burglar Alarms	10.3	12.3	1.2	2.3	17.3	7.67	9	7	4	0	0
Maritime Matters	8	9.5	1.19	4.5	19.5	4.33	9	9	2	0	0
General Nuisance	9.7	10.1	1.04	3.2	11	3.47	41	34	12	3	25
Fire/Bomb	11.5	12.67	1.10	6	22.83	3.81	37	34	6	1	17
Hoax	3	5	1.67	5	14	2.8	5	5	1	0	0
Missing Person	16	19	1.19	4.2	24.5	5.9	28	24	6	3	50
Overall	9	11.1	1.23	3.9	17.7	4.53	693	390	170	35	20.6

AVERAGE NUMBER OF WORDS IN NOTE OR LOG (PLUS RATIO) IN EACH SUBJECT AREA

The major results are summarised in Table 11.3. It can be seen that the average scrap note is comprised of 12.9 words and this is expanded into 28.8 words for the average log. A ratio of 1:2.24. This 'hypothetical' average note is made up of approximately nine non-redundant words and just under 4 redundant words. When we reach the target message log, however, these proportions have reversed with the 29 words of the log being made up of nearly 18 redundant words, and on average 11 non-redundant words.

In other words the ratio of words on the scrap notes to words on the log is considerably different for redundant and non-redundant information.

An analysis of variance was carried out on the expansion ratios from the notes to the logs for the 2 categories of redundant and non-redundant information, with the result that $F = 58.74$, $P < .001$

It can be seen from the standard deviations in Table 11.3 that the variability of redundant information is very much greater than that for non-redundant information.

On 20.6% of the message logs no redundant information was recorded on the scrap notes. Table 11.4.

Graphs and tables were produced for the distributions of each call and subject category to see whether there were any pronounced bimodal (or multi-modal) distributions which might suggest underlying differences between subject categories.

Subject evaluation

A check was made of each of the four categories, that is:-

1) Non-redundant information in the notes.

2) Redundant information in the notes.

3) Non-redundant information in the log.

4) Redundant information in the log.

This check was to determine whether the number of words used in each of these categories varied significantly over the 23 call subject categories which were represented in this sample. A tentative initial hypothesis was that there would be variations for different subjects in the redundant information and probably no variation for subject in the non-redundant "factual" information. The results were as follows:-

Redundant words in operator's notes:

F ratio = .455 DF = 22/147 Result - not significant

Non-redundant words in operator's notes:

F ratio = 1.783 DF = 22/147 P is significant at < 0.05

Non-redundant words in 999 message logs:

F ratio = 1.575 DF = 22/147 Not significant

Redundant words in the message logs:

F ratio = 1.45   DF = 22/147   Not significant

It would seem that the Null hypothesis concerning the variation in the number of redundant words has not been disproved by this sample.

The moderately significant result ($P < 0.05$) for non-redundant words in the operators' notes seems to be made up in the main from a few missing-persons logs which invariably contain a considerable element of personal descriptions and often more than one address. This subject has been referred to in a previous section.

I feel that the call subject effect on call parameters has not been fully explored in this investigation, mainly because there are certain call subjects which have an esoteric nature coupled with a low rate of incidence. This means that although such calls may well be dealt with differently from the average, a very large sample would be needed to give a statistically reliable result.

Incident Description Words

From each scrap note in this sample I extracted the word or words which seemed to be describing the nature of the story or incident. These are previously termed redundant words. I noted these words in the actual form which was used by the operator including contractions and special terms. If an abbreviation was in general use throughout the police force, such as RTA for road traffic accident, then this was termed to be one word. If, on the other hand it was a contraction which was peculiar to that particular operator, it was expanded to its full word form, e.g. DOEL means 'documents and excise licence'. The absence of a vocabulary item was indicated by a null in my coding schedules.

I totalled these words over the complete sample and in their raw form there were 693 words used in a total vocabulary of 390 different words. 35 of the 693 words used were null entries which leaves a real hit rate of 658 words from a vocabulary of 389.

The vocabulary in its raw form of course contains contractions, plurals and synonyms. By combining the plurals in the database the overall vocabulary size was reduced by 9 and by combining the synonyms it was reduced by a further 30.

Certain contractions had been used by the operator such as "I've, I'll, O/S (for outside) and NI (for no injuries)".

These effectively increased the number of hits by 6 and the vocabulary by 1.

The result was that there is effectively a total number of words used of 664 and a total vocabulary of 341.

A comparison of the words used was made by subject category to ascertain whether a small number of key words might be used to invariably indicate a particular subject category, e.g. it might be possible that the word RTA was always used to indicate an accident. The relative absence of frequently occurring words meant that no strong effect of this nature could be distinguished from the data. There are, however, indications that certain words do occur more frequently in certain categories than in others. For instance the words 'burglary' and its synonym 'break' only occur within the crime category. The word RTA and its synonyms occur 9 times out of 10 within the road traffic accident category. However, there seemed to be very few words such as this with a strong association for a particular category. There do seem to be certain indications concerning the probability of various words occurring within various categories, but with nearly 100 potential subject categories and a large vocabulary, the sample size was quite inadequate to accurately chart such a distribution of probabilities.

Discussion

It would seem that the operators certainly have elements of a fairly coherent strategy. This is very much evidenced by the fact that there is a prominent group of categories which occur in nearly every telephone message.The category of 'Caller's Name, Address, Telephone number' and 'Time of the call' are obviously informational categories which the operator feels it is important to gather and to note. This finding may relate to the hierarchy of information suggestion made in the last chapter. The advantage of obtaining at an early time, and noting in a fairly explicit form, the caller's details means that it is much more possible to recover the situation if the telephone communication is ever lost. If the operator has at least obtained an address he can despatch a unit to that address to continue the conversation, and obtain sufficient information to complete the incident. In many ways obtaining information about the location of the incident and the location of the caller may be considered to be more important in the initial stages of the message than obtaining information concerning the actual details of the incident. Similarly, the high incidence of requests for the caller's telephone number, tends to support the construction that I have suggested concerning the operators' apparent strategies.

The fairly poor showing of incident location is not as significant as it might seem, as for a large proportion of the messages, the caller's address and the location of the incident are co-located, or at least so nearly as not to be important. For example, domestic disputes are often reported by a member of the household, accidents by people living near the scene, and even disturbances by shopkeepers and publicans living in the vicinity.

The time of the call is fairly strongly represented in the main because one of the criticisms which is most likely to be levelled at police action is with respect to a tardy response. It has therefore become axiomatic amongst operators that they should note call time. I notice from my observations that many of them in fact wrote down the time as they picked up the telephone receiver. (However, see Appendix VII for an indication of the accuracy of this information.)

It is interesting to note that there are many more categories of information concerning facts of an identifying nature such as name and address and telephone number, etc., to factual words which describe the story or the incident. It is in this respect that the concept of redundant and non-redundant information becomes important. The results in this section on redundant and non-redundant information clearly show that these two types of information are being dealt with quite separately and differently by the operators. It would seem that there is almost a 1 to 1 relationship between the notes that they make concerning non-redundant information and the subsequent log entries. In other words they are noting nearly all of that type of information. On the other hand, there is a very much greater expansion ratio for the redundant information. The operators are recording only key words in this respect, presumably to jog their memories when they subsequently come to make up the logs.

It would therefore seem that the information reaches the message logs by two different and distinct routes dependent upon the type of information. Factual descriptive information is noted pro-tem on a piece of paper in almost a verbatim form. It is then transcribed word for word onto the log.

The story information on the other hand is noted in a very condensed form, in many cases just key words, which are used to jog the memory, the main information being kept by the operator in his head. Thus when he comes to write up his log at a later time he then uses these key words and reconstructs the story.

This would tend to fit in with the results which were obtained from the propositional analysis and also from my observations of the various message logs (see next chapter). I found from those occasions that the surface structure, i.e. the actual words used on the log, differed quite considerably from the surface structure of the telephone call. This is despite the fact that the majority of logs are written as though they were verbatim reports of the conversation with the member of the public.

The fact that the redundant category of information is very much more variable than the non-redundant category would also tend to support the premise that the redundant story information is more creatively inspired than the reportive non-redundant information.

The difference in expansion ratios between the results and the logs for redundant and non-redundant information was highly significant.

With respect to the actual words used rather than the number of words used, it does not seem that there is a small pool of words which uniquely describe each subject category. In fact even the word abbreviation which was used most frequently for one particular category, namely 'R.T.A.' for 'Road Traffic Accident' occurred on less than half of the notes involving that particular subject category. It would therefore seem that different operators at different times used different words as keys to recall the story information. Obviously there will be a greater probability of certain types of words occurring than others within the various subject categories. As previously discussed words concerning theft are more likely to occur in the crime category, slightly less obviously pejorative adjectives such as 'punks', 'louts', etc., are more likely to occur in public order situations as are words such as 'disturbance', 'fight' or 'trouble'. In an even more speculative vein I would hypothesize that the time of the incident could be an indicant of the type of activity. Crimes are more regularly reported a long time after the event than are public order situations, or road traffic accidents. Also the location of incidents varies according to subject type and therefore the type of words used to describe the location could be an indicant of the subject category. However, at the moment these suggestions are speculative and are not supported by the evidence in this fairly small sample. It would require a very much larger sample to produce a reasonably accurate probability distribution, and such an undertaking is outside the scope of this particular research. A parellell study investigating the operator's subjective views on the geographical and temporal aspects of incident workload, is reported in Chapter Thirteen. It could, however, be a very interesting avenue to follow in the future and the results are likely to be useful for any automated speech input note-taking facility.

A further discussion of the significance of these results when combined with other findings from parallel investigations will be pursued in the overall discussion chapter.

CHAPTER TWELVE

SEMANTIC ANALYSIS

The preceding chapters have predominantly concentrated on the functional and dynamic aspects of the emergency telephone calls. The objective of a telephone call of the nature that I am currently investigating is, however, to transmit from one person to another, the understanding of certain events (or meaning). Therefore, I decided to look closely at the meaning content in the messages as they were transferred from the caller to the message log.

This is an area which has historically been fraught with difficulty, as inevitably the assessment of meaning is a subjective event. I decided to approach the analysis using two related methodologies.

In the first place I carried out an investigation which looked at the surface structure of the language used in the verbal transactions of the call, and the subsequent written information, as it appeared on the message log. Transformations in the surface structures (that is actual words used) were then noted.

The second element of the analysis involved the use of a number of instruments aimed at ascertaining whether any change of meaning had occurred irrespective of any possible changes in the surface structure. Two devices were employed:

(i) the use of judges making subjective assessments, and

(ii) the use of an instrument devised by an Open University team, which they style 'Propositional Analysis'.

Both of these measures are attempts to uncover 'meaning components' at a somewhat deeper level than can be found at the surface structure level of the first investigation.

LITERATURE ON SEMANTICS

At the beginning of their book on language and perception George A. MILLER and Philip N. JOHNSON-LAIRD say,

> "A repeated lament of those who would understand nature is that everything is related to everything else." (MILLER & JOHNSON-LAIRD 1976.)

Nowhere is this more true than in the study of a human being's view of 'meaning'. There is a wealth of investigative evidence in the area of language, stretching from the interpretation of phonemic components, right through to the integration of the incoming information with world knowledge, in the science of pragmatics. Yet at each level the interactions with other levels within the study of language, semantics and related disciplines are numerous, leading to a cat's cradle of interdependent findings. However, one coherent theme which seems to stand out from all of the work on language, and related sciences, is the essential nature of the human mechanism not as a simple recording device, but as an organism attempting to distil the meaning of events from the information it receives. It seems that at every level inference and reference are used to make sense of what is often a distorted and incomplete communication, rather than simply an attempt to record the actual physical message which is received.

Even after 48 years BARTLETT's view of perception as an 'effort after meaning' still seems to be central to the description of human abilities in this area (BARTLETT 1932).

The Essentially Semantic Nature of Long Term Memory

Most researchers seem to accept that the information which is stored in long term memory is essentially one for meaning rather than the actual words used. WANNER (1974) in a rather ingenious experiment, using a set of instructions for one of his laboratory classes, changed various word orders in the prose. Two types of changes were cleverly devised. In one, the change in word order actually changed the meaning of the sentence, whereas in the other the change of word order though, of apparently similar surface structure, had no effect on the meaning of the sentence. Subjects were able to recall the correct instance of the words when there had been a meaning change at almost the 100% level. Where the word change had no effect on meaning, recall was no greater than chance. This study clearly suggests that it was the meaning which was being attended in these particular circumstances rather than the actual words used.

In an earlier study, SACHS (1967) presented prose to subjects, and then asked them to judge whether a test sentence was structurally identical, that is, similar in both meaning and syntax. She tested subjects after time intervals of 0 and 67 seconds. The findings were that at zero seconds, judgement for both meaning and surface structure were good. However at 67 seconds whilst meaning remained good, the evaluation of surface structure was poor. In other words there had been a significant decrement in the subject's ability to accurately recall the surface structure of the prose passage, after an interval of only 67 seconds had elapsed from the completion of reading the passage. A number of findings have supported the premise that subjects are good at verbatim recognition immediately after hearing a sentence, but their performance in this respect drops off relatively quickly over time. On the other hand a person's ability to retain meaning is maintained at a much higher level and decrements much more slowly over time. (FLORES d'ARCAIS 1974 a), (BEGG 1971), (BEGG and WICKELGREN 1974), (JAMES and ABRAHAMSON 1977). BEGG also suggests that the memory for wording is statistically independent of memory for meaning, suggesting that a different system is used to recall verbatim words than for the meaning content of the sentence.

LIGHT and CARTER-SOBELL (1970) noted that context had a considerable effect on subject's ability to recognise previously presented words. They used polysemous words, (i.e. words having more than one distinct meaning) such as jam (e.g. strawberry jam and traffic jam). They found that if the previously presented context was similar to the one used for recognition, i.e. the difference between 'strawberry and raspberry jam', then there was very little effect on the subject's ability to recognise the target word, however, when the context was changed a significant decrement in their ability to recognise the words was noted. This again indicates that words are being semantically coded rather than stored in the form of a simple surface structure. Similar findings have been noted by TULVING and THOMSON (1971). PERFETTI and GOODMAN (1970) extended these findings by noting that context could encompass words which were semantically similar, i.e. if the polysemous word 'top' was used, which has the dual meaning of being at the summit or a toy then, depending on the original context of the presented sentence, semantically related words were on occasions erroneously identified, e.g. 'bottom' instead of 'top' equals summit, or 'toy' instead of 'top' equals spinning top.

These findings stress the essentially semantic character of long term memory. This of course doesn't mean that it is not possible to recall prose verbatim; indeed many actors do this as part of their employment, and all of us do it for certain situations such as prayers and in the case of policemen, the oaths in a witness box. However, it is likely that this employs unusual mechanisms which are not part of everyday recollection. The semantic nature of the long term memory has been epitomised in most of the attempts to construct computer metaphors of memory by the various Artificial Intelligence practitioners. Most systems such as those produced by the LNR Group employ a semantic network model for the representation of meaning. (ANDERSON and BOWER (1973), QUILLIAN (1969), RUMELHART (1975),

WINOGRAD (1972), WILKES (1973). Even TULVING's eposidic memory is not intended in any way to be a verbatim memory, but merely another form of semantic memory which has a time and locational reference. (TULVING 1972).

Translation

If memory is not a verbatim recording then this automatically implies that there must be some translation from the surface structure of the words at sentence level to the internal representation. There must be some attempt to interpret meaning from the words used.

This conversion is the basis of Chomsky's transformational grammars. (CHOMSKY 1965, 1968). A whole subject area of cognitive linguistics has been developed to investigate the phenomena of this translation process. However, here we wish to concentrate on one particular area, that is the area of implications or additional constructions which are placed upon words in an effort to make sense of them. This area has been explored by BRANSFORD, BARCLAY and FRANKS (1972), and is encapsulated in their 'Assimulation theory'.

They argue that comprehension is a constructive process in which there is an attempt to build a meaningful whole from the information received. If the information is sketchy and incomplete then it is likely (according to assimulation theory), that plausible constructions will be placed upon events to cater for any gaps. This is similar to some of the ideas which have been proposed in relation to scripts and frames which will be introduced later. The well known experiment by BRANSFORD, BARCLAY and FRANKS (1972) involved presenting the subjects with some sentences, e.g.

1. "Three turtles rested beside a floating log, and a fish swam beneath them," and

2. "Three turtles rested on a floating log, and a fish swam beneath them."

Subjects were then asked whether they recognised another similar sentence which in fact said,

> "Three turtles rested on a floating log, and a fish swam beneath it."

Subjects who had been initially presented with sentence no. 2 were very much more likely to state that they recognised the test sentence. Bransford et al argue that when people first see a sentence they place a construction (possibly even visualise) the situation of the turtles, viz a viz the logs, in which case it is a reasonable implication that if a fish was swimming under the turtles and the turtles were resting on the log, then the fish swam under the log.

Similar investigations were carried out by BARCLAY (1973) using slightly more complicated positional type sentences which essentially support BRANSFORD's findings. FILLENBAUM (1966) noted that subjects were likely to make implications concerning relatively simple events, e.g. given an indication that a window was not open they were likey to incorrectly identify sentences which stated that the window was closed. He also noted that this was not a simple transposition of opposites. In circumstances where opposites existed but where the implication could not normally be drawn under realistic conditions, then no automatic inferences were drawn, i.e. if a sentence contained the information that a bottle was not empty, no transposition would occur to infer that it was full. JUST and CARPENTER (1976 b) further argued that these inferences have to be made at the time the sentence is presented. If they are not then the subject takes a longer time to judge a test sentence such as 'the window is open', to be true.

JOHNSON, BRANSFORD and SOLOMON (1973) carried out an interesting study in which they produced prose passages which included a story about somebody who was undertaking the construction of a bird house. The sentence "He was 'pounding/looking for the nail when his father came out to watch him and help him to do the work" was included in the prose. Each subject was only presented with one of the alternative phrases i.e. either 'pounding' or 'looking for'. The subjects were later presented with sentences which indicated that John had been using a hammer in his activities. Those who had been presented with the sentence which included the word 'pounding' were very much more likely to infer that he had been using a 'hammer', although in neither of the passages was the word hammer used.

It is likely therefore, that the new information is integrated with existing expectations concerning the type of events under consideration.

Confusion as to Source

It seems that information is transformed from a surface structure to some form of semantic representation. There are indications that this latter representation does not always contain strong tagging as the source of the information.

In work by ANDERSON and BOWER (of semantic data base fame), (ANDERSON and BOWER 1973), they presented people with sentences concerning historical figures. Each sentence contained a number of statements and on occasions it was possible to infer that the person who was the subject of one sentence was the same person as was the subject of another sentence, i.e. in one sentence a person may be referred to as 'George Washington' and in another as 'The first President of the United States'. They found in a later recognition test that people were often unable to recall accurately the origin of their information. Apparently they had integrated the information from the various sentences. This factor led them to make erroneous identifications of sentences which contained composite items of information from two or more of the sentences which had previously been presented to them.

In a similar vein, ANDERSON and HASTIE (1974) asked subjects to learn a set of related facts. In some cases it was possible for the subjects to infer from the outset of the session that the facts related to a single person. In other situations this was not possible until the end of the session. Subjects who had been able to employ the integration early in the session were very much more able to accurately recognise statements made about the subject. In other words it seemed that when it was obvious that the various (potentially disparate) pieces of information were being presented, if it became apparent to the subject the information related to one entity, then it was encoded in a connected way, despite the fact that the sources of information were different (in this case different sentences). On the other hand if no such inference could be made, the information was encoded in the subject's memory as separate entities. The memory record was not recoded when it was later found to refer to a single person. This finding parallels those of SACHS (1967) in as far as it suggests that the coding of information takes place at a relatively early stage.

An interesting study on the integration of information with existing knowledge was carried out by SULIN and DOOLING (1974) they gave subjects a passage to read about an imaginary girl named 'Carol Harris". Various facts were given to the subjects about this particular child. Other subjects were given exactly the same paragraphs except the name was changed to 'Helen Keller'. Many persons in America know the story of Helen Keller who was deaf, dumb and blind, and was taught language by her tutor. This information, however, was not included in the passage which was presented to the subjects.

When both groups were later asked whether the passage had contained information concerning the girl being deaf, dumb or blind, virtually none of the first group made this claim, whereas many in the second group (the Helen Keller group) stated that this information had been included.

It would seem that the information they obtained from the paragraph was integrated with information which they already held, and that it was difficult for the subjects to unravel the source of their knowledge.

In a similar vein, LOFTUS (1975) carried out an experiment by presenting subjects with a film of a road traffic accident. Immediately after the film, a number of the subjects were asked to answer the question 'How fast was the car going when it ran (through) the stop sign?'. A large number of the subjects who were asked this question subsequently stated that they had seen a car run through the stop sign. Very few who had not been asked this question made this assertion. The film did not contain a stop sign.

Information Changes

In addition to being integrated with existing knowledge it is possible that new information is masked by preceding information or visa versa. A study into the potential of this effect was carried out by CROUSE (1971) in which he presented subjects with a series of autobiographal paragraphs concerning a ficticious poet 'John Paynton'. One group of subjects were then given a second set of autobiographal paragraphs about other persons, the details of which were different but contained marked similarities to the original person concerning "John Paynton", i.e. that his father had died and that he had lived in poverty etc. Another group were given a second set of paragraphs to recall which were very different in nature from the first, concerning for instance, Libraries or South Sea Islands, etc.

Very clear interference effects were found. The subjects who had been given similar passages following the initial common passage concerning John Paynton able to recall only 54% as much of the original passage, as those who were given completely different material. In can therefore be seen that it is very easy for similar events to be confused in memory, and (1) either integrated with, or (2) mask another.

Memory for Prose

Most of the discussions so far have centred around relatively small units of discourse, i.e. sentences or paragraphs. The theme that I am following concerning the interpretative nature of human perception has also been widely investigated in larger passages of prose.

The most famous of these is the series of seminal studies of BARTLETT (1932). He presented European subjects with a somewhat alien story from North American Indian mythology, called the 'War of the Ghosts'. He asked them to recall the story at different periods and noted a number of different types of changes. Amongst the changes he noted more the sharpening of certain details and the levelling of others. Overall there was a rationalisation of the story, so that it 'made sense' in the logical and cultural context of the persons who were intepreting it. He described the activities of the subjects in the phrase that I have already used once in this review, namely 'an effort after meaning'. In other words his subjects were attempting to make sense of the story in terms of the world model which they already possessed. Evidence of how a person's view of the world (or his world model) can effect the actual perception of events, has been described in a number of subsequent studies. What seems to happen is that the perceiver attempts to hypothesise about the general area which is being discussed. Once he has sufficient information with which to make sense of the incoming data, he then suddenly uses a global representation which applies coherence to all of the information. Everybody has been aware of circumstances where suddenly an apparently incomprehensible stream of information 'clicked' as we realised what somebody was talking about. An extremely entertaining version of this phenomena was presented by BRANSFORD and JOHNSON (1973). They produced a very carefully constructed paragraph describing an every day activity in terms of a sequence of operations. Whilst it is possible to understand the paragraph in general terms, there is absolutely no specific reference as to the name of the operation. On the conclusion of the paragraph you are informed that in fact it describes the activity of washing clothes, if you then re-read the paragraph with this information it becomes immediately apparent that your mental operations are quite different from those when you read it as a relatively abstract paragraph of prose. This is of course a subjective assessment but I have tried it out on a number of my contemporaries, and they all state that given the clue as to what the passage describes they are able to visualise the various operations being suggested. They can actually see piles of clothes. The other interesting effect is the almost palpable relief when they find out what it is all about.

BRANSFORD and JOHNSON (1973) used a similar approach in another study. This time instead of an abstract operation the prose contained two potentially different themes. The two themes were:

(i) 'Watching a peace march from the fortieth floor', and

(ii) 'A space trip to an inhabited planet'.

They gave the same piece of prose to different subjects, the only difference being that one group would be given the first title and the second group the second title. They found that people attempted to build a global representation of the events and they essentially ignored information which did not fit into their representation. Information which fitted their initial 'set' was accepted and that which did not was in most cases forgotten.

The importance of an ability to organise the incoming information according to some coherent structure was demonstrated as early as 1955 by D.B. Fry (FRY 1955). He recorded two persons in conversation and then artificially distorted their speech so that not a single word could be recognised. Subjects who were initially asked to listen to the recording without being given any indication as to the subject matter were quite unable to dicipher the meaning of the conversation. Fry found that after informing them that the subject of the converstion was the purchase of a suit, the subjects were able to answer questions concerning the discourse, including the price of the clothes and styles etc. Subjects stated that the words 'jumped' out at them from the distortion. This interesting demonstration also suggests that the interpretive nature of human perception operates at all levels in the process of comprehension.

Plans for Comprehension

If in fact meaning is coaxed out of discourse, rather than being presented in terms of implacable, logical tomes, what in fact directs and guides this process?. This is something which is at the heart of both cognitive psychology, and many of the artificical intelligence models of discourse. However, before I turn to those I would like to discuss a number of relevant principles which have been produced by linguists.

The most prominent of these, is the two principles for semantic interpretation which have been produced by GRICE (1967). These are the 'Reality Principle' and the 'Co-operative Principle'. Essentially the Reality Principle argues that discourse between human beings makes sense, i.e. it is an attempt to pass coherent information and therefore any interpretation by the listener is usually based on that presumption.

The second principle stands, I feel, on slightly more tenuous ground, in so far as it argues that most persons involved in discourse do so on a basis that the propositions which they are being given are in fact true, i.e. people are attempting to pass information to one another which is reliable. In a slightly different vein, WEINER (1947) stated, 'the most important thing about a message is that it makes sense'.

If these principles are utilised by speakers then one can readily see, that given a listener receives a moderately ambiguous message, then he will exert his energies to provide a rational and coherent interpretation, presumably within certain limits. FILLENBAUM (1971, 1974) dramatically illustrated this principle by the use of perverse sentences. In this he presented sentences such as 'John dressed and had a bath' or 'don't print that or I won't sue you'. These sentences are perverse in so far as they are contrary to the normal interpretation of events which most people would expect in these circumstances. FILLENBAUM found that his subjects invariably ignored the surface structure of the message and interpreted the 'real' meaning. It is just this sort of ability by human beings which makes the job of the newspaper proof reader so difficult.

In a similar experiment, TURNER and ROMMETVEIT (1972) presented pictures showing cats chasing dogs and noted that once again there was a bias towards a more natural interpretation of these events.

Schema

It seems that there is a tendency to bias interpretation towards some normality. If this is so then how does the perceiver represent 'normality'. Obviously there must be some form of internal representation of the situation. There are a great many contenders for the organistion of this particular model, ranging from the psychological description of schema towards the more procedural definitions of the artificial intelligence workers such as scripts, frames etc. The idea of some sort of orientating model or schema has been in existence since BARTLETT's investigations.

NEISSER (1976) proposed a view of schemata which both prescribe the manner in which information is accepted, and the uses to which it is put. In this, his view of schema as constraining both the perception and use of information, draws on work by MILLER, GALANTER and PRIBRAM (1960) and MINSKY (1975). MILLER, GALANTER and PRIBRAM in their seminal paper on 'Plans', put forward the idea that behaviour could be described in a form of plans. A major point of their thesis was that one plan could be called by another plan so that there was a nested, recursive attribute to the system of plans. Minsky's frames have similar characteristics. His idea is that a situation could be represented as a scenario i.e. a person's perception of a room would be that there were for each and every room, certain characteristic attributes, such as walls and ceilings etc. A person upon entering a room would not necessarily have to attend to each and every part of the room to be certain that it contained the necessary qualities of a normal room. In Minsky's view there would be certain default values which, if not directly sampled, would automatically be inserted into the 'global representation'.

SCHANK (1972, 1975) has proposed a system which he refers to as scripts which has a very strong geneology, both with MINSKY's frames and with the plans of MILLER, GALANTER, and PRIBRAM. Essentially the argument that SHANK puts forward is that situations have scripts. Like MINSKY's frames the scripts have certain default values and like the plans of MILLER, GALANTER and PRIBRAM a large general script can call smaller scripts 'or vignettes' as he calls them, to deal with certain minor episodes in the overall script.

For instance, if there is a restaurant script which involves entering the restaurant, selecting a meal, eating a meal and paying for it, there may be minor scripts to deal with each of these sub-categories, e.g. paying for the bill, and it is possible that even the sub-categories could be broken down into further lower level vignettes.

What is interesting about these models is that they each suggest two main points:

(i) that for certain types of behaviour there is a relatively predictable comprehension structure, and

(ii) that in order to give these relatively rigid structures flexibility, without an undue processing load, default values are provided for the comprehension of events which are not directly or specifically sampled in any particular situation.

If this is true, these type of models could explain some of the implications which have been found in experimental psychology and also the biases towards normality. For, if, as Niesser believes, the schema is used not only to make sense of the information but also to direct the collection of further information, this would fit in with experimental findings of researchers such as BRANSFORD and JOHNSON.

Prototype

The idea of scripts and frames filled with default values, approximates to the idea of prototypes, a concept which has been in existence for some considerable time. Eleanor ROSCH (nee HEIDER) (ROSCH 1972, 1973a, 1973b, 1975 and 1977) carried out a great deal of work on the idea of prototypes.

The suggestion is that instead of human memory maintaining a definition of some object (or concept) in the form of a set of defining features, it is more likely that a set of characteristic features are maintained as a form of ideal of the concept. The difference between characteristic and defining features is of course not absolute. A fish could be described as having a sleek body, this description making use of a characteristic feature. A defining feature would be that it breathes through its gills.

A great deal of work has been done on subjects' abilities to recall various concepts as being members of different classes. The evidence generally suggests that the further away a concept is from the ideal prototype the more difficult it is to classify. For instance, whales are invariably classed as fish because they are quite close to the fish prototype in most peoples minds.

I feel that an interesting aspect to the idea of prototypes has been illuminated by its amalgamation with the concept of fuzzy sets as advanced by ZADEH (1965, 1976) and GAINES (1976). The idea here is that concepts often have fuzzy boundaries and it may be more accurate to suggest that an entity has degrees of membership of various concepts, rather than having an absolute membership of one particular category. These degrees of membership could be expressed in terms of multi-valued or even continuous scales. The prototypes of each concept would, of course, occupy the central position, and it would therefore be possible to describe any particular entity in a semantic space measured in terms of distance functions from the prototypical entities.

The generality of the idea of prototypes seems to be quite wide. ANDERSON et al (1976) presented subjects with a sentence stating that somebody had been attacked by a fish. He found surprisingly enough the word shark was a much more effective cue to recall this particular sentence than the word fish, although 'shark' had not been included in the original passage. This is similar to JOHNSON's 'hammer' sentence.

ATTNEAVE (1957) argues that use of prototypes would be parsemonious in processing. He suggests that the reason why most Europeans cannot (for instance), easily distinguish differences in the feature of orientals is that they haven't got a good prototype 'Chinese face'. If they had such a prototype face they would be able to compute distance functions and note minor differences. Whether the prototypes can be incorporated into the ideas of scripts and frames or not is an interesting problem. It seems intuitively reasonable that there could be prototype situations as well as prototypes for concrete concepts such as 'birds' or 'houses' etc. Essentially the difference between a prototypic description of the situation and one of SCHANKs' scripts is that the former has a continuous character whereas the latter has a discontinuous nature. As this is not essentially a research project aimed at ellucidating the vagaries of the current models of semantic memory, I regret that I will not be presenting any information to illuminate this dilemma. However, the matters are relevant when we come to discuss evidence of semantic changes which occur when police officers interpret the evidence with which they are presented.

I suppose that a very rigid form of prototype might be considered to be a stereotype. ALLPORT and POSTMAN (1947) carried out some interesting work in this respect when they showed white subjects a picture of an altercation between a white and a black man in a railway carriage. In the picture the white man was quite plainly carrying a razor, however, when the subjects were askd to recall what they had seen, a significant number of them had transposed the razor from the hand of the white man to the black man. Some were convinced that they had seen the blackman threatening the white man with the razor. In their case it seems that the mental models of ALLPORT and POSTMAN's subjects quite strongly mediated their interpretation of the evidence. This seems to epitomise the findings on human perception that human ability to accept and use information is very far from the common sense view of a communication channel and some sort of tape recorder. The evidence points to the human mind as being both moulded by the incoming information and also moulding its own perception of that information. Reality is only sampled through our mental models and our mental models are themselves shaped by the information we sample.

SURFACE STRUCTURAL ANALYSIS

As was noted during the observational phase of this thesis, a large number of the message logs were written down by the operators as verbatim reports. In other words, the written message purports to be an exact transcription of the call, or at least the most relevant parts of the conversation between the police officer and the caller. In these cases the message is in the first person, and in a verbatim style.

Method

I took a sample of 190 messages from the pool of recorded messages which I obtained from the Crownhill Control Room. (This was a different and distinct sample from those used in the preceding E.T.T.A. and in the Note analysis samples.)

Each of these calls was transcribed by a typist and carefully and independently checked by three different police officers, to ensure the completeness of the record. This was necessary because many of the recordings had indistinct sections and some of the transactions were extremely rapid.

The message logs which related to the calls in the sample were then obtained and photocopied.

Each message log was then placed alongside the transcription and visually checked by two judges working in concert. The calls were rated as being (a) of a verbatim style, or (b) of a non-verbatim style. The verbatim style messages were then further rated as to their degree of concurrence with the transcription of the verbal messages. Each clause in the message log was checked against each clause in the log and rated according to

(i) whether it was an exact replication in total of the call;

(ii) whether any clause exactly matched any clause in the log;

(iii) whether any clause nearly matched any clause in the log, (nearly) being defined as no more than five words being transposed in order or changed.

It should be emphasised that in this respect we are talking about the ordering of the surface structure and not the underlying meaning.

Results

The results of this survey are shown in Table 12.1.

Table 12.1 - Surface structure comparison of 999 call transcripts to message logs

Non-Verbatim Style	Verbatim Style Number of logs which contained a single clause which had:		
	Exact Translation	Some Surface Similarity	No Surface Similarity
10	2	46	132
Totals 10		180	

It can be seen that of the 190 messages 180, or nearly 95%, were in the verbatim style. Of these message logs not one exactly replicated the section of the conversation.

The number of message logs which contained a clause which exactly matched a clause in the call was only two (in this case this also amounted to only two clauses as there was only one identical clause per log). The number of logs which contained a clause which was judged to be similar on the basis mentioned before came to 46, or approximately 26% of those in the verbatim style, whilst the majority of logs in the verbatim style showed no appreciable surface relationship to the words used in the conversation.

Discussion

It would seem therefore that the information which eventually reaches the log is transposed to some considerable degree by the operator from the information which he receives in the call, into some linguistic style of his own. In terms of the main focus of this research this is not necessarily a bad thing, providing the important and essential meanings extracted from the caller are effectively deposited into the computer data base, and also used for the subsequent resource allocation activities.

The findings have a potentially serious and far reaching affect insofar as the data which is at present inscribed on message logs is on occasions used in court as first hand evidence of what the caller actually said.

Traditionally, a great deal of weight has been placed on records of this nature which are (supposedly at least) made at the time of the transaction. They are generally believed to be accurate transcriptions of actual words spoken. In normal discourse, of course, it does not matter very much if the surface structure of an utterance is changed drastically, providing the meaning is essentially the same. However, in many court cases different interpretations are frequently placed upon the same surface structure, and it is not unusual for police officers to be questioned very closely on the "exact words" used by defendants and on occasions by other relevant witnesses.

The findings of this section suggest, as has been well known in psychological circles for a long time, that human beings do not operate particularly well as tape recorders. The results fit in well with the work by SACHS (1967) and WARNER (1974). These revelations may come as somewhat of a shock to the legal profession, and it could certainly be unsettling to the evidential procedures currently adopted in the Police Service with respect to written notes made at the time.

Note

A further indication of surface structure inaccuracy can be seen in relation to Message Log timing in Appendix VII.

ANALYSIS OF MEANING

The finding that the surface structure of the message is being changed during its transmission from caller to log does not necessarily mean that the essential meaning is being changed. It is quite possible that the underlying or deep structure of the utterance is being preserved, and the surface structure changes are merely paraphrases. To investigate this possibility, I decided to employ a relatively simple but useful analytic tool called Proposition Analysis developed by the Open University Social Sciences Faculty for their course on Cognitive Psychology.

Proposition of Analysis

A certain amount of work has been carried out since the original writings of CHOMSKY in attempting to break down surface structure of discourse into units which might be said to represent in some way the essential meaning of the communication. The unit which is often reserved for this particular activity has been called the proposition. The major difficulty however seems to be that although the idea for a proposition is widely used throughout linguistics and cognitive psychology, there does not seem to be any unified definition. For instance, the sentence in CLARKE and CLARKE (1977),

'the old man lit his awful cigar'

would in terms of the Open University's propositional analysis only constitute a single proposition (STAINTON ROGERS 1978), whereas according to CLARKE it could be broken down into nine separate propositions. This is a somewhat extreme example, and essentially the various 'propositions' do not conflict insofar as they do not cross boundaries, but merely reflect a difference in opinion as to how far the sentences should be decomposed before the individual elements are given the title of 'proposition'. Essentially in the CLARKE view, each assertion concerning the event, constitutes a new and separate proposition. In which case each adjective and even each inference that the information has been previously recorded (in this case by the use of the word 'the'), constitutes a separate proposition. Whereas in the O.U. version only the main action, (i.e. in this case the lighting of a cigar), constitutes a new 'propositional triplet' as they call it. In some ways the term propositional analysis is misleading, as the more detailed analysis of the Clarke system is much closer to the traditional level of breakdown which has been employed in componential analysis and procedural semantics. The Open University system is much closer to the case grammar of FILMORE (1968) and also has certain similarities with the idea of templates by Yorick WILKS (1973).

I shall return to the more exact definition of the Open University system in a moment, but first I would like to describe work by KINTSCH and GLASS (1974) on the effect of propositions in sentences. Their propositions were closer to the Open University definition than the componental analysis systems. They found that if there were more propositions in a sentence (keeping the number of words static) the subjects processed the sentence more slowly. This tends to underline the relevance of the proposition as a meaningful unit of comprehension. In a later study they scored certain propositions as being central in passages of prose, and they found that these higher order propositions were more readily recalled by subjects. This is similar to the results of THORNDYKE (1977). He used a system which had originally been devised by RUMELHART who divided stories into hierarchies of settings and episodes. The higher in the hierarchy the more central was that particular episode. THORNDYKE found that persons could recall the central theme of the story much more readily than the less important episodes. GOMULICKI (1956) scored the number of ideas which were correctly reproduced from a prose reading. He found that subjects were more likely to remember aspects which they considered to be important. JOHNSON (1970) had ideas in a set of prose judged by one set of subjects on the basis of importance, and then gave another set of subjects the same prose in a real experiment. He found a high level of correlation between the propositions judged to be important and those which were easily recalled. Similar findings have been made by MEYER (1975), BOWER (1976) and CLARKE (1977).

Open University System

The Open University propositional analysis has a varied geneology extracting aspects from KINTSCH's Propositional Analysis, whilst at the same time being related to the Solo (Artificial Intelligence) Computer Data Base which is employed by the Open University (EISENSTAD 1978).

Essentially, the Open University system is a simplification of normal propositional analysis as used in componential analysis and procedural semantics. The major difference being that the O.U. system does not carry out the analysis to the same atomic level. Their analysis is centred around the main verb in a clause and takes the form of (in the simplest examples) 'subject-verb-object'. It can be seen immediately that this has great similarity with

FIL 1ORE's Case Grammars (FIL MORE 1968) where in his simplest example he uses 'agent-verb-recipient'. The lineage from the Solo Data Base is also apparent in so far as elementary assertions are normally designated in the form of 'node-relation-node'. Example of sample sentence is shown in Figure 12.2. The sentence here has been analysed using the O.U. system at the top of the page and then again further down using Kintsch's more detailed Propositional Analysis.

The major difference between the O.U. system and other systems is in the method of dealing with adjectival and adverbial clauses. In most forms of propositional analysis these are considered to be separate propositions, whereas in the O.U. system they are normally attached to the superior (or kernal, to use MILLER's phrase) proposition. The O.U. system generally gives a simpler and more easily read presentation. Another factor of the O.U. analysis, which emphasises the similarity to a Case Grammar, is the fact that the location and timing of events are also included in the proposition, on the basis that all events must occur at a location or at a specific time even if these quantities are unknown.

The Open University system includes some additional concepts of semantic complexity in so far as it records the number of subordinate propositions (which they called levels). I have not included this particular part of the system in this analysis.

Method

A random sample of 51 emergency calls were recorded and transcribed. The relevant message log for each call was obtained, and the O.U. Propositional Analysis System carried out on both the call transcription and the related message log. The previously described system to check the accuracy of the transcripts was followed. The propositional analysis was noted on special forms and summary forms of each log were produced. The results were then analysed using a computer programme developed for this purpose.

The following measures were taken:

1. The number of propositions in the call
2. The number of propositions in the log
3. The number of propositions which were identical
4. The number of propositions which were similar

The first three measures are relatively objective and unexceptional, however the fourth evaluation of similarity does require a degree of judgement. A fairly simple definition was used, merely that the propositions had only minor changes of the adjective or verb used, and otherwise described essentially the same event. For instance, 'John smashed a window' and 'John broke a pane' would have been recorded as similar. Only the text proportion of the message logs and the phone call were analysed in this exercise. Information concerning the caller's identity and location etc. were ignored. The objective was essentially to obtain information concerning the propositional content of the "story".

Results

Fig. 12.2 - Comparison of Various Propositional Analyses of an Item of Prose

Prose Sentence

Romulus, the legendary founder of Rome, took the women of the Sabine by force.

Propositional Analysis of Kintch's Method (1973 version)

Proposition 1	(Took, Romulus, Women, by force)
Proposition 2	(Found, Romulus, Rome)
Proposition 3	(Legendary, Romulus)
Proposition 4	(Sabine, Women)

Propositional Analysis by Open University Method

Proposition 1

Subject	=	Romulus (legendary)
Verb	=	was founder of
Object	=	Rome

Proposition 2

Subject	=	Proposition 1
Verb	=	Took
Object	=	Women of the Sabine
How	=	by force

Table 12.3 - Analysis of propositions in emergency calls and log

	Mean	SD
Number of propositions in the call	6.25	2.79
Number of propositions in the log	3.33	1.76
Number of propositions in the log which were identical to propositions in the call	1.12	1.34
Number of propositions in the log which were similar to propositions in the call	1.08	1.06

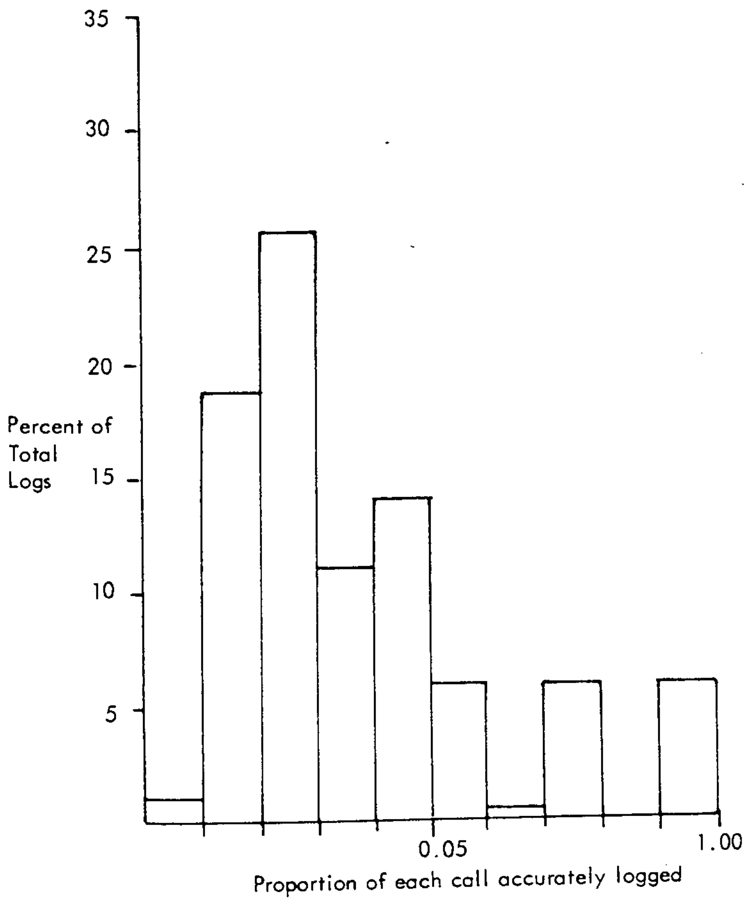


Fig 12.4 Proportion of call which was accurately represented in the related message log.

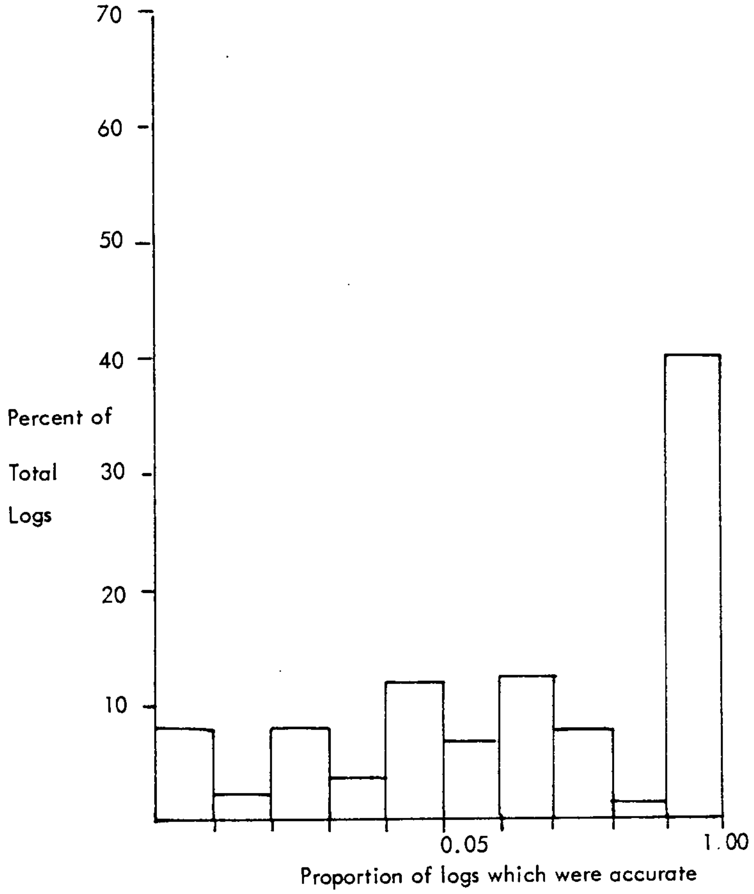


Fig 12.5 Proportion of logs which were accurate

Discussion

It can be seen from Table 12.3 that the number of propositions in the average call came to 6.25 with a standard deviation of 2.78. In the logs this was reduced by nearly a half, to an average number of propositions of 3.3 with a standard deviation of 1.75. Overall approximately two-thirds of the proposition in the log were either similar or identical.

The first factor which can be seen is that which might be expected. There is a fairly drastic reduction in the amount of information which is entered onto the log. The total number of propositions in the log as compared with the total number on the call is approximately one half. In addition, if one looks at the proportion of propositions which are in the log and accurately represent a statement made in the call, one finds that these amount to only 35%. In other words, in the typical call one can expect approximately 35% of the information which is given by the caller to be accurately represented on the log.

Figure 12.4 shows the distribution of the sample which was considered in this analysis and it can be seen that the modal distribution between 20% and 30% of the log. (As the distribution is skewed, naturally the mean and the mode do not coincide.) It was found that 45% of the logs had no single proposition which was absolutely identical but only 8% failed to have a single proposition which was either identical or similar.

This points to a considerable degree of selectivity insofar as the type of information which is actually extracted from the call and inserted in the log, and this is as one might suspect.

Figure 12.5 investigates the slightly different transformation which is seemingly taking place in these logs. Obviously the amount of information is being reduced, but is the message retained an accurate representation of information which was in the call?.

Figure 12.5 plots the percentage of each log's propositions which were accurately represented in the call (i.e. in a sense it is a reverse of Figure 12.4 insofar as we are saying, given that a log X contains a number of propositions, how many of these are accurate, or similar?). The distribution is rather interesting as it can be seen that there is very high mode at 90-100% with approximately 42% of all logs having 90+% of their propositions as accurate. The other 58% is spread relatively evenly. It can be seen that 34% of the logs had about half of their propositions as inventions.

The 42% which showed high accuracy were examined. There seemed to be two distinct features about this group. They were either:

(i) made up a very high proportion of relative simple incidents such as road traffic accidents, fights or reports of theft, or

(ii) the log has been drastically reduced from a complex call to only one or two propositions.

This sub-sample was effectively too small to carry out a comparison by topic category, and the cell counts would be too low.

Conclusion

Two major effects seem to be demonstrated by this investigation:

1. There is a dramatic reduction in the amount of information from the call to the log, and

2. A relatively large percentage of the logs contain a high proportion of inaccurate statements.

Most of the logs however seem to contain at least one proposition which is reasonably accurate. It seems from the observations made during the course of this investigation that most of the inaccuracies occur in what might be described as the subordinate propositions, i.e. those which are less important. This is a finding which is very close to the experimental findings by GOMLUCKI and KINTSCH and it also has a relationship with MILLER's idea of "kernal" concepts. It would seem that what the operator considers to be most important he can record with moderate accuracy. However, I think that most investigators would view the very poor showing on subordinate propositions as somewhat alarming given the important nature of this data collection operation.

JUDGEMENTAL ANALYSIS

The findings in the section on propositional analysis were relatively clear However, in order to support those findings I decided to approach the same problem using a slightly different instrument, to ascertain whether they could be substantiated using an alternative methodology. Towards this end I devised a relatively simple judgement task.

Method

A random selection of 25 calls was obtained and transcribed, care being taken to ensure an accurate transcription. The related message logs were also obtained and the two collections were evaluated by seven judges. The judges comprised of three police officers, one police employed civilian and three civilians who had no police or legal profession involvement. The judges were asked primarily to indicate on a one to seven scale whether or not the meaning in the message had been distorted, one on the scale being taken to indicate that no distortion had taken place, and seven to indicate that it had been so grossly distorted as to render it difficult to reconcile the two versions.

The judges were then asked five supplementary questions, one to indicate whether the level of detail had increased or decreased between the call and the log; whether the apparent firmness of the caller's knowledge had changed; the apparent severity of the incident, and the apparent urgency of the incident with the coherence decreased. Firmness of knowledge was taken to indicate that the caller was more or less certain about the facts, e.g. if in the call he said "I think I heard the sound of breaking glass" and in the log it said "I heard the sound of breaking of glass", then this was taken as an increase in firmness. 'Severity' or 'urgency' are self explanatory. Judging the coherence was directed at ascertaining whether the entry in the log was more coherent or easily understood than the message in the original call. All of these supplementary questions were answered by the judges ticking an anchored scale. Copy of the form used can be seen in Appendix III

The 25 messages in the sample were each evaluated separately by the seven judges. Procedure was fairly slow and it was found that 25 was about the maximum that could be asked of any judge.

The results were tabulated and analysed in a computer programme written for the purpose. Kendal's Coefficient of Concordance (W) was run against the results and indicated that there was a good degree of agreement between the judges. In addition a print-out of each judge's ratings under each heading was made and sight checked for undue variations.

Results

Table 12.6 - Effects upon the message during transfer from 999 call to message log - analysis of judgements

	Mean	SD
Level of distortion	3.44	1.50
Judgements used a 1 - 7 scale (1 = low 7 = high)		
Amount of detail	3.78	1.10
Degree of firmness	2.88	.73
Apparent severity	3.11	.61
Apparent urgency	3.10	.61
Coherence of story	2.22	.61
Judgements used a 1 - 5 scale (1 = High or Much More 5 = Low or Much Less) 3 is Midscale = No Change		

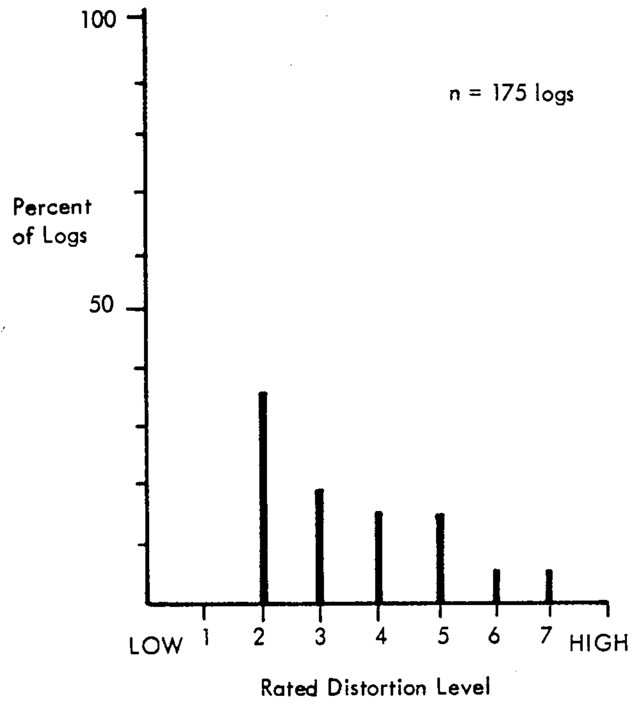


Fig 12.7 Level of Distortion of Message Log.

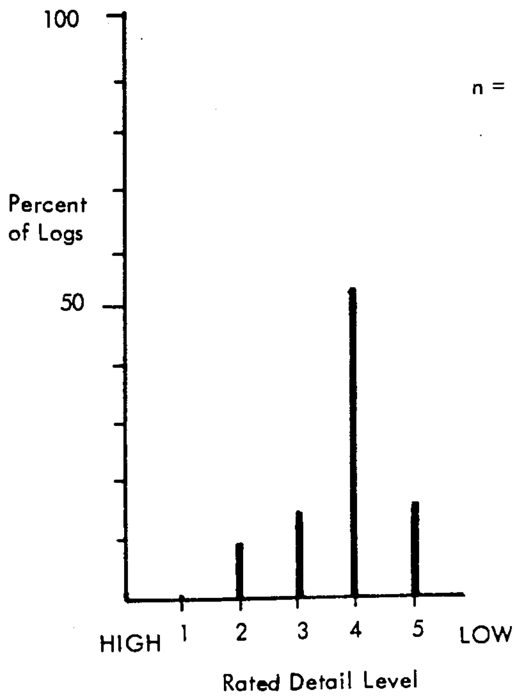


Fig 12.8 Amount of Detail of Message Log

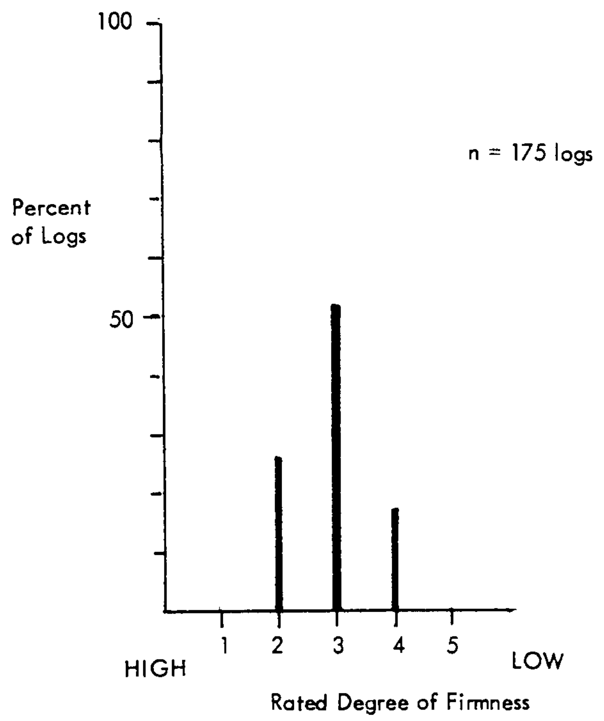


Fig 12.9 Degree of Firmness in Message Log

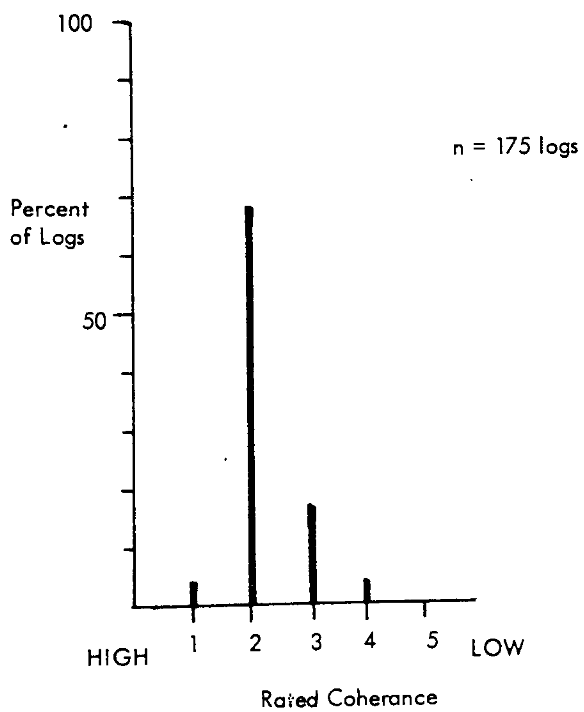


Fig 12.10 Coheronce of story in Message Log

Discussion

A relatively surprising result which can be seen in Table 12.6 was that the mean level of distortion was rated at 3.44 on a 1 - 7 scale. This means that a high number of the judges rated many of the calls as being distorted. In fact only one judge rated one call as being an exact accurate translation. Figure 12.7 shows the distribution of the distortion and it can be seen that there is a mode at distortion level 2, a sudden drop down to distortion level 3 followed by a relatively gentle tapering off towards distortion level 7. Nonetheless quite a large number of calls were rated as being seriously distorted. In many ways the distribution of the histogram has considerable similarities to Figure 12.4 which is demonstrating a similar sort of change but using the propositional analysis instrument. This similarity lends some mutual support to the two independent measures of meaning.

It can be seen from most of the judges that the amount of detail has been reduced. This is a 5 point scale with 3 being the median at no change. It can be seen that the mode of the distribution as shown in Figure 12.8 is at level 4, namely less detail, and the majority of judges gave the logs as having less detail than the call. The degree of firmness, the severity and urgency are all very close to the median value, though in the case of the degree of firmness there is a slight distribution towards the logs increasing the apparent knowledge of the caller.

An interesting finding is with the coherence of the story. There is a very dramatic result in so far as the great majority of the logs were judged as being more coherent than the telepohone conversation. This is indicative of the fact that a considerable amount of cleaning and rationalisation had taken place from the story to produce a more coherent and readable version in the log.

Comparisons of Semantic Changes by Subject

The sample in the first part of the judgement analysis was obviously too small to carry out an evaluation, of even the major subject areas. For this reason two of the judges were asked to evaluate a further 100 calls (making 125 in all for those two judges). The same procedures were adopted and then the 125 calls were analysed according to subject area. There was a high degree of correlation between the two judges. In addition findings of this judgement of the 125 messages per judge over two judges was very close to the findings of 25 messages per judge over seven judges.

For those subject areas which had a high enough sample it seemed that there was a considerable degree of variation in the level of distortion, although no single category, even with very low hit rates went below a deviation of two. Categories of general nusiance complaints, allegations of disorder, general complaints, complaints concerning crime and suspicious circumstances seemed to be those which were most distorted.

When one considered the 'amount of detail' the same subject categories, with the addition of 'domestic disputes' were the ones in which detail was most drastically reduced. The caller's 'degree of firmness' of knowledge was more likely to be exaggerated in general nuisance complaints and suspicious circumstances. However in neither of these cases was this effect particularly pronounced. 'Apparent severity' and 'urgency' did not seem to vary systematically with subject matter. There does seem to be some indication that missing persons were somewhat exaggerated in this respect, but because the samples were very small it would not be possible to place any great reliance on those results.

In the area of 'coherence of story' there was fluctuation between the various subject matters but it was of a very small order around the mean of 2.18. There would not seem to be any very great difference between the various subject matters with respect to changes in coherence.

Terminology Changes

We have already concluded that there is a considerable degree of change in the surface structure of the message from the call to the log. I decided therefore to investigate the hypothesis that particular police terms might be incorporated into the log which were absent in the call.

Method

I caused the two judges to check the logs that they had previously judged for distortion and to itemise any terminology changes that they noted. The objective of this exercise is to get a qualitative rather than a quantitative idea of the types of changes which occur. Essentially the definition of a terminology change was where some situation, event or object, was described in a call, and also described in the log but in slightly different terms. It is realised that this definition has a considerable subjective element to it. This is because the call as a whole has been proved to have considerable surface structure changes, it is a matter of judgement to decide whether the same event, object etc. is being described in both the call and the log, or where the description in the log has differed to such a degree as to be no longer describing the same event, object etc. However, although caution must be employed when considering this type of evidence, the results seemed to be sufficiently interesting to warrant the risk.

Results and Discussion

It seems that there are essentially two types of terminological changes which occur in the logs. One is a simple terminology change whereby something which is obviously the same event, is being described in different words. There are two forms to this, firstly where the new words used in the log have a distinct police flavour, and secondly where no such systematic biases can be ascertained.

The second category includes the position where the event is obviously the same one as being described, but where there seems to have been some change of meaning, or at least of emphasis.

Some examples might explain the distinction.

Simple Terminological Changes - Police Flavour

CRASH	became	ACCIDENT
PINCHED	became	STOLEN
LAMP POST	became	LAMP STANDARD
DISTURBANCE	became	DOMESTIC

Simple Terminology Changes - General

SOMEONE	became	KIDS
BLOKE	became	CHAP
SOME	became	FOUR
DURING THE NIGHT	became	OVERNIGHT
CHAP	became	MAN
DUFFLE COAT or REEFER COAT	became	DONKEY JACKET
SIDDED AND COLLIDED	became	HAS HIT
THREE BOYS	became	SOME BOYS
SOMEBODY	became	A FIGURE
SMASHED TO HELL	became	HAS BEEN HIT
IT'S ALL BUGGERED UP	became	DAMAGED TELEPHONE KIOSKS
VERY OBSTREPEROUS	became	ARE BEING AWKWARD
GONE UP AROUND	became	GONE OFF TOWARDS

Terminology Changes with a Meaning Change

SUPERMARKET ON THE CORNER	became	GATEWAY SUPERMARKET MUTLEY PLAIN
THE LADY WHO'S DRIVING	became	MY FRIEND
WE HAVE HAD A BOMB SCARE	became	THERE IS A BOMB IN
MY HOUSE HAS BEEN BURGLED	became	THE METERS HAVE BEEN BROKEN OPEN IN MY HOUSE
PLAYING	became	TAMPERING
MY GIRLFRIEND'S EX-BOYFRIEND	became	ANOTHER MAN OUT IN THE STREET

Surprisingly enough, the simple terminology changes, with a police flavour, were very much less in evidence than might have been anticipated. Although this evidence is qualitative, I consider that it would be quite impossible to support the hypothesis that the logs were being changed to a special police jargon.

The greatest category of changes were simple teminology changes whereby the same incident was described in different words. Inevitably there was some slight change in meaning but in many cases this would be judged as being moderate.

Judges' Remarks

All of the judges were invited to make any remarks they felt necessary about the changes that they noted. Most of the remarks concerned specific meaning changes in individual logs. This area has been covered in the previous discussions on proposition and judgement of meaning changes. However, a number of categories of remarks are worth mentioning in this section. There were two important points made by the judges.

1. In many cases there seemed to be no great attempt on the part of the operator to seek further knowledge which the judges felt from the tone of the whole transcription might well have been available.

2. Information which was actually mentioned in the call and which the judges felt to be important was omitted from the

log. In a small number of logs wherein criticisms of police action were made, there was a suspicion on the part of the judges that the story was deliberately edited to remove these items.

SEMANTIC DISCUSSION

The first and most dramatic finding is that the surface structure of the logs bears little relationship to the verbal content of the call. The second major finding is that as one might expect the logs contain very much less detail than is generally found in the call. This is a result which is supported by both the investigation using propositional analysis and also by the judgement tasks. Finally the coherence of the story told in the log is, in virtually all cases, very much better than the coherence of the call itself.

These findings underline that whatever else the job of a controller is, it certainly is not one of simply transcribing information passed to him by a witness. His activities involve a considerable amount of selective extraction of information. That information is then translated in a manner which to some degree involves cleaning up the message that he is given, to present it as a coherent and easily digestible story.

The actual type of changes which occurred between the meaning encapsulated in the call and that on the log are also of interest in themselves. It seems that the operator is not always certain about the location of the source of his information. For instance, in one log, the report of a coach theft, which in fact came from an anonymous caller, was inaccurately attributed to a specific coach firm. There seems little doubt in this case that the name of the caller which was omitted in the haste of the conversation was supplied by the police officer from his own local knowledge.

In a slightly different vein, one log report (attributed to the caller), stated that a car had hit a wall. In fact this information came from another log. Obviously the police officer read the second log at some time subsequent to the first call.

In yet another log, the description of stolen property which was attributed to the caller, was not available at the time of the call. The information actually came from a patrol officer who radioed in the details some time later.

There is no suggestion that this information was deliberately distorted, although in some cases of course this is possible. In many instances there is no reason why the operator should put down one piece of information rather than another. The confusions that obviously do arise fit in very well with the findings of laboratory experiments on information confusion, integration and substitution, such as those carried out by ANDERSON and HASTY, SULIN and DULING and others.

A number of calls seem to suffer from extremely gross changes of meaning. These seem to happen for at least two distinct reasons which can be epitomised by some examples. In one call concerning miscellaneous occurrences of vandalism, the caller covered such a large number of different subject areas that it is almost certain that the operator lost the thread of the conversation as a whole. The subsequent log bore very little relationship to the actual complaints made. It appeared that the operator just could not make sense of the situations which were being described in the time that he had to make his judgements. On another occasion where a similar very gross distortion occurred, a very serious and potentially dangerous situation concerning the report of a bomb in a school was described to the operator, and once again the operator in this particular case seemed to be unable to accurately assimilate the full facts. In this latter case, it is much more likely that this was because of the urgency and danger of the situation, rather than any complexity in the message. Although it is also possible in this latter case that because this type of incident, although important, occurs relatively infrequently, the operator may not have had an adequate 'schema' which he could quickly and effectively employ.

The findings regarding the terminology changes strongly suggest that the information is coded by the operators in terms of meaning rather than the specific words used, and for this reason the description which actually occurs in the log may embody different words for describing what is essentially the same facts. This is once again in line with the findings of SACHS, LIGHT and

CARTER-SOBELL and others, who suggest that it is essentially meaning which is encoded and later recalled, even after a very short time interval between event and recall.

The findings of course also are very much in line with those of BARTLETT insofar as certain items of information are sharpened and heightened, and this is similar to the arguments put forward by GOMULICKI and KINTSCH. Other details are levelled and finally the improvement in coherence that has been described is once again similar to BARTLETT's idea of rationalisation.

Many of the remarks made by the judges are of pragmatic rather than theoretic interest. Essentially the major argument seems to be that the operators are not always: (i) exercising their abilities to extract information from the member of the public and (ii) adequately attending to useful information which is actually provided. These points are all of interest to system designers.

All of the foregoing remarks concerning the inadequate collection of information, and the occasional inability to make coherent sense of the incoming information, have relevance to the concepts of schema, scripts, frames and plans etc. It can be suggested that adequately formulated scripts for the different types of situation which are likely to arise, would improve the ability of an operator to comprehend the incoming information by the creation of a meaningful context (or frame etc.). At the same time, the script would, following Niesser's view, be used as an orientating schema or plan. It could thereby direct the search for further information, and that in many cases, improvement of operator performance could be obtained by adequate training aimed at improving the operators repertoire of mental models or schema.

<u>Fig. 12.11 - Two examples of meaning transposition during passage of message from emergency call to log</u>

CALL

"I know it's a domestic affair. My husband's drunk and he's smashing all the glass and everything"

1 Know (I, Prop 2)
2 Domestic (Affair)
3 Drunk (My husband)
place,

4 Smash (My husband, glass, now)
5 Smash (My husband, everything, now)

LOG

"Please come quick my husband has come home and is breaking the place up and smashing the glass"

1 Come (You, here, quick)
2 Come (My husband, home, -)
3 Breaking up (My husband, now)
4 Smash (My husband, glass, now)

Fig. 12.11 cont.

Call

"There's three boys broke over the back wall and they been stolen the tiles on the top shed" "and they come down and unbolted the back door and gone out that way"

1 Boys (Three
2 Burgled (Prop 1, premises (presumably garden) (broke in))
3 Climbed (Prop 1, over wall)
4 Stole (Prop 1, props)
5 Tiles (On shed)
6 Climbed (Prop 1, down from shed)
7 Unbolted (Prop 1, back door)
8 Gone out (Prop 1, from (premises) through back door)

Log

"Some boys have broken into my shed and stolen a saw"

1 Boys (Some)
2 Burgled (Prop 1, my shed (broke-in)

3 Stole (Prop 1, saw)

CHAPTER THIRTEEN

VERBAL PROTOCOLS

Induction

It has become apparent from the results in the previous chapters that the control room operator does not accept information and transcribe it or pass it unaltered onto the third party. A considerable amount of selection and distortion takes place and this leads us to an investigation of the mental processes which mediate such changes. This is therefore the first of a number of chapters which aim at throwing some light on the cognitive processes of operators and the possible form of their mental models.

In this chapter this ambitious task has been attempted using an instrument popularised by Lisanne BAINBRIDGE namely VERBAL PROTOCOLS. In the following chapter another slant will be taken at the control room operator's mental models using CONSTRUCT theory.

Description of Technique

Essentially the verbal protocol technique is simply a matter of asking a process control, or similar operator, to think aloud whilst he/she is carrying out his task. The idea is that the operator will thereby describe those aspects of his mental behaviour which mediate his control activity. The investigator is then able to analyse the statements that he makes in a number of ways; either by content analysing the explicit statements, or by using judgements on any information which is implicit in the statements that the operator makes. The form of analysis can be rudimentary in so far as it merely categorises and counts the number of statements according to some syntatic rules or more complex when it attempts to divine the unlying semantic elements.

In all cases verbal data has been found to be a rich and interesting source of information. However since the beginning of psychology as a science, the validity of the spoken word in so far as it may purport to describe genuine cognitive events has been suspect.

The major difficulty as described by BAINBRIDGE (1979) is that there is no evidence to support the notion that the processes which mediate the production of the verbal protocol are necessarily the same ones which control an operator's behaviour, be it physical or ental. Indeed there is evidence suggesting that verbal self description of an operator's activities does not in all cases correlate highly with objective measurements of his behaviour. FARBER (1963), COOKE (1965) and NISBETT & WILSON (1977) all found that people could report influences in situations, but they did not necessarily consider those influences when operating equipment. NISBETT & WILSON (1977) suggest that people do not necessarily consult a memory of the mediating process but apply and generate causal theories about the effects of a particular type of stimulus and its most reasonable response. In this respect they provide reports which are very similar to those of observers. This suggestion follows that of DUNCKER (1945) in arguing that people have no special access to their own thought processes. The view that they build up or rationalise reasons for carrying out various activities is very similar to that noted in the preceeding chapters on semantic analysis, particularly in the work of BARTLETT and others.

Even if the verbal protocol does coincide with a description of the mediating cognitive process, there may still be distortions which are caused directly by the verbalising procedure because -

1. It is very likely that many complex skills do not have verbal labels and, by forcing a description one is bound to obtain information which is in some degree distorted. SCHUCK & LEAHY (1966) specifically studied this problem and noted that events which had obvious verbal labels were very much more likely to be reported than those which did not.

2. The presence of an investigator using this technique may encourage the adoption of uncharacteristically formal procedures. There may be two reasons for this. In the first place many "official" procedures are particularly well laid out in a verbal manner and it may be the case that they are simply easier for the operator to verbalise.

In addition and from a slightly different view-point RYAN (1970), states the investigator will in fact set up a social situation which to some degree must affect and differ from the real operating situation which is in extant when the experimentor is absent. If, in addition, the investigator is thought to be an authority figure, then many of the normal short cuts and easements are likely to be curtailed. The knowledge of the investigator will also affect the interaction. As BAINBRIDGE (1979) states, the type of protocols that an operator will give to a person whom he perceives understands the processes which are being controlled, will be very different from those which he offers to a relatively naive investigator.

3. It is possible that the act of verbalising may actually change the operator's mode of working for none of the reasons mentioned above. It may be simply that forcing him to verbalise causes him to concentrate on aspects of his behaviour in a manner which is abnormal. GAGNE & SMITH (1962) found that for some tasks, causing an operator to verbalise significantly increased the efficiency of his performance.

Types of Analysis

BAINBRIDGE and others have attempted various means to make this type of data as objective as possible, namely by the use of frequency counts on explicit statements. However, this seems to be a somewhat doubtful device particularly in processes where the workload becomes heavy. LEPLAT & BISSERET (1966) in their study on Air Traffic Controllers argued that the more difficult processes are less likely to be reported. There may be a number of reasons for this but one of them certainly is that the verbal protocol itself must be considerably similar in nature to the secondary tasks which were often used to analyse various concepts of mental load in the past. If this is the case when the operator's predominant task, (e.g. process or an air traffic controlling operation), becomes heavy then he is likely to shuffle out of his current repertoire of activities the secondary task of verbal protocolling. It therefore seems likely that at the very time when the investigator is most interested in the data, namely when the operator is under the greatest load, his information becomes more patchy and scarce if not non-existent. LEPLAT et al's observations are supported by KING (1978) who found that validation between protocol statements and observed behaviour was quite good when the level of activity was low, but the corrollation between the two sources of evidence dropped dramatically when the operator became busy.

BAINBRIDGE (1979) and UMBERS (1979) seem agreed that whilst Verbal Protocols as a technique has great merit, it cannot be used unaided to test hypotheses concerning the cognitive activities of human operators.

If verbal protocol data cannot be used to test hypotheses what is its value as a data collection technique. BAINBRIDGE suggests three main valid objectives for using verbal data.

1. As a source of hypotheses about mental behaviour.
2. To test theories of verbal or a report generation, and
3. Verbal data may be collected as direct evidence if it correlates sufficiently highly with observed behaviour to be useful for practical purposes.

In this investigation I intend to use the verbal data in order to generate hypotheses about potential types of mental models employed by the various operators and also in some cases, using Lisanne BAINBRIDGE's third criteria, as tentative support where the information provided by the verbal protocols is well supported by other observational data. My view of verbal protocol as a technique is that it provides a source of information which is too rich to ignore, but which at the same time is not amenable to simple quantitative analysis. I do not therefore intend to use the information other than to tentatively point out various types of mental model which operators may employ. I do not think that frequency counts of this type of data are particularly useful under the circumstances of a police control room operator, and I have therefore not employed them. The essential difference is that I have itemised the comments made by operators under the conditions upon which the protocols were obtained, without attempting to prove any relative frequencies of one type of operation with respect to another.

Method

The method which I employed to obtain the verbal protocols changed slightly during the course of this investigation. Normally this would be a serious defect, but as I am only attempting to obtain categories of information rather than to prove that cognitive events of various types have certain levels of activity, I consider that the licence taken to be quite justified, particularly as it provides a very much richer source of information.

In the first instance, control room operators were asked to give me comments immediately they had received a '999' emergency call. It was my intention that they give me a brief resume of their impressions and actions in the immediate post-call phase. I was surprised to find however, that during some types of call, operators were able to give me verbal statements during the connection. This occurred where the caller was engaged upon what the operator sometimes referred as "rambles". I captured the information by making notes at the time and also by use of a tape recorder. There were three difficulties immediately apparent from this type of data collection.

1. In the first case in the majority of control rooms an emergency call can come in at any one of a number of consoles, as it was not possible to man every console with an investigator, this meant that the investigator had to move to the operator who was currently receiving the call. Even if the investigator was strategically placed in the control room this still tended to mean a degree of disruptive movement.

2. The use of an investigator and a tape recorder was found to be somewhat inhibiting insofar as the protocol could be overheard by other members in the control room.

3. The amount of data which was captured was extremely patchy and as attempts were made to cover the types of calls received over a representative section of the daily workload, it was found that a number of days could be spent in a control room (particularly on early turn) and very little data obtained.

One of the devices which I employed to attempt to overcome the problem of the emergency call operator being influenced by his comrades listening to his protocol, was to ask all operators to verbalise some aspect of their task whether or not it was a matter which was the subject of this investigation. This had the joint effect of (1) giving them something to do and (2) making them look equally silly if they attempted to ridicule their colleague. Whilst engaged in this activity I found that a great deal of interesting verbal material was being produced, not only by this diversionary tactic, but also in the course of normal communications within a control room. Therefore for the second half of my investigation into mental models using verbal data, I set up a central microphone in a control room and recorded all normal conversations within the room. At the same time I was present within the control room to make notes on the various activities. This latter approach yielded some highly interesting data and some extracts from the protocols obtained on two relatively busy nights have been included in Appendix IV.

Once the protocols were obtained they were then checked against the notes and carefully written out in longhand. The protocols were then typed and checked again against the recording. The protocols were finally checked and categorised. The results shown in Apppendix V contain an example of some early protocols together with rough annotations by the investigator.

Results

Essentially there were two distinct types of communication reported in these protocols.

1. There were statements made expressly for the benefit of the researcher who was present in the control room.

2. There were the normal control room commands, requests for assistance, information etc.

The former data contained considerably more information concerning the operators (perceived) models of their environment etc. and as one would expect the latter 'control' communication was able to illuminate the more dynamic and specific aspects of a control room's workings.

OPERATORS MODELS

The protocol statements tended to suggest that the operators had distinct models about different elements of their tasks. The main features which were noted concerned - (a) The incident, (b) The informant, (c) The characteristics of the various resources, (d) a probability model of events by time, (e) a probability model of events by location.

I will briefly describe each of these with the type of comments which lead to my inference.

Incident Model

One of the most dramatic illustrations that I received during these observations concerned an operator augmenting the information that she had received occurred in respect of a serious road traffic accident.

The operator said -

It's an R.T.A. - serious head on fast stretch of road out there. Caller doesn't know if anyone injured. Will need Fire Brigade.

A check of the tape of the '999' call showed that in fact the operator was given exactly that information. On the basis of her knowledge of the road and the fact that the person said that he thought that it was a head on collision, she inferred that it was a serious accident and took the extraordinary step of calling the Fire

Brigade before any Police vehicle had been sent to the scene. Her actions were entirely justified, as the incident transpired to be a double fatal accident. The Fire Brigade were needed to cut out an injured person from the wreck. Similar less dramatic incidents illustrate that operators have special views of various types of incident per

> "It's an alarm, at this time of evening it's likely the staff setting it off in error, so I just tend to send a unit and call the keyholder."
>
> "This sounds like a hoax all three services are there now."
>
> "Very peculiar he said two boys have been attacked, but he didn't know who they were and he didn't know where they were. I'm not going to take any action on that one."
>
> "That's a surprise that 'clock' result is further enquiries. I would have bet that it was a duff one, just shows."

It would seem that the operators are trying to fit the incoming information into a pattern, and this was very aptly stated by one Sergeant when trying to explain his actions.

> "You've got to fit things into a pattern. You've got to do this to a certain extent, an R.T.A. is dealt with in a different way from a rape or assault. So with a traffic accident you know that you've got to look for certain things. .... it's in your mind when the person rings in .... you're not interested in a lot of other things. We've got a preconceived idea of an accident and then you put the facts of this new accident around your ideas of what you do for an accident."
>
> "Now an assault's something else .... an assault conjures up a picture of someone being injured, so that means you've got an offender, you might have witnesses .... personally I never think of what the actual assault looks like. I don't conjure up a black eye or a bleeding nose .... just, you know, abstract things called an assault."

This last quotation is a very graphic illustration of what the operators seem to be attempting. They have a template of an incident which obviously has considerable variations depending on aspects such as seriousness and the area covered, but at the same time certain items of incoming information are likely not to fit any type of incident of a certain category. There therefore seems to be a certain degree of pattern matching behaviour in order to validate both the veracity of the incoming information, and also to accurately categorise the incident in terms of type and severity. There were a great number of comments on the subject of domestic disputes. They seem to be particularly difficult to deal with because a very small change in the actions at the scene of an incident (between the two or more parties), can cause a dramatic difference in the end result i.e. from 'No further Police action' to a full murder hunt.

Informants Models

It became obvious from these protocols that the operator expected a certain type of response from the callers under various conditions. If they didn't receive something within a reasonable range of their expectations then they began to immediately doubt the veracity of the caller. Some quotations may exemplify this statement.

> "Seemed to be a nutcase. Didn't seem to make sense to what he was trying to tell me. The story and tone of voice was not right."

> "It's a boy complaining of assault. .... Don't know that address. .... He didn't sound fifteen. That kid was never fifteen. Didn't sound too serious."

"Armed man - nutter! Know her she's always on. That was obviously a hoax. Wasn't clear about the incident. Rang off immediately."

"You can listen to a '999' call and within a few seconds if you like, can turn up exactly what they're meaning. .... I'm not sure if it's logical, it must be something in the brain. It seems to be the instant you hear it, it doesn't ring true."

If a woman breezing in and says "Oh, I was raped" in a light tone, the natural tendency is to say "Oh yes, tell me more my dear."

"His attitude told me it was urgent, wanted to get me there."

Resource Models

Resource models can take on a number of different aspects. Primarily there are the obvious physical differences between resources, such as one car may be double crewed whilst another isn't, and these are comments which are often made when the operators are deploying resources. In addition the operators may make inferences concerning the ability and/or temperament of the resource they are considering sending. Comments such as:

"She's useless always wants back-up for every job she goes to."

"XYZ is on call and he's a law unto himself."

"Old Dave there he's got this attitude with him (referring to a unit come in over one of the radio channels). He gets so excited, the trouble with him is that he eventually gets the operators going."

"We've a bloke on here at City Centre who never flaps, a couple of weeks ago he came up on the radio and said 'I think I'll have a 10-9' (Police Officer needs assistance) and he was in a battlefield down there. Well when he asks for assistance you know that he needs it."

These models are not of course confined to Police resources:

"You'll end up getting down to Yelverton garages again, Ern. They'll come anytime."

The behaviour of the control room obviously is mediated by their views of the various resources. One interesting series in the protocol illustrates how the information passed to a unit can be changed dependant upon the perceived character of the attending Police Officer. The control room Supervisor on one occasion instructed his operator not to give too precise details concerning an incident to which he was sending a traffic vehicle. His reason was that if he told the unit the full details (it wasn't a traffic matter) he might end up with some dissention from the unit about attending. On the other hand if the unit just arrived at the scene he would have to get on with it. The message that was therefore passed was very slightly ambiguated.

Time Models

There seem to be a great number of models to which operators attest to concerning the probability of incidents over time, both throughout the 24 hour, weekly and yearly cycles. Whether or not they actually use these models for any particular purposes is unknown. Comments such as:

"You'll get a quieter period later on," or

"The R.T.A.'s start just after five" etc. are legion.

The fact that these comments are highly subjective is underlined by the number of operators who inform me that it always seemed to be busy when they were on quick changeover (i.e. they'd had very little sleep).

Some of the models seem to be complex in the extreme as evidenced by this quotation.

> "The late shift is always busy. You can get a lull about now. The traffic gets very heavy. It's going so slow innit, about ten miles per hour, then the only accidents that would happen are ones which we wouldn't know about. But just prior to this time or, just after when things quicken up a bit, especially after the drivers have had a bit of frustration when they've been held up then they've got an open road and they're gone. That's when you get the accidents."

Location Models

All of the policemen seem to have differential probablistic expectations concerning the frequency and nature of incidents in various geographical areas. This seems inately logical but it's quite possible that their probabilities differ from those of an ordinary member of the public. Statements such as

"We get a lot of problems with peeping toms on that estate"

or "breakers go to the big houses at the posh end of Blandford Road"

or "tonight people will probably stay drinking in their locals"

and of course the predictions of accidents on certain roads were all very well represented in the verbal protocols.

Specific Information

In addition to the type of information which was obtained which suggests that the operators have various models for evaluating and predicting events, the protocols also illuminated a great deal about the more mundane, but none the less essential, aspects of communication within the control rooms. There once again seem to be two particular elements to this.

Firstly there was a continuing briefing of the Supervisory Officers by the operators dealing with the incidents. This briefing although aimed primarily at the supervisory officers was obviously considered to be of benefit to all persons in the control room. The object of this was apparently to ensure that all persons maintained some form of status model concerning the current dynamic state of affairs. In this respect operators would report -

> "I have just dealt with a break at City Social Club" or
>
> "I have got a fight down on Union Street between three marines and two sailors."

These reports were not necessarily made for confirmation of action, but seemed to be fulfilling some form of briefing function.

Secondly there was the normal request from operators and indeed on occasions from the Supervisors for advice and/or specific information. The most common form of information requested was the location of roads, incidents, buildings etc. In addition however there were requests for confirmation that their particular incident was not being dealt with by somebody else in the room, or that a certain procedure was currently still adopted. In this way the cumulative knowledge of the whole control room was often made available to an operator dealing with a particular incident and in many cases this considerably reduced the difficulty of his task. Two incidents illustrate this fairly well. In one protocol the P.N.C. operator as way of briefing to other operators said:

> "Bloke down there beating hell out of his daughter. Police car on the way."
>
> WT, "Serg. I monitored that one. I reckon she's the one I had the other night. She came home drunk and her father hammered her. But she deserves it."
>
> PC "Linda XXX, I'll check her out."

In this respect the operator's previous knowledge immediately placed a different complexion on the severity of the incident. Similarly in another protocol:

> PC "Call! old lady Delaware Gardens locked out."
>
> WT "I think that you'll find that this particular old lady has got the key wrapped round her neck."

Once again the prior knowledge of the operator was able to reduce the amount of effort put into responding to this call.

Pressure

A number of the operators referred to pressure which they experienced in the control room. Two or three said it took them over an hour to unwind following a tour of duty. In addition a number of operators stated that during periods when they had calls stacked awaiting free resources, they felt particular pressure and tension.

Supervision Effects

An interesting point demonstrated by the protocols was the effect on supervision caused by an increase in workload. This can be illustrated from the protocols of the supervising sergeant and P.C.s. The nature of their instructions to the WT operators concerning the despatch of resources to attend incidents, is obviously mediated by the amount of knowledge they have concerning both the resources at their disposal and also the incidents. To an extent this has been referred to in the section on mental modals. It would seem that there is a continuum from a position where the constable or sergeant has complete knowledge of both individual incidents and the general situation regarding calls for police assistance within the area of his control, and also full knowledge of both the resources available to deal with those incidents and their current state of readiness. This situation can usually be noted at periods of low workload and is amply indicated by the direct and firm control taken by the officers under the circumstances. Protocols such as:

"Send Unit 1 to Debenhams, they will be met at the stores entrance by Mrs. Sherfield to deal with a female shoplifter," or

"get 3.5 as well, there is a heck of a fight going on there."

This type of instruction indicates that the supervisor has full knowledge (as full as possible) of the incident and also has a clear understanding of the availability of units. He has matched these two disparate conditions and come to a decision on the correct unit to allocate, giving clear orders which indicate that he is fully in control of the situation. This situation does not seem to be the norm and occurs invariably under conditions of light incident load.

A more common form of instruction is in the form of,

"Send someone to the Lion and Column, there's a fight in progress," or

"Can we get someone to check the paper shop in New George Street", or

"Gordon, can you get a unit to ....".

This situation indicates that the sergeant has reasonable knowledge concerning the incidents, but no longer retains an up to date evaluation of resources and their current state of readiness to respond.

An alternative but less frequent median position seems to be noted by protocols which say,

"What have you got down at Bretonside, Ron?"

indicating that the supervisor has noted that an incident is going on about which he has no knowledge. This is less likely to occur as invariably incidents are reported initially via the constable or supervisor and then passed to the WT operator. This therefore allows him, if he is not unduly loaded, to monitor or at least be aware of an incident's existence. Any loss of knowledge concerning an incident is usually in terms of how it is progressing rather than its existence. Protocols such as

"How did the Griffin finish up, do you know Gordon?"

indicate that the supervisor is aware of an incident's existence but not its current status.

Under heavy load conditions the situation seems to occur in which the supervisor's level of knowledge is low, in relation to both resources and incidents. This mainly seems to occur because he is personally dealing with either one area or, on occasions one particular incident. Protocols such as

"Who have we got out at Devonport?" or

"What's going on in the Bretonside area?"

tend to indicate low knowledge of both incidents and resources.

There therefore seems to be a continuum from light incident load to heavy incident load in which the defacto nature of the supervisor's job changes from one of relatively complete control and co-ordination at low incident levels, progressively to a low level of control at high incident levels. Effectively, therefore, the authority within the control room and the various work load levels shifts from the supervising officers consuls outwards towards the WT operators under these varying incident load conditions.

CONCLUSIONS

The subjective evidence presented in this chapter strongly suggests that the operator has models about many elements of his task. It is not, of course, suggested that the five models presented are in any way exhaustive or definitive.

What is indicated is that the operators use the models to augment the limited amount of information which they frequently receive from emergency calls and other sources. The whole tenor of the protocols indicated a sifting, probing and discriminating activity aimed at making sense of what was frequently incomplete information. The control room staff are required to manipulate a remote world, and all of their information concerning that world is gathered second hand from either members of the public, or the resources which they despatch to attend to incidents. Their task imposes a vital need to maintain an understanding of the very dynamic events which are occurring, in order that they can apply controlling action. It is this theme which is central to all of the protocols which I have recorded.

The essential point seems to be that all items of information are evaluated against the models held, either individually or collectively, by the control room staff. In this they are probably no different from any other human being, only their activity in this respect becomes particularly prominent, because of the requirements of police resource control.

The protocols which did not directly refer to models tended to indicate the dynamic nature of control room work, and the need for officers to be thoroughly briefed to do their job. Once again, the continuing attempt to maintain an overall picture of the current situation was emphasised.

The points which were made concerning both the supervision and also specific difficulties concerning knowledge of geographical locations, are all matters which have direct relevance to design of control room systems, both of the computer and non-computer variety.

It is very difficult to know whether the operators actually use all of the models which they suggested during these protocols. My impression is that with some of the more complex models there was more than a little element of rationalisation. However, this is only a factor which could be fully investigated by a study aimed directly at this one particular item.

The major point does seem that control room operators are certainly not passive acquirers and transcribers of information.

CHAPTER FOURTEEN

OPERATORS' CONSTRUCTS

The objective of this investigation was to explain the behaviour of operators in dealing with 999 calls, which I had noted in the earlier enquiries.

Preceding chapters have attempted to demonstrate in one manner or another the actual behaviours that operators traditionally exhibit. It is to be supposed that their reactions to the various calls they receive are based on some internal model of the requirement for their job, and this presumably in some way reflects their past training and experience of the task itself. To an extent an evaluation of their views concerning the way they regarded aspects of their job was embodied in the original survey work. What I wanted to do in this particular phase was to use a more sensitive instrument to attempt to discern at perhaps a slightly deeper level, the elements that they considered most important in their job.

Construct Theory

The instrument that I decided to use is based on Kelly's Theory of Personal Constructs (KELLY G.A. 1955). The essence of Construct theory is that it regards man as a scientist (BANNISTER and FRANSELLA 1971), who is continually attempting to make sense of his world. KELLY embodied this in his fundamental postulate which states "a person's processes are psychologically channelised by the ways in which he anticipates events".

The argument is that a person develops 'constructs' which he uses to evaluate the objects, events or persons etc. which form part of his environment, and with which he has to interact. The idea of constructs is very similar to the axes in Osgood's Semantic Differential (OSGOOD, SUCI and TANNENBAUM 1957). The main difference is that in the semantic differential approach the axes are provided by the experimenter or the clinician. In Construct theory the constructs are provided by the subject himself. Kelly argues that people may have large or small construing systems. Constructs have a range of convenience. In other words, a person only applies relevant constructs when making an evaluation of a situation or event etc.

The fundamental idea is that by employing a large number of constructs (or semantic axes) with which to describe some object or situation, it is possible to fix that object in dimensions of what may be termed semantic space. Any later objects which come up for consideration can then be viewed in what is almost a spatial relationship (within the semantic space) with the original object. The object of a person's thoughts, is in Kellian terms, labelled an element. (SMITH 1978).

Constructs can be of many types varying from the relatively abstract descriptions such as good-bad, weak-strong, to those with a more specific orientation, epitomised in labels such as green-not green.

KELLY's construct theory has been used in a number of different venues. In the clinical field, BANNISTER and FRANSELLA employed techniques to look at the problem of stutterers and also scizophrenic thought disorders (BANNISTER and FRANSELLA 1966). In the industrial field, Mildred SHAW has used construct theory to ascertain the views of inspectors in the cloth manufacturing industry (SHAW M.L.G. 1979). PEACE and EASTERBY used the theory to evaluate managers' views of impending computerisation programmes (PEACE and EASTERBY 1973). McKNIGHT, in an interesting coalition between construct theory and RAIFFA's decision theory, carried out investigations to predict the likely verdicts in a magistrates' court with a high degree of success (McKNIGHT 1977), and THOMAS (1977) has used construct theory for a very wide range of applications, including the evaluation of delinquent behaviour (personal communication) and the provision of assistance in staff appraisal (THOMAS et al 1977).

Elicitation of constructs

Historically, construct systems have been extracted by hand using various forms of Kelly's repertory grid techniques. However, recently a series of programmes have been developed by Mildred SHAW at Brunel University to produce grids during an interactive session on a computer terminal. The programmes have been given the acronym Pegasus (Program Elicits a Grid and Sorts Using Similarities). The programmes that Mildred SHAW produced had two major objectives (SHAW 1979), (SHAW 1980):

1. to elicit grids to aid various types of research and clinical counselling, etc. and

2. to provide the person producing the grid with an insight as to how they themselves viewed the world.

In this latter respect the program gives frequent feedback to the subject on how his grids are progressing, and whether or not there seems to be any logical (or actually statistical) inconsistencies.

Program Method

Part of the process of Construct elicitation using the system is demonstrated in Fig. 14.1.

FIG. 14.1 Example of Construct Elicitation using Interactive Computer Program.

```
You must now find a difference you have not already used.

You have  3  Constructs which are as follows :-
 1.URGENT ASSISTANCE                    -----     LESS URGENT ASSISTAN
 2.MAY ESCALATE                         -----     SINGLE ITEM
 3.USE WPC                              -----     DO NOT USE WPC

Would you like to choose your own triad of 999 CALLS ? NO
Does one of the following 999 CALLS :

5: HOUSE FIRE
9: DEATH MESSAGE
10: DISTURBANCE

differ from the other two in a NEW way which will help you
TO DECIDE HOW TO DEAL WITH INCOMING 999 CALLS IN A POLICE CONTROL ROOM? YES
WHAT IS THE NUMBER OF THE 999 CALL THAT DIFFERS? 9

OK.

                    YOU HAVE SAID THAT DEATH MESSAGE
IS DIFFERENT FROM HOUSE FIRE AND DISTURBANCE.
PLEASE TYPE  [One or Two]  WORDS DESCRIBING A WAY IN WHICH  DEATH MESSAGE DIFFERS.
[None of these  999 CALLS  need be extremes in terms of this difference].

DEATH MESSAGE IS:? USUALLY COHERENT
ON THE OTHER HAND HOUSE FIRE AND DISTURBANCE ARE:? OFTEN CONFUSED

 Are you reasonably happy with this description? YES

                    PLEASE DESCRIBE THE 10  999 CALLS ON THE SCALE:

OFTEN CONFUSED                                              USUALLY COHERENT
          COMPLETELY VERY QUITE  -  QUITE VERY COMPLETELY
              1        2     3   4    5     6      7

ASSAULT ON A FEMALE         ? 2
DOMESTIC DISPUTE            ? 3
ROAD TRAFFIC ACCIDENT       ? 6
MISSING CHILD ? 5
HOUSE FIRE      ? 3
SUICIDE         ? 5
BURGLARY        ? 7
THEFT           ? 7
DEATH MESSAGE   ? 7
DISTURBANCE     ? 1

WHAT POINT ON THIS SCALE WOULD BE IDEAL? 7


LEFT 1 --OFTEN CONFUSED

DISTURBANCE       1

ASSAULT ON A FEMALE           2

DOMESTIC DISPUTE              3
HOUSE FIRE        3

MISSING CHILD     5
SUICIDE           5

ROAD TRAFFIC ACCIDENT         6

BURGLARY          7
THEFT             7
DEATH MESSAGE     7
-IDEAL-           7

RIGHT 7 --USUALLY COHERENT


Do you want to change anything? NO
OK

                    ...... The two constructs that you called
 2 SINGLE ITEM--MAY ESCALATE
 4 USUALLY COHERENT- OFTEN CONFUSED
ARE MATCHED AT THE 8?% LEVEL.  THIS MEANS THAT
MOST OF THE TIME YOU ARE SAYING SINGLE ITEM
YOU ARE ALSO SAYING USUALLY COHERENT.
AND MOST OF THE TIME YOU ARE SAYING MAY ESCALATE
YOU ARE ALSO SAYING OFTEN CONFUSED.


CAN YOU THINK OF ANOTHER 999 CALL WHICH IS
EITHER SINGLE ITEM AND OFTEN CONFUSED
OR USUALLY COHERENT AND MAY ESCALATE? YES
PLEASE NAME THIS 999 CALL
? PLANE CRASH
```

The subject is first asked by the program the objective of carrying out this particular session. In the case of the investigation that we are considering, all of the subjects were given the objective of the session as "To decide how to deal with incoming 999 calls in a Control Room". The program then asked the subjects to name a number of objects which were relevant to this particular decision. The objects could be persons, articles, even abstract ideas if necessary, but in this particular case they were "999 calls". The majority of respondents provided 999 call (object) labels such as "Road Traffic Accident", "Burglary", or "Domestic Incident". However, though the preponderance of replies were in this fairly concrete direction, it would have been quite in order for respon- dents to have named these elements in terms such as "large scale incidents" or "small scale incidents", etc. In the sessions for which we employed the program the subjects were first asked to enter between six and eight such elements into the computer system.

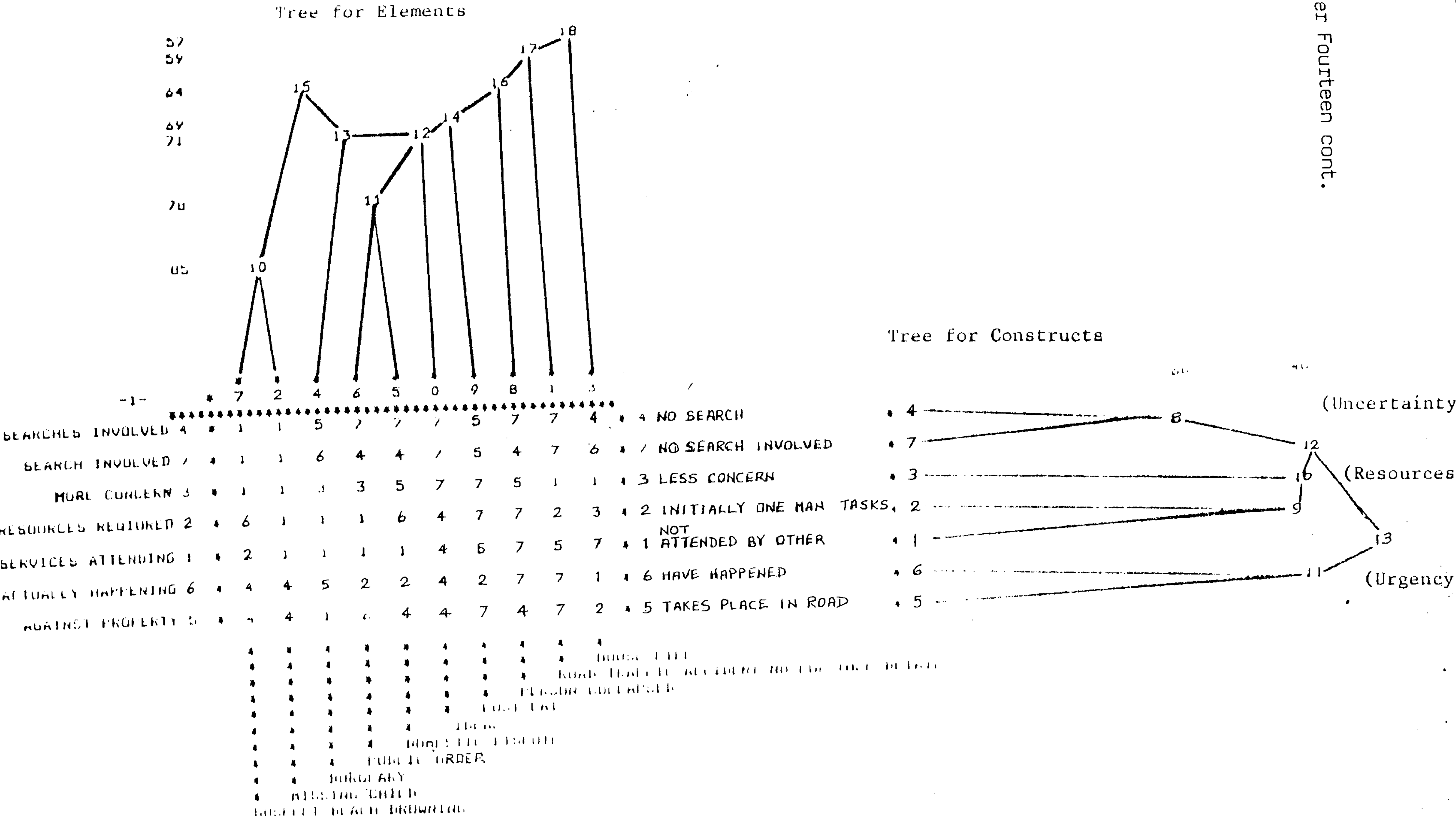
The program then selected at random three of these elements and asked the subject whether any one of them was different in a significant way, which would assist him in evaluating how he dealt with incoming 999 calls in the control room. If the subject found that one of the calls was different he was then asked to explain the difference and then rate all of the elements which he had inserted into the machine on a one to seven scale, between <u>two</u> poles of the element. E.g. if he had produced a construct of serious/not-serious then he might well rate the element 'a plane crash' as seven on the serious scale, whereas a 'domestic incident' might be in the region of two or three towards the not serious end of the semantic axis.

The program then continued to present the subject with further groups of three elements (called triads), and the procedure of eliciting constructs using this method was recursively followed until the subject felt that he had adequately described his views concerning the situation under consideration.

The program provides powerful feedback facilities, and if any of the elements or any of the constructs on the repertory grid are highly related, then the subject is given the opportunity of either explaining why they should be kept separate or amalagamating them into a single item.

The product is a fairly coherent grid of elements and constructs with a typical results printout resembling that in Figure 14.2.

FIG. 14.2 Results of Construct Elicitation Session



Program Changes

I carried out a number of program changes to the original series of programmes produced by Mildred Shaw to:

1. Provide a system which would run under the DEC RSX11M operating system.
2. To improve certain aspects of the triad elicitation. I made this somewhat faster by ensuring that the subject only needed to choose one of the triads as distinct from choosing two as in the original programmes. The effect was the same, but the procedure was easier for the subject.
3. I noted that subjects tended to forget the exact wording of their original constructs when using a screen based system. This was because only one screen of information was available at a time, and their previous constructs had disappeared from view. I therefore provided a facility which listed their constructs and kept them on the screen during most of the interactions so that they were always aware of the discriminations that they had previously made. If this was not done it was found that the same construct was elicited over and over again. The program was quite capable of eventually amalgamating this back to a single construct, but it did mean that a considerable amount of both experimenter's and subject's time was wasted.
4. There was some general improvements made to the interaction of the system to improve the conversational ability of the terminals.

Method

There were two phases to the investigation. In the first place, a large sample of constructs were elicited using interactive computer sessions. This sample of constructs was then evaluated by a group of judges to produce a smaller set of operationally viable construct categories.

Elicitation of Constructs

Sixteen subjects who were either police officers or civilian members of the Devon and Cornwall Constabulary undertook an interactive session with the program which I have just described. Each subject was either an operator or a supervisor in a control room. In each case the objective for the session was given as "To decide how to deal with incoming 999 calls in a police control room". Each session lasted approximately three hours. Most of the sessions were carried out at Police Headquarters in the Computer Section offices, although three were carried out in divisional offices when the operators could not travel. In these cases, the terminals were connected by GPO (switched) telephone lines.

In all cases the level of feedback at which an operator (or subject) was asked whether or not he wished to delete a construct was given at or above a match between elements or constructs of 62%. However, in all cases the decision as to whether to finally amalgamate an element or construct was left with the subject himself.

Elicitation Results

All of the subjects decided to give elements which were based on police definitions of incidents. This was despite the fact that it was very carefully explained to them that such elements were not the only ones to be allowed. An immediate finding was that in many cases the traditional definitions of incidents employed by the Police Service were found not to be coherent categories. An example should illustrate this point. Many of the subjects employed the term "missing person" as an element. This is because the Police Force has a set of procedures for "missing persons". However, it immediately became obvious to all of the subjects that they dealt very differently with a 'missing child', from say a 'missing adult'. Similarly an incident concerning a missing person with suicidal tendencies would be dealt with differently from a report of a 'missing person' without those tendencies. In many ways, the missing child was dealt with, as far as the initial work of the control room was concerned, very much more like the early stages of a murder enquiry. An early finding therefore, is that the official or semi-official police definition of incidents does not necessarily provide coherent operational categories.

A total of 95 constructs were elicited and are listed in Table 14.3. Each subject had on average 5.9 constructs with a standard deviation of 1.8. The range of number of constructs per subject was wide varying between two and nine.

TABLE 14.3 OF ELICITED CONSTRUCTS

Urgency

1 HAPPENING - IN COURSE OF --- HAVE HAPPENED
2 URGENT --- NON URGENT
3 PRIORTY HIGH --- LOW PRIORITY
4 PRIORITY FIRST --- LOW PRIORITY
5 URGENT - NON --- URGENT
6 URGENT - NON --- URGENT
7 REPORT - DELAYED --- REPORTED IMMEDIATELY
8 IMMEDIATE RESPONSE - NON --- IMMEDIATE RESPONSE
9 URGENT - LESS --- MORE URGENT
10 EMERGENCY - NON --- EMERGENCY
11 URGENT --- LESS URGENT
12 EMERGENCY - NON --- EMERGENCY BECAUSE OF POTENTIAL DANGER
13 URGENT --- NOT SO URGENT
14 RESPONSE SLOWER --- REQUIRES FASTER RESPONSE

Scale of Resources

15 RESOURCES REQUIRED - MORE --- INITIALLY ONE MAN TASKS
16 RESOURCES - MULTIPLE --- ONE PERSON
17 UNITS REQUIRED --- NEED LESS UNITS
18 RESOURCES - LESS --- MORE RESOURCES
19 UNIT - ONE ONLY --- REQUIRE MORE THAN ONE UNIT
20 MANPOWER - LESS --- MORE MANPOWER
21 RESOURCES - LESS --- MORE RESOURCES
22 RESPONSE SINGLE --- MULTI RESPONSE
23 RESOURCES MULTI UNIT --- SINGLE UNIT
24 ACTION TAKEN --- NO ACTION
25 RESOURCES - LESS --- MORE RESPONSES

Type of Resources

26 SEARCHES INVOLVED --- NO SEARCH
27 RESOURCES - OTHERS ATTEND --- ATTENDED BY OTHERS
28 SEARCH INVOLVED --- NO SEARCH INVOLVED
29 CID NOT REQUIRED --- CID INVOLVEMENT
30 INVOLVES OTHER SERVICES --- PURELY POLICE
31 INVOLVES FIRE BRIGADE --- PURELY POLICE
32 SOCIAL SERVICES NOT REQUIRED --- SOCIAL SERVICES
33 RESOURCES OTHERS REQUIRED --- NO OUTSIDE ASSISTANCE
34 POLICE FIRST --- AMBULANCE FIRST
35 TRAFFIC - NON --- TRAFFIC
36 POLICE ONLY --- INVOLVES OTHER SERVICES
37 CID REQUIRED --- UNIFORM PERSONNEL
38 RESOURCES NO OTHERS INVOLVED --- OTHER SERVICES INVOLVED
39 RESOURCES TWO --- POLICE RESPONSE
40 SEARCH NOT REQUIRED - INVOLVES SEARCH
41 RESOURCES NONE OTHER REQUIRED --- REQUIRES OTHER SERVICES

Chapter Fourteen cont.

Injuries

42 INJURY - MULTIPLE --- SINGULAR COMMITMENT
43 INJURY - MULTIPLE --- FEWER INJURIES
44 INJURY - KNOWN --- UNKNOWN QUANTITIES
45 INJURY --- POTENTIALLY LETHAL
46 INJURY INVOLVED --- NO INJURIES
47 INJURY - NON --- INJURIES INVOLVED
48 INJURY - NON --- PERSONAL INJURY
49 --- INJURY & LESS RESOURCES NEEDED MORE INJ & MORE RE
50 INJURY - NON --- USUALLY INJURIES
51 INJURY - NON --- INJURY
52 INJURY - NON --- USUALLY INJURY
53 INJURY LESS LIKELY --- MAY INVOLVE INJURY

Danger to Life

54 LIFE NOT ENDANGERED --- LIFE DANGER AND IMMEDIATE
55 VULNERABLE - NONE --- VULNERABLE
56 DANGEROUS --- NOT DANGEROUS
57 DANGER - LESS --- DANGER
58 LIFE ENDANGERED --- NOT DANGEROUS
59 DANGER LESS --- MORE DANGEROUS

Human - Property

60 PROPERTY - AGAINST --- TAKES PLACE IN ROAD
61 PROPERTY --- HUMAN
62 HUMAN - NON --- HUMAN
63 PROPERTY INVOLVED --- INVOLVING PEOPLE

Violence

64 VIOLENT - LESS --- MORE VIOLENT
65 VIOLENT - NON --- VIOLENT
66 AGGRESSIVE ACTS --- VULNERABILITY
67 VIOLENT - NONE --- POSSIBLY VIOLENT
68 VIOLENT - NONE --- VIOLENT

Deliberate - Accidental

69 ACCIDENTAL --- DEFINITE ACT
70 ACCIDENTAL - NON --- ACCIDENTAL
71 ARRESTABLE - NON --- ARRESTABLE
72 CRIME --- NOT CRIME

Certainty of Information

73 INFORMATION - LACK OF --- FULL INFORMATION
74 TELEPHONE CALL --- DIRECT LINE
75 INFO SECOND HAND --- DIRECT COMPLAINT
76 DEFINITE --- LESS DEFINITE
77 DETAILS - MANY --- NO DETAILS TAKEN
78 CERTAINTY - LESS --- MORE CERTAIN

Chapter Fourteen cont.

Severity of Incident

79 CONCERN - MORE --- LESS CONCERN
80 SERIOUS - LESS --- SERIOUS
81 SEVERE - LESS --- MORE SEVERE

Complexity

82 PROCEDURE VARYING --- AUTOMATIC PROCEDURE
83 THE SUM OF FEWER PARTS --- THE SUM OF MANY PARTS
84 PERSONS - LESS AFFECTED --- AFFECTS MORE PERSONS
85 TIME FACTOR SHORT --- LONG TIME FACTOR
86 ROUTINE - NON --- ROUTINE
87 VARIABLE --- PREPLANNED RESPONSE
88 SUSPECT - ONE --- SUSPECTS

Locations

89 LOCATION NO PROBLEM --- LOCATION PROBLEMS
90 LOCATION - EASY --- DIFFICULT TO LOCATE

Public - Private

91 HIGHWAY NOT INVOLVED --- INVOLVES VEHICLES ON
92 PROPERTY PRIVATE --- PUBLIC PLACE
93 PUBLIC - NON --- IN PUBLIC VIEW

Previous History

94 EXPERIENCE - NON --- EXPERIENCE
95 HISTORY - NO PREVIOUS --- PREVIOUS HISTORY

Evaluation of Constructs

On the conclusion of the sixteen sessions, the constructs produced were placed in a single file and three judges sorted them into subject areas of similarity. The categories which were thus produced were the subject of negotiation between the judges on the basis of the constructs which had been produced by the subjects. The decisions to include a particular construct within one of these categories was based on the apparent meaning of the words of the construct. In cases where there was any doubt in this respect reference was made back to the original subject.

Evaluation Results

The judges divided the 95 constructs into fourteen different categories which are shown in Table 14.4.

TABLE 14.4

CATEGORIES OF CONSTRUCT

Construct Categories	Subjects who had Constructs in Category		Constructs in Category	
	Number	Percentage of Total Subjects	Number	Percentage of Total Constructs
1 Urgency	12	75	14	15
2 Scale of Resources	11	69	11	12
3 Type of Resources	10	63	16	17
4 Injuries	9	56	12	13
5 Danger to Life	6	38	6	6
6 Human - Property	3	19	4	4
7 Violence	3	19	5	5
8 Deliberate-Accidental	4	25	4	4
9 Certainty of Information	5	31	6	6
10 Severity of Incident	3	19	3	3
11 Complexity	5	31	7	7
12 Locations	2	13	2	2
13 Public-Private	3	19	3	3
14 Previous History	2	13	2	2

A check was made to ascertain whether a category such as urgency was closely correlated with any other category such as injuries or danger to life. This was done by checking the original grids to ascertain which other constructs were closely linked to one which had been categorised in the urgency section. No coherent linking could be ascertained by any of the judges, and therefore it could not be said that any generally agreed operational definition of urgency or resources required etc. can be obtained from this data.

Discussion

The objective of this investigation was to ascertain whether there were any predominant ways in which operators viewed incoming 999 calls. It can be seen from Table 14.4 that there are in fact four major categories which virtually all of the operators employed, namely urgency, scale of resources, type of resources and injuries. Attempts to obtain an operational definition of a category such as urgency were not successful, and it would seem that each operator has a different definition of 'urgency' or 'need for resources' etc. The variability in the number of constructs, and the lack of any easily discernible shared pattern of constructs, tends to suggest that the operators have all got very different views of the requirements for their job. This demonstrates a lack of standardisation and the potential need of training to improve uniformity.

The type of constructs which were not produced may in many cases be almost as interesting as those which were.

1. There were no constructs concerning the difficulty of obtaining information for the various types of incidents.
2. There were no constructs concerning the differential amount of information required for briefing or logging various different topics.
3. There was no indication from the constructs that certain types of incident were more difficult to service than others.

Or 4. That certain types of incident were more variable or difficult to deal with on the ground.

The Center for the Study of Human Learning at the University of Brunel have recently produced an addition to their suite of programmes which is known as Socio Grids. This is a program which is intended to be used to compare a number of persons' views of a shared knowledge area. For instance, the number of persons who work at the same job. The major difference between the procedure adopted for socio grids and the procedure which I have adopted is that for the socio grid elicitation it is necessary to provide the participants with their elements. In the main, this is done in consultation with the subjects themselves, and is therefore not quite as rigid as Osgood's semantic differential which was discussed earlier. However, I decided to adopt the procedure of allowing the subjects greater freedom in deciding their own construct axes, in order to ensure that I in no way constrained their mode of response. It would now of course be possible to use the elicited grids, and the categorisations which have been produced by the judges, as a starting point for a set of shared grids, potentially based on the fourteen construct categories produced. I think that such an exercise is outside the requirement for this particular thesis but it is certainly something which could be considered by the Training Department of the Devon and Cornwall Constabulary, and might well provide the basis for designing training modules for control room operators.

One of the main findings of this phase of the investigation was the great variability in the way that the different operators looked at their task, this surely must point to a need for some form of standardised training of operators. At the present time no such training is undertaken and all operators obtain their expertise by in-station learning (sitting by Nelly). It would appear that this form of training is deficient, in so far as it obviously provides extremely variable results, in terms of the way operators view the elements of their job.

SUMMARY - PART III -

IN DEPTH INVESTIGATION OF PROBLEM AREA

The six chapters which comprise Part III of this thesis have ranged from a relatively prosaic evaluation of an operator's physical activities, through an inspection of the characteristics of the call, the note taking and logging actions of the operator, to a final relatively speculative evaluation of the mental models which may mediate their behaviour. The result has been a very wide spectrum of findings, which in addition to their immediate relevance to this thesis, also constitute a valuable database for future design activities by the Service.

A number of themes seem to be prominent:

1. The '999' call and the logging activity are very much more complex than one might have believed.
2. Operators have adopted a narrow strategy of concentrating on certain topics.
3. There are fairly serious changes in the information content of the message as it is transposed from the caller through the operator to the log.
4. The operators possess potentially extensive but variable mental models of their environment.

The early work in this part of the thesis illustrated that the environment of the operator was relatively complex. The observations show that he spent approximately two and a half times as long to log the call as he did to receive it and this factor alone would tend to militate against the possibility of logging calls whilst on line to an emergency call. The E.T.T.A. analysis in Chapter Ten demonstrated that the average call contained approximately twenty-nine transactions which is probably much more than one would have anticipated. The high percentage of call maintenance transactions (involving feed-back etc.) underlined the operator's view of the emergency call as a very fragile link.

The findings of the note analysis in Chapter Eleven fitted neatly between the preceding chapter on the evaluation of transactions within a call and the following chapter, (Chapter Twelve), which focused on the meaning content of the transposed information. The E.T.T.A. and note analysis both emphasised the fact that the operators were following a relatively narrow strategy in concentrating on certain topics of information during the call. In the main this tended to be information concerning the identity of the caller. This emphasis on a narrow topic line, was echoed by the remarks of judges in Chapter Twelve and also later, in Part IV, of judges in the simulation experiment. All the judges were disappointed with the generally poor level of interrogative performance demonstrated by the operators.

The finding of the note analysis investigation covering the different treatment of the non-redundant and redundant information leads directly into the work on the semantic content of the messages. The story information generally seems to be very much more expansive and creative, compared with the non-redundant information which concerned names and addresses, and which was reported in a relatively accurate and verbatim manner.

The very large Chapter Twelve concentrated a number of different types of enquiry in this area. It was found that there were fairly gross changes in both the surface structure of messages, and more importantly in the information content, during transfer from caller to log. Once again there was a concentration on certain kernel concepts of the story information. There was a disturbingly high proportion of information which were essentially inventions. These findings were compared with the experimental work which has gone on for some time in the area of cognitive psychology. They sit well with the current body of empirical evidence which suggests that human beings do not operate particularly well as tape recorders, and that information is moulded and transformed by an operator's mental models of his environment.

The evaluation of the mental models held by the operators was carried out in Chapters Thirteen and Fourteen. In Chapter Thirteen the device of 'verbal protocols' was used to ascertain the views of the operators over a wide range of their potential tasks. It was noted that they seemed to have implicit models in at least five major areas, covering the nature of the incident itself, the informant, the resources and also some ideas of probability concerning incidents by time and incidents by location. All of these vignettes were potentially available to evaluate incoming information and to provide plans of action at any phase.

Kelly's Construct Theory was employed to look in greater depth at the first two sections of those models as they might be involved in the collection of data during the call itself. It was noted that the operators did in fact have constructs with similar labels, but a deeper investigation tended to suggest that this surface similarity was not matched by any standard definitions. It seemed that the operators had considerable differences in the way they looked at otherwise similar incidents. This seems to be an undesirable situation which strongly argues for a programme of standardisation training. Some of the constructs which were not included in the operators' repertoire were as interesting as those which were; in particular there was no indication of different difficulties in obtaining different types of information or the difficulty of obtaining different types of information for different subjects. To some extent this may relate to the narrow interrogation strategies which were highlighted in Chapters Ten and Eleven in so far as operators do not seem to tailor their interrogating techniques to varying situations.

It was argued that there may well be an information hierarchy in which caller identity information was considered most important. If this is true then under conditions of pressure one would anticipate that the operator would tend to move his interrogative threshold further up the hierarchy. It may well be that many operators, due

Summary Part III cont.

either to the pressures of their task or poor training, or both, developed a system of only collecting the minimum, most urgent, information.

Overall the general indication seems to be, that the present quality of logged information is poor, even under the familiar manual system.

If the manual system is less than totally effective, then great care should be exercised in introducing new working methods, particularly systems such as Command and Control, which at present are in no way designed to assist the operator in his data collection activities.

THESIS PLAN

PART 1: INTRODUCTION

PART 2: PRELIMINARY INVESTIGATIONS - PERCEIVED PROBLEMS

PART 3: IN DEPTH INVESTIGATION OF PROBLEM AREAS

PART 4: SOLUTION EXPLORATION

PART 5: CONCLUDING SUMMARY

PART 6: BIBLIOGRAPHY

CHAPTER FIFTEEN

PAIGNTON MANAGEMENT EXPERIMENT

Preamble

The orientation of this chapter is somewhat different from the preceding five chapters of the in depth section. In the main they have concentrated on the activities of the operator in his attempt to glean information from an emergency call. In this chapter I am taking a very tentative view at the other end of the process; namely the uses to which the message log information may be put when it is incorporated in a management information system. This chapter is very more in the tradition of "action research", in that a project has been developed which can be used operationally and from which design data can be simultaneously derived.

Although a great deal is talked of in the police service about management information, there seems to be very little work on the type of information police managers need to effectively administer their various domains. Of the few specific management information systems which have been developed within the Service have nearly all been under utilised by managers (HOUGH 1980). On the other hand, the operational systems are invariably heavily used, and appreciated by the police personnel.

The lack of knowledge concerning both the type and quality of information required for police management information leads to a dilemma. In order to know what type of data should be captured in the various input areas within a police computer system, it is necessary to know, at least in broad outline, the type and volume of data which is needed for the various management functions. The operational functions are reasonably well defined, but the management functions are not. Perhaps this is a clue to the success of the former and the failure of the latter.

Against this background there has been a tendency amongst designers of police facilities to reduce the amount of data which is input into certain of the systems, in particular incident logging in the control rooms, in order to reduce the number of keying operations that an operator has to do whilst under pressure. If that trend is continued there is very likely to be a conflict between the managers' requirements for information and the ability of the incident log data base to support those requirements. I therefore decided to embark on a modest investigation of the probable requirements for management information.

I would emphasise the word "probable" in the preceding paragraph for two reasons:-

1. Various types of managers at various levels would obviously need different types of data. This differentiation should not be too difficult a problem and, with care, the type of data required could be specified.

2. The managers in the police force are not used to using data and it is likely that their requirement for the various facilities will change over time as they grow adept at manipulation and use of information to aid them in their various tasks. For this reason, no rigid specification will ever be possible, although certain envelope parameters should always be attempted to guide the systems designer.

The rest of this chapter describes a system which was put into operation in order to provide some of these envelope parameters.

My first action was to interview a number of managers at sub-divisional officer level. I interviewed approximately ten managers and found that they had great difficulty in describing their information needs. In many cases they informed me that they gained quite sufficient information by "flicking" through the day's message log every morning. It did not seem, however, that their ability to recognise trends, and/or monitor errors, was likely to be very good, using this rather supine approach to information absorption. Most of the managers also had great difficulty in envisaging the type of information that a computer system could provide for them. In addition most of them were unable to objectively answer elementary questions concerning workloads and demand for resources in the areas under their command.

In view of these findings I decided to produce an embryo management information system for a limited geographical area in order to act as a catalyst to the imaginations of the various management and operational officers within that area. The sequence of events which I decided to follow are set out in Fig. 15.1.

Figure 15.1 - Activities in Paignton Management Project

1. To produce a management information system based on my own knowledge and that of a few other interested officers. The system would contain various details and would provide statistical and graphical representation of information, of a type which we personally considered to be of interest. (This was the catalyst element.)

2. The system would be provided for use by the operational and managerial officers of a particular sub-division and they would eventually be requested to provide an evaluation of it.

3. (a) The system would be changed to produce new facilities in the light of their views.

   (b) there would be a recursive and continuing looping between items 2. and 3. and the system would gradually transmogrify into a viable MIS system.

4. It was felt that after a period of time the rate of requests for change would decline as most of the requirements became satisfied. At this point the experience gained would be a useful starting specification of the MIS requirement for the computer project. In this respect, this sub-project has a planning benefit for the Force.

5. It should be possible to derive an input requirement from the specification of item 4. above.

Description of system

Data

The original data which was captured consisted of seven items taken from the message logs in the Paignton Sub-Division. The seven items were -

(i) date (and day of the week)

(ii) source of information - police office

(iii) time of day of report

(iv) location of incident

(v) national grid reference of incident

(vi) a verbal description of the incident

(vii) details of the police officer resource and/or units attending.

Police officers in the Paignton/Brixham area were deputed to abstract information from the logs each morning and an input document was prepared.

I produced a system of approximately 40 programs which allowed for the automatic entry of the data, the production of a number of data base files, statistical, and graphical output.

Output descriptions

The main types of information which were produced was of the hard copy variety on normal computer listing paper. It consisted of -

(a) sorted lists of information, sorted by time/date, or incident type etc.

(b) histograms of incidents by time of day, incident types etc.

(c) maps for either incidents of all types or those of a specific nature or those occurring during specific time intervals were added very soon after the start of the project.

I devised a system for providing both weekly and monthly information. Each management officer within the sub-division had a different portfolio of reports which was uniquely tailored to his particular job requirements. For instance, the CID officer obviously had all of the reports referring to crime but was spared details concerning some of the general policing matters.

Some examples of the various print outs are produced in Figs. 15.2 - 15.6.

Fig 15.2

PAIGNTON MANAGEMENT PROGRAM
INCIDENTS BY CATEGORY

(C) JOHN HULBERT 14-NOV-79
APPLIED PSYCHOLOGY DEPT
UNIVERSITY OF ASTON
DEVON & CORNWALL CONSTABULARY

LISTING OF INCIDENTS

* CRIME *

WEEK-COMMENCING 15TH OCTOBER 1979

DAY	DATE	TIME	INCIDENT DESCRIPTION	LOCATION	ATTENDED BY
MONDAY	15TH	1020	BREAK	MARINE GARDENS	K40
MONDAY	15TH	1145	THEFT	CLENNON VALLEY	CC
MONDAY	15TH	1435	MOLESTING WOMEN	TORBAY ROAD	CID
FRIDAY	19TH	830	THEFT	BOROUGH ROAD	CC
FRIDAY	19TH	920	THEFT	THE GROVE	K42
SATURDAY	20TH	840	THEFT	HYDE ROAD	CC
SATURDAY	20TH	955	THEFT	WINNER STREET	CC
SUNDAY	21ST	1840	THEFT	WINNER STREET	K40

* OTHER OFFENCE (NOT TRAFFIC OR CRIME) *

WEEK-COMMENCING 15TH OCTOBER 1979

DAY	DATE	TIME	INCIDENT DESCRIPTION	LOCATION	ATTENDED BY
TUESDAY	16TH	2257	DRUNK	FORE STREET	K43
FRIDAY	19TH	1401	LITTER	TOTNES ROAD	PC SALSBURY
SATURDAY	20TH	1549	MEN PLAYING WITH THEMSELVES	REDCLIFFE PUBLIC TOILETS	PC DATE

* SUSPICIOUS CONDUCT *

WEEK-COMMENCING 15TH OCTOBER 1979

DAY	DATE	TIME	INCIDENT DESCRIPTION	LOCATION	ATTENDED BY
MONDAY	15TH	1140	SUSPICIOUS VEHICLE	ZOO CAR PARK	K42
FRIDAY	19TH	120	PROWLER/INTRUDER	DARTMOUTH ROAD	K42
FRIDAY	19TH	120	PROWLER/INTRUDER	DARTMOUTH ROAD	K42
SATURDAY	20TH	1240	SUSPECT VEHICLE	COOMBE LANE	K42
SATURDAY	20TH	2041	PROWLERS	PAIGNTON ZOO	K57
SUNDAY	21ST	234	PROWLERS/INTRUDERS	WATERLEAT ROAD	K41 K42
SUNDAY	21ST	1357	THREE SUSPICIOUS YOUTHS	RING ROAD FIVE LANES	K42
SUNDAY	21ST	1930	SUSPICIOUS YOUTHS	WESTLEAT AVENUE	K41

* VANDALISM *

WEEK-COMMENCING 15TH OCTOBER 1979

DAY	DATE	TIME	INCIDENT DESCRIPTION	LOCATION	ATTENDED BY
TUESDAY	16TH	1715	CRIMINAL DAMAGE	12 STANMORE TOR	K41
TUESDAY	16TH	1800	CRIMINAL DAMAGE	TOTNES ROAD	H2
WEDNESDAY	17TH	2003	WINDOW SMASHED	3 GREAT REA ROAD	K43
WEDNESDAY	17TH	2003	WINDOW SMASHED	3 GREAT REA ROAD	K43
THURSDAY	18TH	2300	CRIMINAL DAMAGE	FISHER STREET	CC
FRIDAY	19TH	750	GATE REMOVED	ST MICHAELS ROAD	H1
FRIDAY	19TH	750	GATE REMOVED	ST MICHAELS ROAD	H1
FRIDAY	19TH	905	DAMAGE	PAIGNTON SCHOOL	WPC HALL
FRIDAY	19TH	1200	CRIMINAL DAMAGE	GAIETY CAFE PRESTON SANDS	CC
FRIDAY	19TH	1200	CRIMINAL DAMAGE	ROUNDHAM ROAD	CC
FRIDAY	19TH	1255	DAMAGE TO CAR	FISHER STREET	PC BARNES
FRIDAY	19TH	1435	DAMAGE TO CAR	ST MICHAELS ROAD	K41
FRIDAY	19TH	1505	DAMAGE TO CAR	MARINE DRIVE	PC DATE
FRIDAY	19TH	2020	DAMAGE TO BOAT	28 CLIFF ROAD	K42

* CRIME PREVENTION *

WEEK-COMMENCING 15TH OCTOBER 1979

DAY	DATE	TIME	INCIDENT DESCRIPTION	LOCATION	ATTENDED BY
TUESDAY	16TH	2205	INSECURE PREMISES	EUGENE ROAD	K57
SATURDAY	20TH	2115	SOUND OF BREAKING GLASS	UPTON MANOR ROAD	K43

* PUBLIC ORDER *

WEEK-COMMENCING 15TH OCTOBER 1979

DAY	DATE	TIME	INCIDENT DESCRIPTION	LOCATION	ATTENDED BY
SATURDAY	20TH	[illegible]	DISTURBANCE	HYDE ROAD	K57
SATURDAY	20TH	[illegible]	NOISY DISTURBANCE	MERRICK ROAD	NONE
SATURDAY	20TH	[illegible]	DISTURBANCE OUTSIDE	ITT BRIXHAM ROAD	K42 K57

* ROAD TRAFFIC ACCIDENT *

WEEK-COMMENCING 15TH OCTOBER 1979

DAY	DATE	TIME	INCIDENT DESCRIPTION	LOCATION	ATTENDED BY
MONDAY	15TH	[illegible]	RTA	NEW ROAD	K43
TUESDAY	[illegible]	[illegible]	RTA	[illegible] ROAD	K41
FRIDAY	19TH	[illegible]	[illegible]	[illegible]ERTON ROAD	K41 K40
SUNDAY	21ST	[illegible]	[illegible]	NORTHFIELD [illegible]	PC BAKER

PAIGNTON MANAGEMENT PROGRAM

Fig. 15.3

(C) JOHN HULBERT 14-NOV-79

LISTING OF INCIDENTS BY DATE AND TIME

****

* WEEK-COMMENCING 15TH OCTOBER 1979 *

****

MONDAY 15TH OCTOBER 1979

TIME	INCIDENT TYPE	LOCATION	CODE	ATTENDED BY
831	RTA	NEW ROAD	21	K43
930	DOMESTIC	BARTON FARM	66	PC 524
1020	BREAK	MARINE GARDENS	1	K40
1140	SUSPICIOUS VEHICLE	ZOO CAR PARK	3	K42
1145	THEFT	CLENNON VALLEY	1	CC
1325	UNTAXED VEHICLE	WILLICOMBE ROAD	24	G1
1435	MOLESTING WOMEN	TORBAY ROAD	1	CID
1908	HOAX FIRE CALL	WINDMILL CLOSE	98	K43
2030	CIVIL TRESSPASS	COLLEY END ROAD	67	K40

TUESDAY 16TH OCTOBER 1979

TIME	INCIDENT TYPE	LOCATION	CODE	ATTENDED BY
852	OBSTRUCTION	MARLDON SCHOOL	25	K40
1139	FEMALE MENTALLY ILL	54 LITTLEGATE ROAD	63	K57
1230	COURT WARNING	WELL STREET	71	PC MOXHAM
1255	ENGUIRY FOR TOTNES	MORIN ROAD	99	WPC 918
1340	MISSING BOY	FOXHOLE ROAD	62	PC 2091
1649	STRAY HORSE	RODANTHE ROAD	83	K41
1715	CRIMINAL DAMAGE	12 STANMORE TOR	4	K41
1800	CRIMINAL DAMAGE	TOTNES ROAD	4	H2
1830	TRANSMITTER ALARM	BEACON HILL	85	K40 K56 K58
1922	FIREWORKS	123 DARTMOUTH ROAD	89	K41
2000	OBSTRUCTION	BISHOPS PLACE	25	K40
2010	CONCERN FOR NEIGHBOUR	GREAT WESTERN CLOSE	65	K42
2125	RTA	TORBAY ROAD	21	K41
2205	INSECURE PREMISES	EUGENE ROAD	5	K57
2257	DRUNK	FORE STREET	2	K43

WEDNESDAY 17TH OCTOBER 1979

TIME	INCIDENT TYPE	LOCATION	CODE	ATTENDED BY
6	DOMESTIC	49 RAMSHILL ROAD	66	K40 K57
736	OIL SLICK SIGHTED	ELBURY COVE	87	K42
736	OIL SLICK SIGHTED	ELBURY COVE	87	K42
1140	OBSTRUCTION	LANGDON ROAD	25	K40
1140	OBSTRUCTION	LANGDON ROAD	25	K40
1400	OBSTRUCTION	GERSTON ROAD	25	K41
1647	HOAX CALL RE CHILD ABDUCTION	TORQUAY ROAD PRESTON	98	K42
1647	HOAX CALL RE CHILD ABDUCTION	TORQUAY ROAD PRESTON	98	K42
1735	BALL GAMES IN STREET	DUCHY GARDENS	89	F1
1833	MISSING PERSON LOCATED	CARLTON DRIVE	62	K42
1833	MISSING PERSON LOCATED	CARLTON DRIVE	62	K42
1945	BREAKDOWN	ESPLANADE ROAD	25	K41
2003	WINDOW SMASHED	3 GREAT REA ROAD	4	K43
2003	WINDOW SMASHED	3 GREAT REA ROAD	4	K43
2015	COMPLAINT RE SKATEBOARDERS	AILESCOMBE DRIVE	89	PC ALLCHIN
2220	FIRE	PONTINS KINGS ASH	90	K41 CID
2220	FIRE	PONTINS KINGS ASH	90	K41 CID
2259	UNLIT SKIP	SOUTHFIELD AVENUE	24	K42
2259	UNLIT SKIP	SOUTHFIELD AVENUE	24	K42

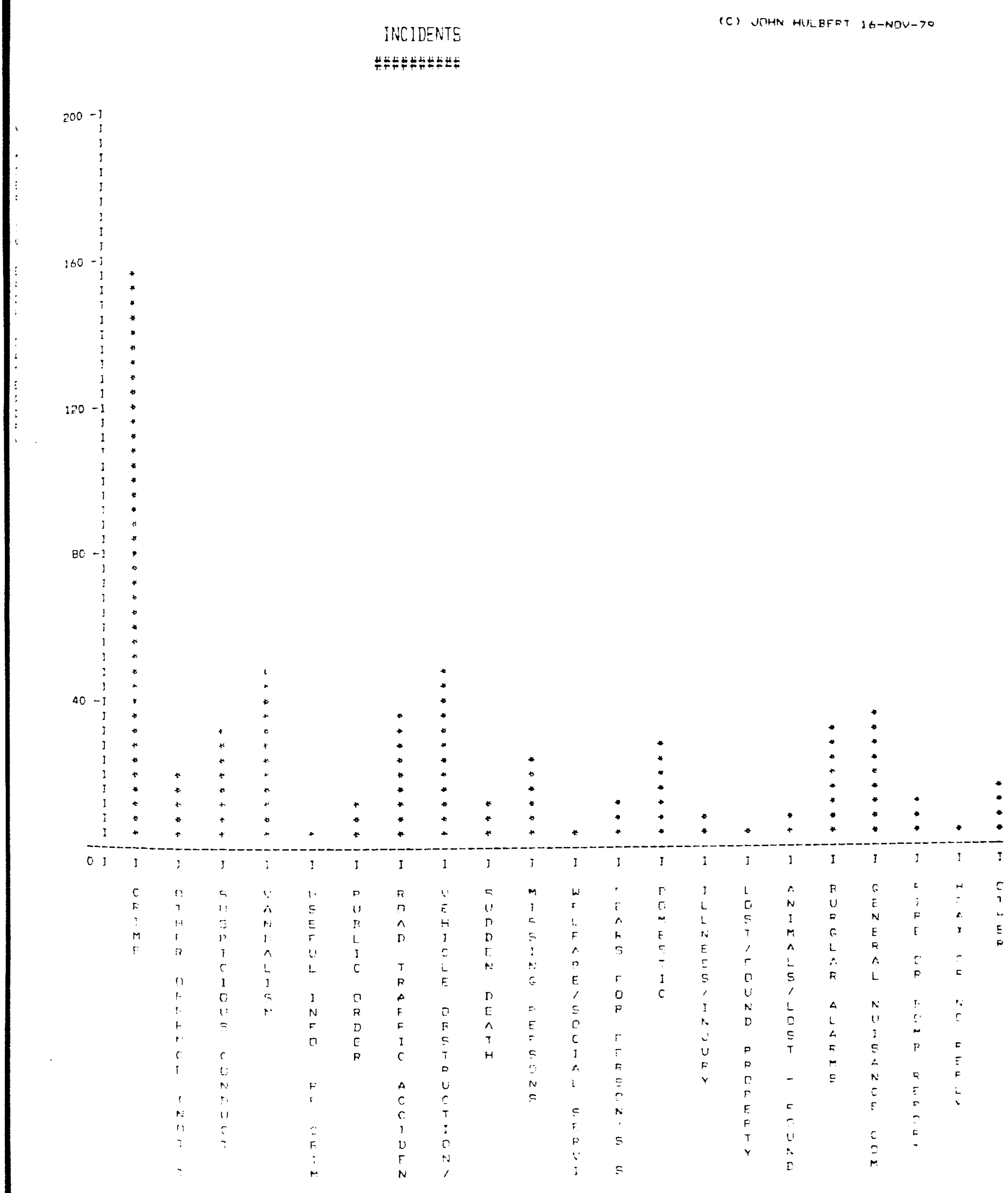
THURSDAY 18TH OCTOBER 1979

TIME	INCIDENT TYPE	LOCATION	CODE	ATTENDED BY
2300	CRIMINAL DAMAGE	FISHER STREET	4	CC

FRIDAY 19TH OCTOBER 1979

TIME	INCIDENT TYPE	LOCATION	CODE	ATTENDED BY
120	PROWLER/INTRUDER	DARTMOUTH ROAD	3	K42
120	PROWLER/INTRUDER	DARTMOUTH ROAD	3	K42
750	GATE REMOVED	ST MICHAELS ROAD	4	H1
750	GATE REMOVED	ST MICHAELS ROAD	4	H1
830	THEFT	BOROUGH ROAD	1	CC
857	INJ RTA	YALBERTON ROAD	21	K41 K40
905	DAMAGE	PAIGNTON SCHOOL	4	WPC HALL
920	THEFT	THE GROVE	1	K42
1142	ELDERLY MAN FALLEN OVER	ELM PARK	68	RELATIVES CALLED
1200	CRIMINAL DAMAGE	GAIETY CAFE PRESTON SANDS	4	CC
1200	CRIMINAL DAMAGE	ROUNDHAM ROAD	4	CC
1255	DAMAGE TO CAR	FISHER STREET	4	PC BARNES
1401	LITTER	TOTNES ROAD	2	PC SALSBURY
1435	DAMAGE TO CAR	ST MICHAELS ROAD	4	K41
1501	DAMAGE TO CAR	MARINE DRIVE	4	PC DATE
2020	DAMAGE TO BOAT	28 CLIFF ROAD	4	K42
2055	ANON PHONE CALLS	27 STURCOMBE AVENUE	99	H1
2230	BREAKDOWN	BUTLAND AVENUE	25	F1
2345	NOISE COMPLAINT	LULWORTH CLOSE	89	LIC DEPT

FIGURE 15.4

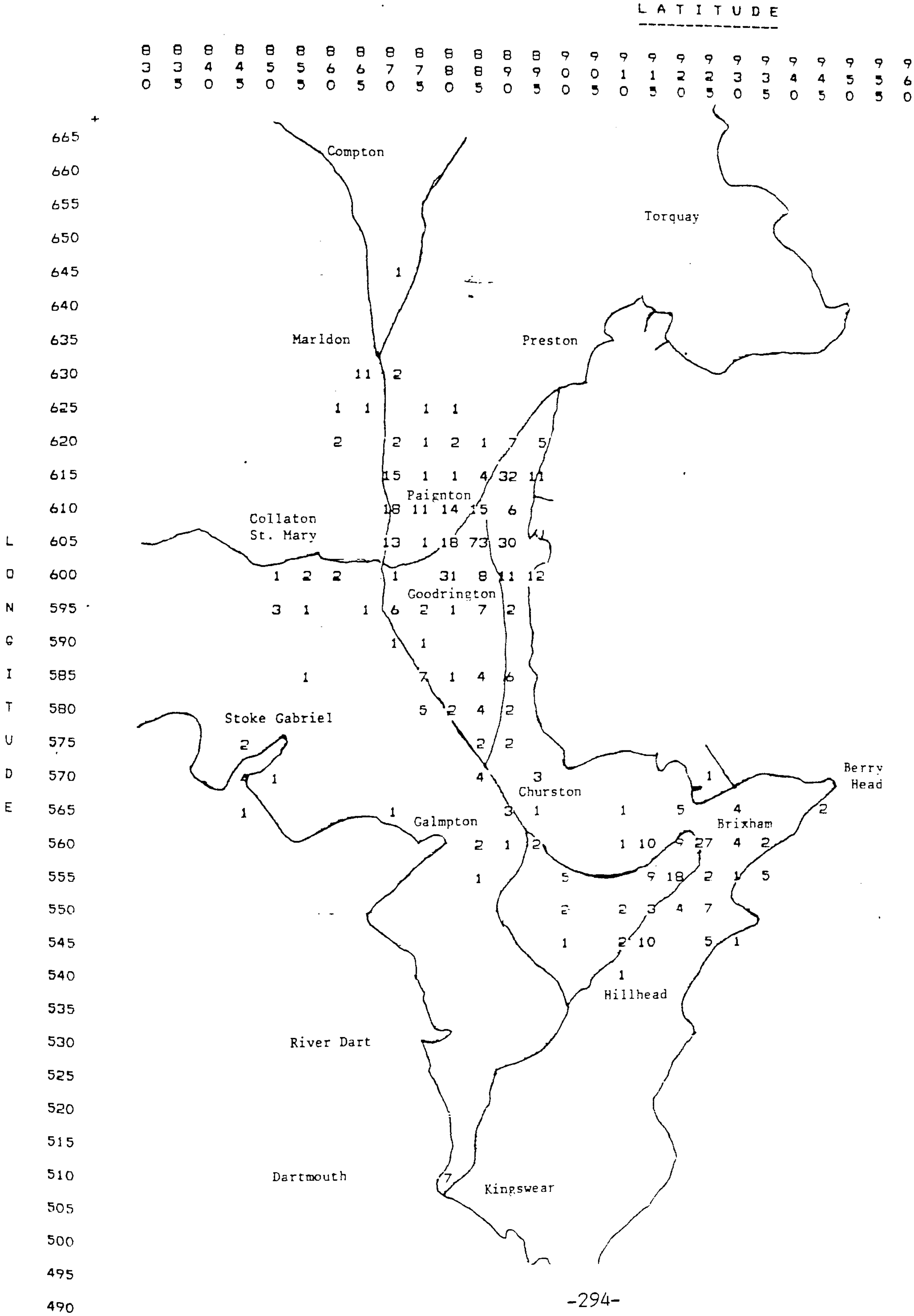


AVERAGE (M)
TOTAL NUMBER
STANDARD DEVIATION FROM THE MEAN (AVERAGE)

27.90
586
31.63

Paignton Management Report MAP OF INCIDENTS FOR SEPTEMBER

CATEGORIES OF INCIDENT CATEGORIES



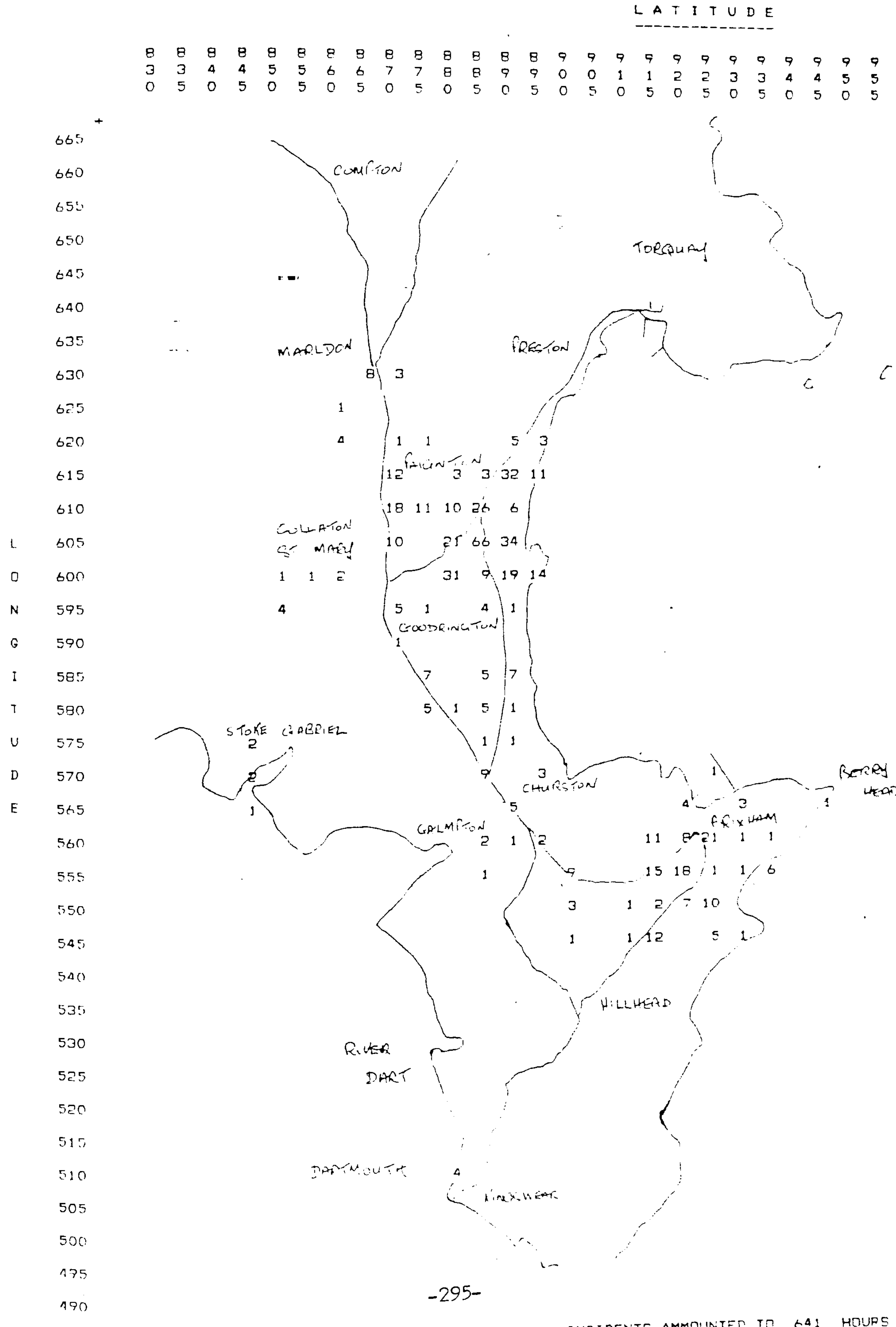
THERE WAS A TOTAL OF 607 INCIDENTS
DURING SEPTEMBER

FIGURE 15.6

(C) JOHN HULBERT 16-NOV-79

PAIGNTON MANAGEMENT REPORT
ALL CATEGORIES OF INCIDENT

MAP OF INCIDENTS FOR SEPTEMBER
****



THE TOTAL ESTIMATED TIME SPENT ATTENDING INCIDENTS AMMOUNTED TO 641 HOURS DURING SEPTEMBER

History of the system

Figure 15.7 - Flow Chart for Paignton Management System

(The main flowchart for the system is shown below in Fig. 15.7)

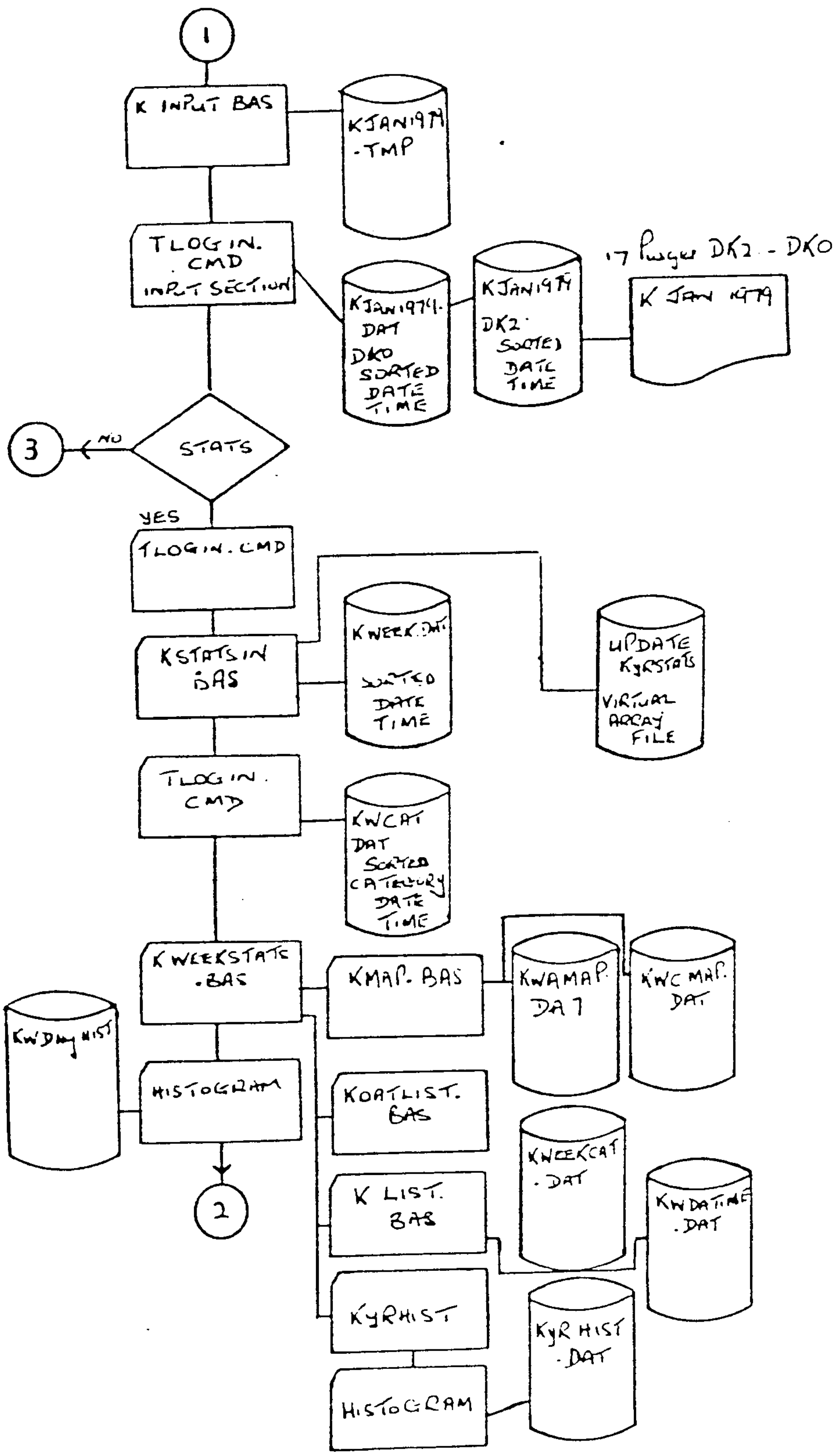
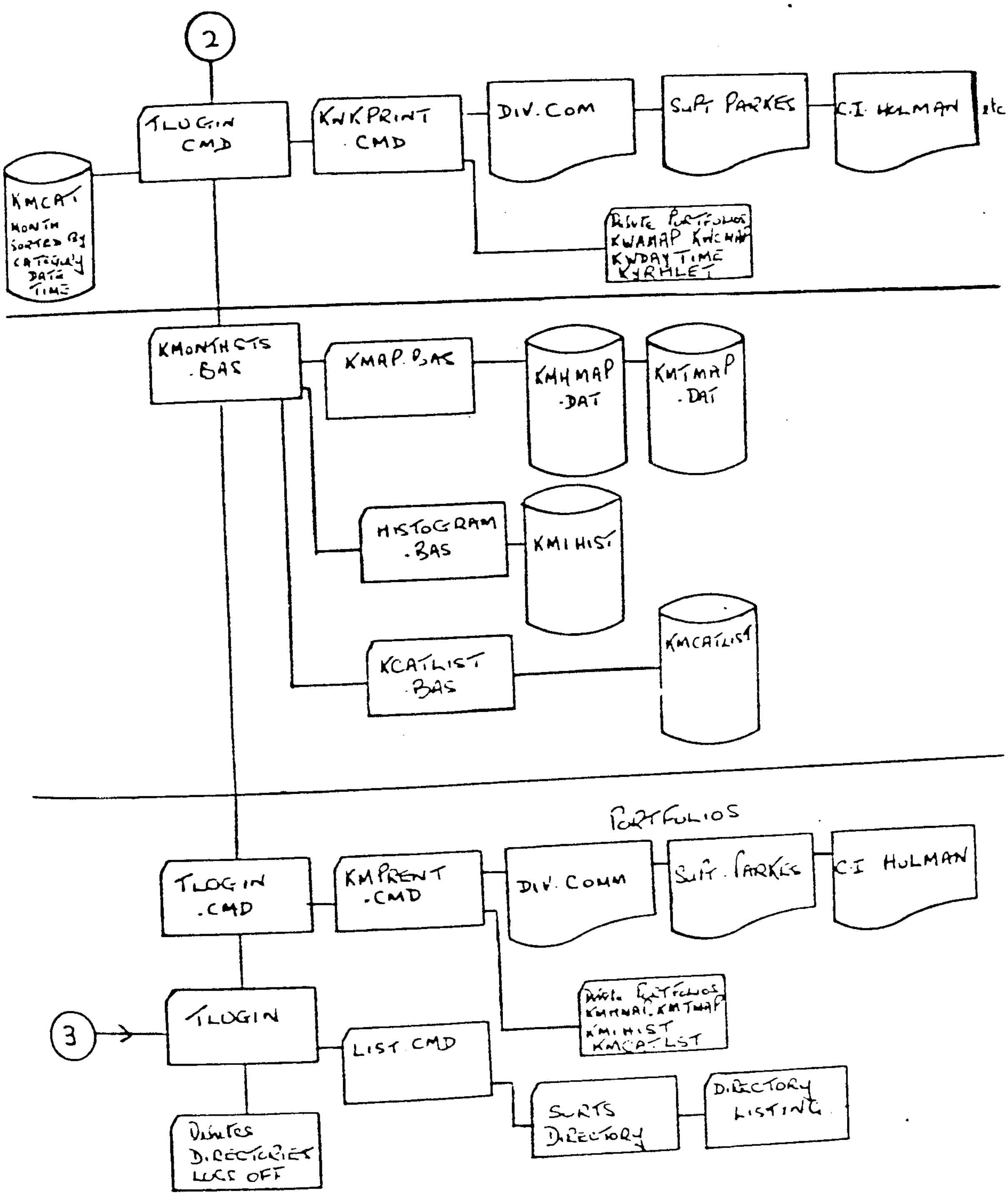


FIGURE 15.7 (continuation)



The system has been running with data since the 1st January 1979 up until the present time (August 1980). Whilst data has been available for the complete period, various operational difficulties were evinced, in the main with obtaining persons to enter the data on a regular basis.

The data has been circulated to officers between the rank of constable and chief superintendent (in fact also to Chief Constable level) and a summary of some of their requests for additional information is set out below -

1. Requests for more specific information concerning grid references for:
   (a) location of the caller;
   (b) location of the incident;
   (c) either location of the vehicle or resource sent to deal.

   This request was embodied in requests for analyses involving a cross reference between these three locations.
2. An indication of police time taken up by each incident (often broken down by type).
3. The number of resources attending per incident.
4. The car beat attendances -
   (a) this was required to assist in the training of operators and
   (b) to acquaint management with the optimal location of beat boundaries, etc. An example of the type of print out produced for this sort of request is shown in Fig. 15.8.

5. The addition of extra data into the input format, e.g. such as details of juvenile offenders schools, including location, meal break times etc.
6. Programmes to produce an indication of trends by area, by time, or by incident type or a combination.
7. Greater detail concerning the result of police action.
8. A request for better maps which could be more easily assimilated by the manager. I made some attempt at improving map display with the assistance of scientists from the National Physical Laboratory and a static illustration of the dynamic screen map which we produced is shown on Fig. 15.9.
9. There were frequent requests for more details regarding incident types.
10. There were requests for the specific tagging of certain types of incidents, such as juvenile shoplifters etc.
11. There was a request to add socio economic data to assist in some of the social initiatives of the Force.
12. There was an interest in the period to the conclusion of the average investigation, particularly in crime cases.
13. There was a request for information concerning other services involved in incidents to be included -
    (a) to assist in the following up for various specific enquiries and
    (b) for management use.

14. There was a request that there should be more specific particulars concerning the officer or other resources attending to ensure that management could monitor the proper matching of incidents with resources.

15. There was a request that more informant details should be included such as sex, age, social class etc. This once again was intended to be used by management and force statistical

officers to ensure that we were making the maximum use of the public as an ally in dealing with various policing matters.

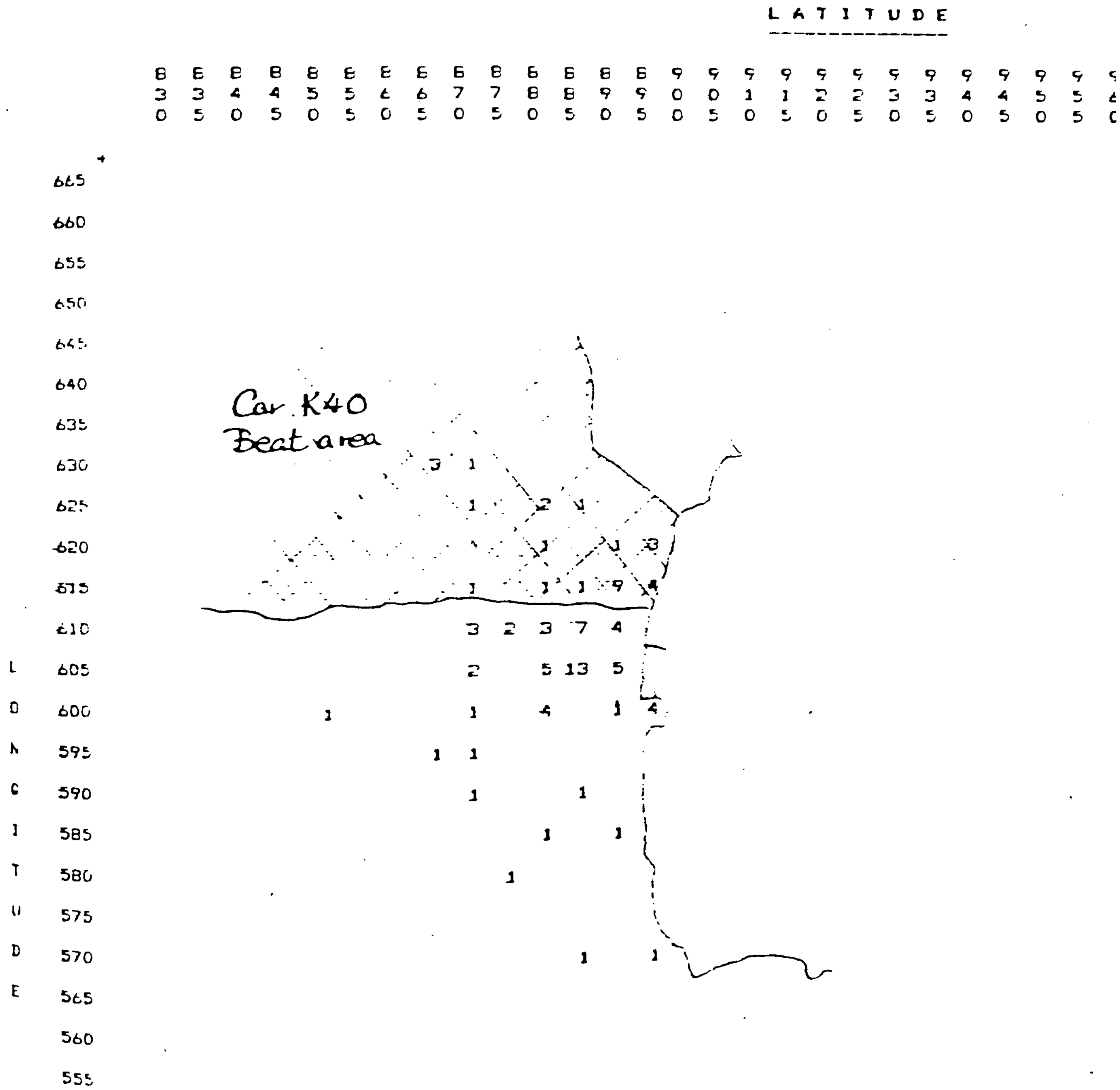
16. It frequently became obvious that single dimension data, whilst easier generally to understand, could often be misleading and we were interested to note that after some experience with uni-dimensional data, such as histograms, managers felt that they were able to understand the very slightly more complex displays such as cross tabulations etc.

FIGURE 15.8

(C) JOHN HULBERT 30-NOV-79

MAP OF INCIDENTS FOR JUNE

...RIES OF INCIDENT CATEGORIES ATTENDED BY CAR CALL SIGN K40



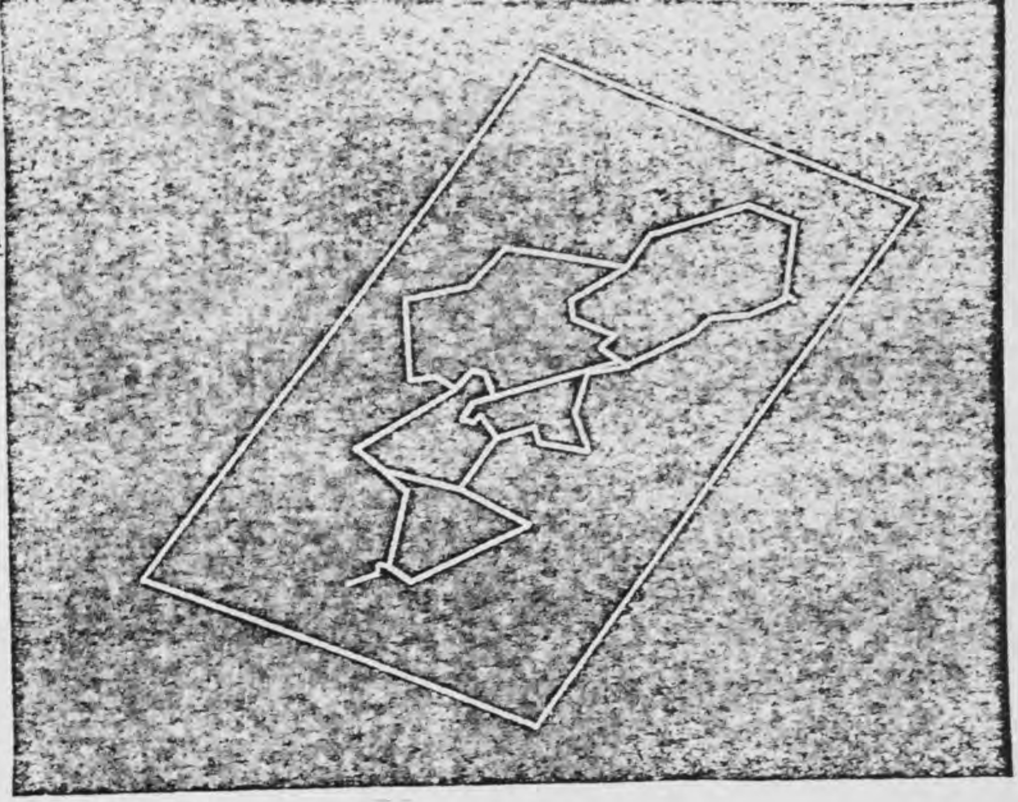
Uses made of the system

The system, as well as being of interest in providing some indication of the requirement for the volume of data was also being used for legitimate ancillary purposes. A number of these are as follows:-

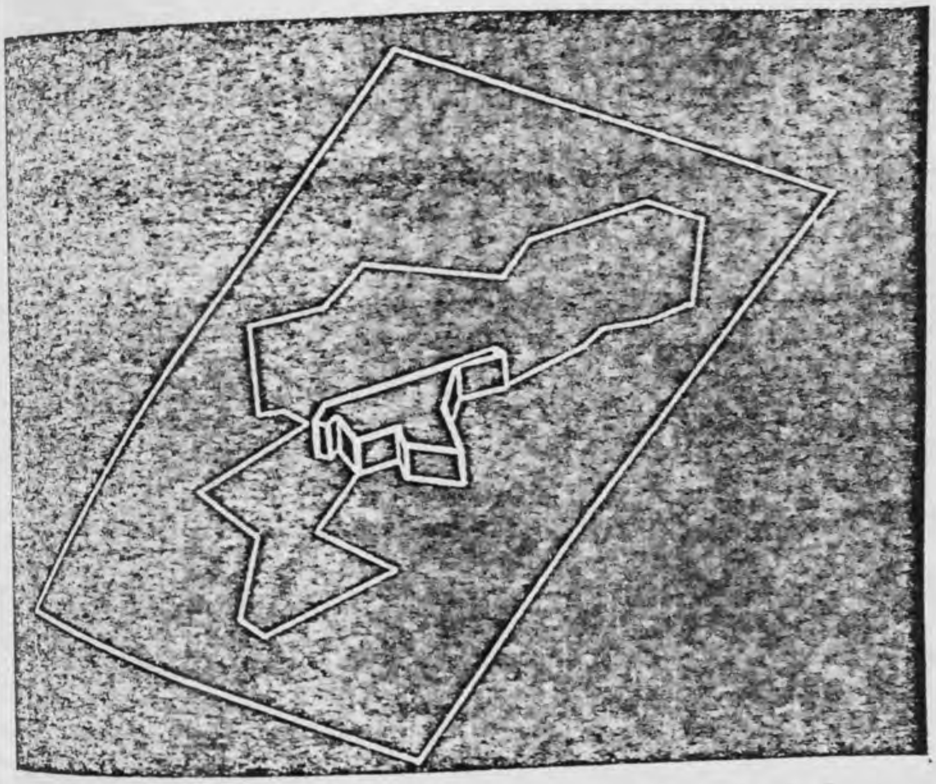
1. It has been used within the sub-division to re-assess the community policing beats. In particular the maps, which in a later version of the system included standard incident times (Fig. 15.6), were employed in this particular work.
2. The system has been employed to brief Her Majesty's Inspector of Constabulary on the problems of the sub-division which was under scrutiny during his annual inspection.
3. The specific finding concerning the incident attendance of various mobile resources, and this compared with their legitimate beat boundaries has resulted in a new Force radio training schedule and also a reappraisal of car beat boundaries in the sub-division. (This relates to the 'C' call problems described in Chapter 7.)
4. The information has been used as a catalyst at the Police College seminars by officers from the sub-division who attended representing the Devon and Cornwall Constabulary.

FIG. 15.9

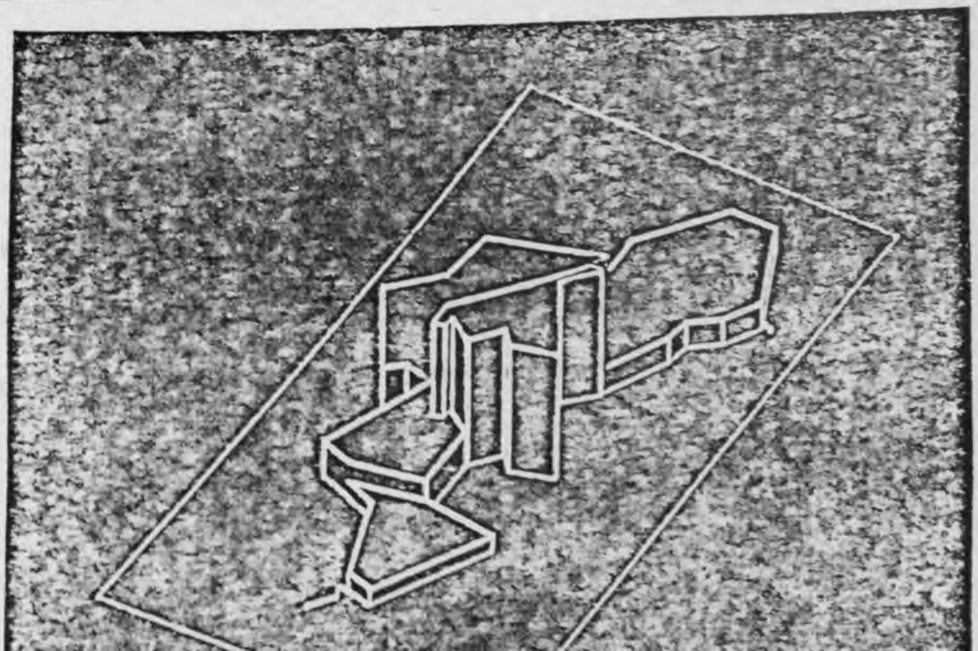
Photographs of (3D) Screen Formats - Paignton Management System



1. Map of 'K' Division Boundaries



2. Incident Histogram for Central Sub-Division only



3. Incident Histograms for all Sub-Divisions

Conclusions

I have deliberately not itemised the number of different types of requests for different types of data etc. The object of this exercise was very much more qualitative than quantitative. It is on-going and the results will continue to be refined and will provide a catalyst for managers in providing useful information concerning the type of system with which they should be provided.

It seems clear that the message log in its present form should in no way be curtailed. All of the information at present on the message log has been requested by a number of officers in the course of these action research activities. In addition, a modest amount of additional information, particularly concerning geographic locations and timings, has also been requested. It seems clear that any trend towards reduction of data is likely to lead to a diminution of the value of the data base for the provision of subsequent management information. This factor is something which must be seriously considered in the design of Computerised Message Log Input systems. The finding strongly suggests that attempts to reduce the scale of the keying operation may reduce the efficacy of the whole operation.

The Paignton Project obviously has provided a great deal of information on many areas of computerisation and police work. I have, however, concentrated in this chapter on the areas which have some relevance to the task of the control room operator.

As a postscript, a decision has been made to extend this half manual/half computer experiment so as to cover the whole Force. An Inspector from the MIPT will be running the system and the evaluation of use and display methods will be directed by Superintendent Pollard of the Crime Prevention Support Unit (CPSU). It is intended to run the system for about eighteen months to two years to gain experience in the use of data for management purposes. The design criteria thus evolved will then be used to implement the MIS modules on the Force computer network.

CHAPTER SIXTEEN

VOCABULARY INVESTIGATION

Objective

The preceding chapters have outlined problems experienced by operators when attempting to enter data into a computer system under normal control room conditions, and also to explore the parameters of their task. This chapter has the dual objective of continuing the investigation in so far as it looks at the type of words that are actually used on the message, evaluating in particular the frequency of the vocabulary.

The main objective, however, is to ascertain whether certain potential solutions to the operators' problems are feasible. One of the novel forms of input which I was interested in evaluating was that of speech input. There are a number of different systems currently on the market and of course furious activity in research establishments throughout the world to provide that first lucrative continuous speech input facility.

The main drawback, which is likely to continue for some considerable time, is that both the current commercial and experimental systems have limited vocabularies. A major reason for this particular investigation, therefore, was to evaluate the vocabulary sizes currently used on the manual message logs in order to see whether or not further consideration of the various potential voice input systems was justifiable.

The investigation is divided into two parts. The first was a straightforward analysis of the actual words used in the message logs, the second arose out of findings in this initial survey and was aimed particularly at the form taken by the address section of the message logs.

VOCABULARY INVESTIGATION

Method

A total of 472 message logs were transcribed into a machine readable form. They were then printed out and checked against the original logs. A number of vocabulary analysis and tabulation programs were written which allowed various forms of vocabulary analysis, the main objective being to analyse the total number of words used. The programs allowed for the selective removal and/or amalgamation of spurious words and letters, the amalgamation of synonyms if required and various forms of sorting.

Results

The raw data file contained 19,109 words and an unabridged vocabulary of 2,726 words in the total of the 472 message logs.

Table 16.1 outlines the distribution of the word categories in the message log.

Table 16.1 - Distribution of word categories in message logs

	Number of Words	Percentage of Total
Normal Vocabulary Words	15,836	82.9
Proper Names	885	4.6
Street Names	1,272	6.7
Isolated Letters	1,061	5.6
Errors	55	0.3

The normal vocabulary consisted of 1,389 different words

FIGURE 16.2 WORD AND VOCABULARY FREQUENCY TABLE

WORD AND VOCABULARY CALCULATIONS
****

13-OCT-80 (C)JOHN HULBER

DEVON & CORNWA

SOURCE FILE= VOCAB RESULTS FILE= VOCAB TAB 12 24 24 13-OCT-80

DESCRIPTION OF THE EXPERIMENTAL DATA
----

999 CALLS FROM PLYMOUTH CONTROL ROOM - RANDOM SAMPLE

THE WHOLE OF THE RAW DATA FILE WAS ANALYSED
SPURRIOUS WORDS AND LETTERS REMOVED FROM THE RAW FILE
SYNONYM AMALGAMATIONS
THE FILE HAS BEEN SORTED BY FREQUENCY

WORD	WORDS				VOCABULARY	
	FREQ	CUMULATIVE FREQ	PERCNT	CUMULATIVE PERCNT	CUMULATIVE FREQ	CUMULATIVE PERCNT
THE	422	422	2 915	2 915	1	0 072
A	329	751	2 273	5 188	2	0 144
AND	301	1,052	2 079	7 267	3	0 216
IN	277	1.329	1 914	9 181	4	0 289
I	276	1,605	1 907	11 087	5	0 361
TO	270	1.875	1 865	12 953	6	0 433
SEND	245	2.120	1 692	14 645	7	0 505
MR	228	2.348	1 575	16 220	8	0 577
ROAD	214	2.562	1 478	17 698	9	0 649
ATTEND	179	2.741	1 237	18 935	10	0 722
IS	177	2.918	1 223	20 158	11	0 794
STREET	169	3.087	1 167	21 325	12	0 866
[illegible]	165	3.252	1 140	22 465	13	0 938
OF	165	3.417	1 140	23 605	14	1 010
UNIT	162	3.579	1 119	24 724	15	1 082
AT	161	3.740	1 112	25 836	16	1 154
POLICE	157	3,897	1 085	26 920	17	1 227
HAS	148	4.045	1 022	27 943	18	1 299
ON	142	4.187	0 981	28 924	19	1 371
THERE	139	4.326	0 960	29 884	20	1 443
MY	134	4.460	0 926	30 810	21	1 515
ALARM	127	4.587	0 877	31 687	22	1 587
HAVE	126	4.713	0 870	32 557	23	1 659
MRS	125	4.838	0.863	33 421	24	1 732
BY	107	4.945	0 739	34 160	25	1 804
CRIME	98	5.043	0 677	34 837	26	1 876
BEEN	97	5.140	0 670	35 507	27	1 948
ALL	95	5.235	0 656	36 163	28	2 020
NOT	92	5.327	0 636	36 799	29	2 092
IT	91	5.418	0 629	37 428	30	2 165
YOU	89	5.507	0 615	38 042	31	2 237
CAR	84	5.591	0 580	38 623	32	2 309
ARE	82	5.673	0 566	39 189	33	2 381
ACCIDENT	80	5.753	0 553	39.742	34	2 453
NOW	78	5.831	0 539	40 281	35	2 525
SEE	75	5.906	0 518	40 799	36	2 597
INFORM	73	5,979	0 504	41 303	37	2 670
WITH	73	6.052	0 504	41 807	38	2 742
CHECK	71	6.123	0 490	42 278	39	2 814
CALL	69	6.192	0 477	42 774	40	2 886
VEHICLE	67	6.259	0 463	43 237	41	2 958
AN	66	6.325	0 456	43 693	42	3 030
AVENUE	66	6.391	0 456	44 149	43	3 102
CAN	66	6.457	0 456	44 605	44	3 175
JUST	65	6.522	0 449	45 054	45	3 247
FOR	64	6.586	0 442	45 496	46	3 319
FROM	64	6.650	0 442	45 938	47	3 391
OFF	64	6.714	0 442	46 380	48	3 463
CO	62	6,776	0 428	46 809	49	3 535
PREMISE	62	6.838	0 428	47 237	50	3 608
ORDER	61	6.899	0 421	47 658	51	3 680
HERE	58	6.957	0 401	48 059	52	3 752
OUT	57	7.014	0 394	48 453	53	3 824
HAD	56	7.070	0 387	48 840	54	3 896
Errors	55	7.125	0 380	49 219	55	3 968
HOUSE	55	7.180	0 380	49 599	56	4 040
TELEPHONE	51	7.231	0 352	49 952	57	4 113

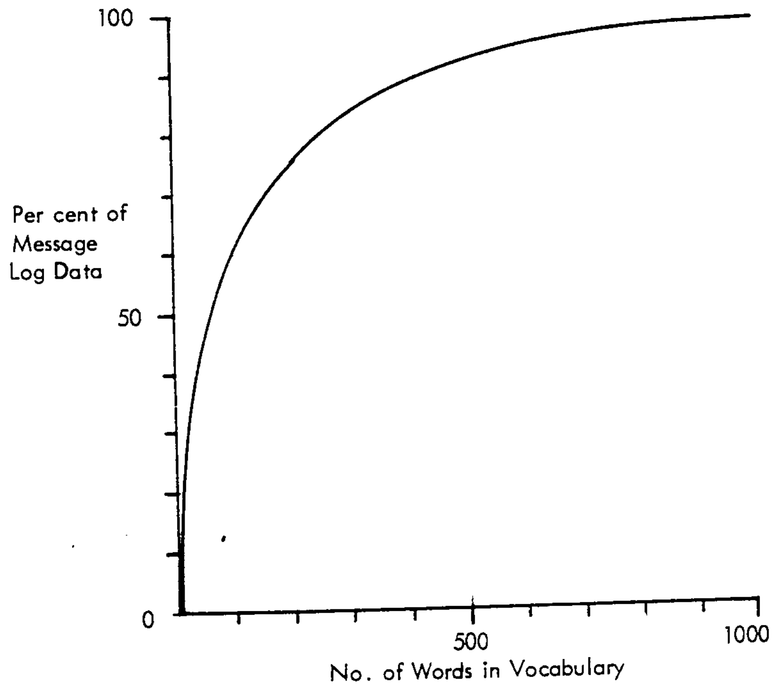


Fig. 16.3 Percentage of message log data accounted for by vocabulary items.

Table 16.2 shows the beginning of a printout indicating the most frequently used words. In this particular table three genuine words, namely 'communications', 'text' and 'action', have been removed as they were in fact part of the message log format.

Discussion

It can be seen that the actual vocabulary of different words used is relatively small despite the quite large sample. The vocabulary size of 1,389 is quite close to that being used in some present day commercial discontinuous speech systems. The finding therefore fully justifies continuing with an evaluation of speech input systems (discussed in Chapter 17). It can be seen that approximately 83% of the total information apended to message logs consists of normal vocabulary words with only the remaining 17% consisting of proper names, street names and isolated letters etc. A perusal of Fig. 16.3 also indicates that for the normal vocabulary itself a relatively small vocabulary provides a large percentage of the data. In fact, for words alone a vocabulary of 58 words caters for over 50% of the total words used on the logs. This is in keeping with normal findings for the vocabulary analysis of prose. As can be seen from Table 16.2, all of the normal function words are well represented at the top end of the frequency table. In addition, the distinctive domain from which this information was abstracted is also well represented in words such as 'send', 'road', 'attend', 'unit', 'police', 'alarm', 'crime', 'accident' etc.

The fact that a relatively small number of words could in fact cater for a large percentage of the words used in the logs would suggest that some slight curtailment of the vocabulary would not necessarily greatly impair comprehension of the message log. I designed a small system which has been called "RETEXT" which for various sizes of vocabulary reconstitutes the initial message log.

Chapter Sixteen cont.

The aim here is to examine the size and type of vocabulary which could provide reasonably comprehensible message logs. An example of a Retext output is shown in Figure 16.4 with a fuller version in Appendix XIII.

Fig. 16.4 - Examples of RETEXT Reconstituted Message Logs with Limited Vocabulary of 196 words or 12.5% of Total Vocabulary

TWO MEN HAVE BEEN CAUSING TROUBLE HERE THEY HAVE NOW ####
BUT THEY ###### TO BE THROWING ###### AROUND AS THEY GO DOWN THE STREET

I THINK MY HOUSE HAS BEEN BROKEN INTO I M ####### WITH MY ######
AND I VE JUST BEEN TO MY HOUSE AND THE WINDOW WAS ######

WILL YOU SEND A CAR HERE I VE GOT A #### OF BOYS CAUSING
TROUBLE IN THE SHOP

MY HUSBAND HAS COME HOME DRUNK AND WE HAD AN ######### I AM
TO GO BACK HOME I AM AT THE #### PARK NOW AND I WILL GO
BACK

JUST A ###### I #### HERE WITH MY #### ###### AND WE VE BEEN
OUT ######### I ##### TO OPEN THE FRONT DOOR BUT THE ### ###### T
IT I ####### TO GET IN THROUGH THE BACK DOOR AND
IS ALL IN ##### BUT I VE ####### THE FRONT #### #### AND IT S
########### BEEN ######## WITH I ##### #### TO SEE A PC AS WE
HERE

THERE ARE YOUTHS AROUND THE ####### AGAIN THROWING ######
AND #### COULD AN OFFICER ##### THEM OFF PLEASE

WE HAVE HAD A BREAK IN

A YOUNG ##### HAS JUST COME UP AND ####
A MAN HAS #### A BOMB WILL GO OFF IN ST #######
SCHOOL CALL #### ON ######## #### #########
ARE ##### A #####

SOMEONE ##### TO BREAK INTO MY HOUSE LAST NIGHT THEY VE TAKEN
THE ##### FROM MY WINDOW

THERE HAS BEEN AN ACCIDENT AT ###### ROAD BOTTOM OF ##### WAY
THE ####### IN THE VEHICLE HAVE BEEN INJURED

I HAVE JUST FOUND AN OLD MAN IN THE #### I HAVE TAKEN HIM TO
BUT I THINK YOU ##### TO SEE HIM

I HAVE TROUBLE WITH A MAN ON THE PREMISES CAUSING TROUBLE
I ###### GET HIM OUT

MY ## ######### HAS TURNED UP CAUSING TROUBLE HE S #####
IN THE FLAT I VE COME OUT WITH MY CHILDREN

The Retext system has been devised as a design tool and therefore no enquiry or results have been included in this chapter. It has, however, been mentioned as a spin-off from the main research.

In a similar vein, there is another potential spin-off from this pure vocabulary research in so far as it is likely that different subject matters have different vocabulary frequencies. I devised a system that produced vocabularies from the same message log data base, broken down by subject type. Such a system would be of use in aiding the search for key words to be used in the design of input systems, particularly those involving speech input. A specimen of this output has been included in Appendix 14. The information thus gained will be invaluable in the design of Control Room aid systems.

ADDRESS INVESTIGATION

It has become obvious from the various researches that have been carried out, that great attention is paid by the operators to the noting of addresses. Although that data forms a relatively small percentage of the total information placed on the log, it is of course vital. It is possible that, providing the number of street names is relatively small, a street name recognition system could be provided in Control Rooms. There is the prospect that such a system could be speech based. It was for this reason that I mounted the following enquiry.

Method

A sample of 100 messages for each of the Control Rooms was randomly sampled for each of the years 1977, 1978 and 1979. The address section of each message log was checked and the address given was categorised according to the table of results in Table 16.5.

Results

Table 16.5 - Location of addresses on the message logs

	PERCENTAGE		
Control Room	Within Division	Anonymous	Outside Division
Camborne	91.3	5.3	3.3
Barnstaple	90.6	2.3	7.0
Plymouth	87.3	8.9	3.6
Exeter	81.7	3.3	15.0
Exmouth	77.0	3.0	20
Paignton	96.3	2.3	1.3
Plympton	80	1.6	18.3

Average of samples taken from 3 years 1977-79
No significant differences between years

DISCUSSION

It can be seen that a remarkably small number of these addresses which are actually given are outside the divisional boundaries of the control room which receives the message. This is an extremely surprising result for an area which is renown for its mobile population, particularly during the summer months. A check of the message logs found that visitors tended to give local (temporary) addresses rather than home addresses, and that for the purposes of the message logs these were usually found to be sufficient. (For those divisions which had a higher than average count of addresses outside of the division, in all cases the excess came from one of the immediately adjacent divisions.)

There is every reason therefore to suppose, that based on this data, that viable divisional indexes of street address names could be compiled and used as part of a control room support system.

Call Analysis

A similar vocabulary analysis was carried out on transcripts of the actual calls. A total of 347 calls were transcribed and punched into computer readable format and then analysed using the Cocoa package at Aston University. The result was a total of 11,183 words and an unabridged vocabulary of 1,216 words. This once again is a surprisingly small vocabulary and reflects the very limited domain of discourse of the data being analysed. In addition, as the vocabulary for the calls is in fact smaller than that of the logs, this negates any suggestion that the logs are being artificially restructured into a smaller vocabulary size of police jargon.

Conclusions

The main conclusions are that it seems to be quite feasible to further consider the various potential speech input modes in view of the relatively small size of the vocabularies used in the message logs. In addition, the other potential major source of variation, namely address names, similarly seems to be confined within a relatively small set, and amenable to searching by computer techniques. The way therefore seems open, to further evaluate both speech input modes and some of the other control room facilities such as automatic address location systems.

CHAPTER SEVENTEEN

MAN MACHINE COMMUNICATION - SIMULATION EXPERIMENT

Communications Modes - Review of some Previous Studies

Comparisons of the various methods by which human beings may communicate with machines is not an area that has been widely researched in the psychological literature. The work of Alphonse CHAPANIS (CHAPANIS et al 1972, 1973, 1975 and 1977) however is a notable exception. CHAPANIS and his associates have conducted a large series of experiments to evaluate the different modes of communication, both to and from a simulated computer system. The channels of communication which they have evaluated are:

1. Speech
2. Writing
3. Typing
4. A mode which he calls 'information rich'
   (This in fact normal face to face conversation and consists therefore, of speech plus non-verbal communication)

He justifies concentrating on these four modes (CHAPANIS 1973), by arguing that the communicative abilities of most people are exhaustively described by these four categories.

The experimental situation which was set up by CHAPANIS was intended to mimic a real life co-operative relationship between a computer system and a potential user. Four relatively complex tasks were considered viz.

(1) involving the geographic orientation of the user

(2) the assembly of a complex piece of equipment

(3) a library information retrieval task,

and (4) the selection of an item of stock from a list of parts etc.

None of these problems were trivial, and most of them took between thirty minutes and one hour to complete.

Over the course of the experiments CHAPANIS and his associates tried every combination of these four communication modes, comparing both direct effects and interactions with the problem types.

The experimental set-up was for one person to act as the hypothetical 'user' of a computer system and the other person to simulate the computer. The latter, who was called 'the information source', had the aim of simulating a futuristic computer system, with some verbal and written communication capabilities. Obviously this human simulation provided a very much higher performance level in terms of interaction, than can be provided by presently available computer equipment.

CHAPANIS used a great number of measures to evaluate the performance of the various subjects, including length of time to solve the problem, measures of the extent of verbal exchange and observational activity analyses.

The most interesting finding was that for the verbal modes the time taken to solve the problems was approximately half that for typing modes. An interesting corollary to this finding was that despite the great play made in psychological literature of non-verbal communication, there was very little difference between the plain verbal communication and that which also allowed both visual and verbal contact. This may have been because the communications were essentially purposive and concerned with passing factual information, rather than social or attitudinal nuances. CHAPANIS argues that this may throw light on the reason why the telephone is so successful as a communication device, whereas the very much more expensive video phone has not as yet gained much ground

A second most impressive finding was that, when CHAPANIS et al considered two variations of the typing mode, one involving experienced typists, and another involving inexperienced typists, the amount of time taken to solve the problems for both of these groups was not greatly different. This was contrary to their expectations and certainly flies in the face of most of the assumptions made in the design of management information and similar communication systems, viz that a high level of typing skill is essential to good system performance.

When considering measures of verbal content the position is reversed and the voice channel systems were very much more wordy than either the hand written or the typing systems, which is rather what one might expect.

When CHAPANIS compared the voice versus the typing communication, he found that speech was about ten times as fast for communicating words as typing, but approximately eight times as wordy. However, care must be taken not to compare these two factors too glibly as the redundancy in the voice communication was obviously useful, the voice mode providing by far the fastest problem solution.

The better performance of the voice modes cannot solely be explained in terms of faster communication. The activities required by CHAPANIS of his subjects involved procedures such as searching and looking for information, composing answers, as well as receiving and transmitting information. One of the great advantages noted for voice communication was that it was found that most people were able to concurrently carry out a communication using voice, whilst also (contemporaneously) engaged in another task. They were therefore able to condense more work into the same period of time. CHAPANIS's researchers, however, found that in both the writing and the typing modes, although theoretically it should be possible on occasions to carry out parallel activities (although perhaps more difficult than speaking and searching for instance), the subjects tended not to do so, and concentrated on the communication for one period of time and then on some other activitiy for another period of time, without any overlap.

It was noted that the handwriting system was faster overall than typing, although here there was a slight shortcoming in the experimental layout which prevented the handwriting mode being directly comparable to either the voice or the typing systems. The experimental arrangement for the transmission of handwritten material was to write the information on a tablet and, on completion of the message, to put it into a shute which then went to the other subject. This meant that the person receiving the information could not begin to read the message until all of it had been completed and transmitted. However in both the voice and the typewriter modes, the message began to appear on the receiving equipment from the commencement of the production of the message. In any new experimental set-up the handwriting mode could be made equivalent to the other modes by the use of equipment such as a scribophone (PHILLIPS 1979). If such a device had been used it is likely that the handwriting mode would have been faster than it was, although not as fast as the voice input system. The very large percentage of waiting time in the handwriting mode, noted by the experimentors, would presumably have been reduced by this change in the experimental paradigm.

The findings concerning lack of variation between experienced and inexperienced typists were so astounding that a further series of experiments were set up to check the original work (WEEKS et al

1974). To all intents and purposes their conclusions were the same as the original CHAPANIS reports, namely that typing skill did not greatly improve task performance. There may be a number of reasons for this. In the first place, WEST (1967, 1969) found that free typing rates were much lower than copying rates. This is a fairly obvious fact, but one which unfortunately, is frequently overlooked. Most typists are taught to copy written or audio material. This requires very little mental effort on their part, other than the recognition of words (or characters) and their transposition to the keyboard. This is the basis of the Sight and Sound education systems (Sight and Sound Education Ltd. 1979) which are being widely employed in police forces at the current time, to improve typing skill. However, the nature of the typing skills which are generally required in command and control systems, involve the composition of messages, and their transcription rather than simple copy typing. Whilst copy typing skill obviously assists to some extent, a person who is adept at succinct and effective composition is likely to have a greater advantage than one who simply has typing ability. In addition, the total amount of time spent actually communicating with a computer in this type of system is quite short. In the CHAPANIS work the percentage of time taken up by such communication (both to and from the simulated computer) came to a total of 19% in the typing mode, or approximately thirteen minutes on average, and only 6% in the voice mode, or on average two minutes. It can be seen therefore that the total amount of time spent in communication is relatively small, and using the voice mode was very much lower than that for the other modes.

The other factors which CHAPANIS found which are of interest to systems designers is, that when left to their own devices, all of the communication modes seemed to be rather haphazard and to lack the normal structure of syntax. However, there must have been some degree of order about the communications as they were invariably understood by the recipient, who responded in like manner. CHAPANIS's main points are that, if in the future it is intended to design computer systems wherein naive users can communicate with a computer with very little training, or artifcial restraint, then the systems must be capable of dealing with some gramatically scruffy prose. Present linguistic research is having difficulty in describing how we handle immaculate prose. It is therefore likely to be some time before we shall be able to specify equipment which could deal with the gramatically imperfect utterances of everyday spoken communication.

A point that should be made concerning the CHAPANIS work is that one must not jump to the conclusion that he was merely evaluating various communication modes. Any suggestion that the work could be immediately applied to the present day computer systems may be misleading because of the salient fact that he was not only simulating a perfect voice input and output system, but he was also at the same time simulating an intelligent computer. This fact may be very significant because of the considerable amount of feed-back that a truly intelligent computer system could give to assist an operator in carrying out his task. Although the source was supposedly the repository of the information, the collaborative method by which the simulated computer and the potential user operated, obviously was not one of implacable and immaculate information source versus enquirer, but much more like co-operation between two humans. This simulation is in line with the current activities which are attempting to produce moderately intelligent 'assistants or apprentices' to aid various tasks. Future systems may allow both the computer and the user a degree of feed-back, in so far as the computer and the user could both put forward hypotheses and try them out on one another.

Another point to make with respect to CHAPANIS's work is that his subjects were all naive, in so far as they were not experienced computer operators. It is therefore possible that some aspects of his results might not be so readily generalisable to persons who are experienced operators and who therefore will attain a degree of familiarity and expertise, with both the equipment and the task.

The major theme of CHAPANIS's work seems to be that communication channel (mode) differences effect performance even when different tasks are independently compared.

Affective Attributes of Communications Modes

A parallel series of experiments were carried out by BEVAN and EVANS (1975), when they attempted to evaluate user responses to a number of input modes to be used in a computer aided instruction system. The system that they chose was a programme to teach people the complexities of value added tax. They evaluated six different input systems namely a teletype (10 c.p.s.), a vista display terminal (V.D.U.) (10 c.p.s.), a recorded audio presentation (voice only), a recorded video presentation (voice and picture of speaker), a live audio presentation, and a live video presentation. At the end of each training session the subjects were asked to evaluate the particular media that they were using, using a series of semantic differential measures. The overall effect seems to be that subjects preferred the visual to the audio presentation and that the visual display unit was generally preferred to the teletype.

It should be noted however that there were no really objective measures of the efficacy of the teaching programme; only the subjective measures of mode preference, using the semantic differential. The major differences between this work and that of CHAPANIS is that the communication was not truly inter-active. In the BEVAN and EVANS NPL study the subjects only had the capability of inputting a button-push to allow the programme to continue or on occasions they could provide a simple Yes/No answer. In none of the modes were they allowed to have voice input as in the CHAPANIS systems. The CHAPANIS system was very much an active co-operation between the simulated computer and the user. In the NPL study, however, the computer was active in an instructional task and the user was relatively passive. The type of task was also very different. The user in the NPL task had merely to attempt to understand and digest the information which was being presented to him, whereas the user in the CHAPANIS task had to attempt to consider new ways in which he could inter-act with the computer in order to solve the problem which he had been set.

BEVAN and EVANS however do mention an important factor which may be of use in the design of computer systems, which is the possibility of an affective or attitudinal aspect to different types of computer communication. It may be that certain types of communication are considered more friendly, more forgiving or easier to use than others. This affective attribute may be important in considering the human operator's reaction to the equipment.

OBJECTIVE OF EXPERIMENT

The intention of the present experiment was to evaluate the various input modes, both those which currently exist and those which can be reasonably foreseen, under circumstances which closely mirrored real control room operating conditions. The input modes included written, typed and spoken communication. Measures were taken which could reasonably support comparative inferences between the various modes.

The task which we have been considering throughout this work, is one which naturally involves a high degree of verbal activity. There was a reasonable supposition that the normal verbal communications, say between a 999 operator and a caller, might be affected by the imposition of another speech task, such as speech input to a computer. It was these specific questions and also a desire to have some early insights into the relative characteristics of the various input modes which were the main objectives of this experiment.

DESCRIPTION (OVERVIEW OF EXPERIMENT)

A simulation was set up which attempted to closely parallel operating conditions.

The job of a Police Emergency Operator (Chapter Six) is esentially to answer emergency telephone calls, give suitable advice and reassurance to the caller, interrogate the caller and obtain information which is necessary for both the immediate response and also longer term management purposes. He also has to maintain an awareness of current police resources and to equate the demands of the incoming emergency call with the resources available to meet it. Finally he is normally responsible for actually contacting a resource, briefing the resource on the details of the incident and commanding the despatch of the resource to deal with the incident. He is usually responsible for monitoring the incident through to its conclusion and noting the results of any actions taken. (These actions are described in full in Parts II and III of this thesis.)

In interpretating the results of this particular simulation, I confined the analysis to only the first part of the operator's activities namely, all activity up to the despatch of a resource. It is the early call sequence of activities which is usually under the greatest time pressure. Certainly this aspect of the job is most critical, there normally being other levels of supervisory officer available in the Police Service to check and support the subsequent activities.

In the simulation, experienced operators were presented with emergency 999 calls under experimental conditions. The emergency calls were made by actors who followed transcripts of genuine 999 calls. Upon receiving the call the operator had to deal with the 'member of the public' in the normal way whilst at the same time, logging relevant information and eventually despatching a reasonable resource to the scene of the reported incident (if necessary).

The approach had great similarity to the CHAPANIS work, the major differences being:-

1. Only one task was considered as this was a piece of applied research into that specific task.
2. The input modes were more closely modelled on commercially available (or potentially available) systems.
3. Apart from the ability under some modes to accept speech, the simulated computer was in no way intelligent. Therefore some of the feedback and guidance aspects of CHAPANIS's creation were absent.

DESCRIPTION (COMPONENTS OF EXPERIMENT)

The three major components of an emergency call situation were simulated by the following participants:-

Operator	=	Subject (selected from experienced Police Operators
Caller	=	Actor
Computer	=	Skilled typist (for speech input modes)

The experimentor controlled the simulation and the apparatus, and observers were present to note and time certain aspects of the subjects' reactions.

SIMULATION STAFF

Callers-Actors

Two persons acted as 999 callers. Very explicit instructions were given to them concerning their activities. They were provided with boards containing transcripts of 24 '999' calls. These calls were selected at random from a large pool of transcribed calls which we had available. The prompt boards contained both the original words spoken by the caller and also the original responses by the police officer who dealt with the call in the real environment. The actors were instructed to follow the details on the call where possible but not to sacrifice any interaction with the experimental subject. The emphasis was on providing a credible emergency call rather than slavishly following the exact details of the original 999 call. Nonetheless it was found that rarely were major distortions of fact necessary in order to maintain the flow of conversation.

Speech Input Computer - Skilled Typist

In the speech mode the typist 'computer' could hear the words spoken by the operator through a special set of headphones (Fig. 17.1). She then immediately typed those words onto the screen in front of her, whereupon they were echoed on the screen in front of the operator (subject).

Fig. 17.1 - Experimental Staff - Simulated Computer and Monitoring Sections

The typist was given a great deal of training in this mode of operation and became very skilled at the task. It was found to be useful to allow her to listen on a spare set of the experimenters headphones, wherein she was able to slightly anticipate the general trend of the conversation and be ready to immediately produce any words which the police operator directed towards the 'Computer'. The experimenter at all times monitored this interaction and ensured that the typist did not either step outside the boundaries of the various modes under which she was operating, or provide human judgement of a kind which could not normally be expected of a machine.

The result was an extremely authentic presentation to the operator with virtually no delay between the speech and the appearance of words on the screen in front of him. A number of the operators were unaware until the time of debriefing that they were not actually talking to a computer system, although we had made no attempt to suggest to them that it was other than a simulation.

APPARATUS

Audio

A sophisticated audio system was devised, which allowed the subject (experienced emergency operator) to listen to an emergency call and speak to the caller using a head set and boom microphone (Figure 17.2). The caller was provided with normal speaking and listening equipment which corresponded to a telephone handset.

In the speech modes (described later) the operator was also provided with a push-button (see Figure 17.3) which when depressed diverted his voice channel (only) to the expert typist who provided the speech input computer simulation. The depression of this button did not in any way interrupt the caller's ability to speak to the police officer, but the caller could not hear what the police officer said to the 'Computer'. The objective of this particular design was to follow what was considered to be a reasonable future system which might be employed in any operational context. It allowed the caller to continue passing information to the police officer, and at the same time did not confuse the caller by allowing him to hear any command spoken to the 'Computer'.

The experimenter was able to hear both conversations at the same time. All verbal transactions were recorded on a master tape, and all transactions to the Computer were, in addition, separately recorded.

- Emergency '999' Operator

Aston University

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FIG. 17.3 Simulation Experiment
- Control Room Section - Operator and Observer

Aston University

Content has been removed for copyright reasons

COMPUTER EQUIPMENT

The simulation screens and programs were programmed on a PDP11/34 Computer. Two main formats were used. One was the message log format, this can be seen on Figure 17.4.

Fig. 17.4 - Simulation Experiment

Message Log - Screen Format

It comprises of a screen with various headings of a relatively simple nature. All of the information on the first two lines was automatically provided by the system. I designed the format following many observations of operators carrying out the task of completing message logs in both manual and computer systems. The major innovation is that the subject field is at the bottom of the form. This is because the categorisation of the call subject is normally one of the last tasks of the operator.

The difficulties concerning the variable presentation of information which may well be out of context with any format, was catered for, to some extent, by the provision of a flying cursor facility which allowed the operator to tap the (Return) key twice to cause the cursor to fly to the next field. The system was relatively sophisticated in as far as it allowed him to return to both the same field and even the same line in the same field to either add or change items of information. The format was found to be easy to use, and it is felt that it is probably superior to any operational system employed at the present time. It therefore gives a reasonable test of an easily used message log input mode.

Fig. 17.5 - Simulation Experiment

Note Form - Screen Format

The second format was the Notes Screen (Figure 17.5). This is essentially the same as the Message Log format for the first two lines. Thereafter, however, the screen is a single blank sheet and the operator is allowed to type (or speak, depending upon mode) rough notes directly onto the sceen in any sequence that he might desire. The essential difference between this and the preceding format is that with this latter layout we are evaluating the possibility of completely removing any difficulties of the positioning of data on a screen, whilst the operator is under potentially heavy mental load conditions during the period of the telephone call.

We produced a method of slaving two terminals together in order that any information typed into one was mirrored on the other. At the same time the information was logged and timed in a computer file. In the typing modes the operator had control of the master terminal upon which he used the normal QWERTY keyboard to input his information onto the screen. In the speech modes the operator was merely provided with the button previously mentioned and the slave screen. When he pushed his 'Computer' button any words that he spoke appeared in the relevant position on the format screen in front of him. The object of this was to simulate a speech input system.

METHOD

24 experienced control room operators drawn from various stations throughout the Force acted as subjects in this experiment.

Subjects answered three calls using the apparatus previously described. Each operator answered a number of calls under each of the four modes, using either a message log or note document as the initial form of transcription during the call for each mode. This gave a total of 8 conditions of input with the operator receiving 3 calls for each of those eight treatment conditions. Each subject w

TREATMENT TYPES

Two independent variables were used in this experiment (Fig. 17.7):

(i) the two document types which were employed, and

(ii) the four different types of input mode.

Figure 17.7 - Experimental Treatments - Layout of Independent Variable

Input Modes \ Document Types	Notes	Log
Writing	1	2
Typing	3	4
Discontinuous Speech	5	6
Continuous Speech	7	8

The numbers are merely codes for the treatment types

Document Types

The rationale behind the choice of these two document types lies in the fact that the official position for both this Force and many other forces is that the operator should listen to a 999 call and immediately transcribe information that he obtains onto a message log. For this reason the message log was included as one of the independent variables. As has been described elsewhere in this thesis, a common deviation from the official routine is that the operator produces some form of rough notes, normally on pieces of paper, but on occasions also on blank areas of the VDU screen. For this reason the rough note input form was employed as a second document type.

Input Modes

The four input modes were:

written

typed

discontinuous speech

and continuous speech

The rationale behind the choice of these four modes is that the most common form of input at the present time is a written input onto a paper message log. This is gradually being superceded by various computer systems which employ a typed input using the visual display unit.

Direct Speech Input Modes

Up to the present time no operational systems have used speech input. However, the difficulties which have been experienced with using typed input, led us to look for alternatives. The system which I have termed discontinuous speech as analogous to that employed on a number of commercially available systems such as that produced by EMI Threshold etc. (Threshold 1979). In this a computer terminal is capable of accepting human speech, usually after it has been "trained" onto the voice of a specific operator. This system requires some form of demarcation between each word (or on occasions very short phrases). The most usual form of demarcation is produced by the operator pressing a button to indicate that the voice transmission has ceased. The machines currently on the market will only accept a single utterance at a time, and will not "lift" a target word out of continous prose, or even high background noise.

The facility of continuous speech recognition by computers does not exist at the present time, in any commercial equipment. There are, however, a number of ongoing projects which are making sufficient progress to indicate that a continuous speech facility is likely to be a viable proposition within the next five to ten years. In this context, I am not suggesting a continuous speech facility over the full range of human discourse, but a continuous speech facility in a limited subject domain. In this respect the control room activities for a 999 call are likely to fall within the early capabilities of the emerging continuous speech machines. The type of equipment upon which I am basing these prognoses are systems such as SID development by Dr. Brian PAY of the National Physical Laboratory (PAY 1978, 1979), (RENGGER 1973, 1974), (RENGGER & MANNING 1973), and the Hearsay II facility being produced at Carneagy Melon University in the United States (HAYES-ROTH et al 1978). Both of these machines are presently capable of understanding target words in continuous speech.

It is my contention that a fairly large leap forward could take place when the semantic data base theory of researchers such as WINOGRAD, WILKES, et al, is integrated with the very sophisticated acoustic filtering and analysis systems of persons of people like PAY and RENGGER. The reason for this is one of the major problems for machines such as SID is the searching of an ambiguous input in a large data base. If the data base has a relatively intelligent searching capability there would be the prospect of not only using the data base to recognise individual words but also using its knowledge of grammar and semantics to reduce the future search as the discourse continues. In other words, the data base would not only aid recognition but it would also assist the search for subsequent words. This would seem to be very similar to the human being's method for understanding verbal material, and I think it is reasonable to suppose that a coalition of semantic data base theories and acoustic filtering devices is likely to produce workable continuous speech receivers in a relatively short period of time.

MEASURES

Measures of performance and preference were taken as follows.

1. Each operator was asked to rate each of the various eight input modes in order of preference.

2. Each operator was provided with a sheet of paper at the beginning of the day and asked to make comments during the sessions -

   (a) concerning any difficulties of the various modes of operation,

   (b) concerning the degree of realism of the experimental set-up,

   (c) and his rates preferences for the various input modes.together with reasons for any of the various modes.

3. Each call was subject to various objective and subjective measures depending on the nature of the call. These were as follows.

   i The time period of the telephone call transaction in seconds.
   ii The time period taken to complete the notes (where relevant).
   iii The time period taken to complete the final log at the point of despatch of a vehicle to the scene.
   iv The actors' (callers) performance rating of the operators approach to him as a 'member of the public in distress'.
   v A performance rating made by the actor (caller) concerning the percentage of relevant information concerning the call which the operator elicited from him.
   vi A count of the number of words in the notes.
   vii A count of the number of words in the log (including the various sub-sections of the log).
   viii A utility rating of the operational efficacy of the finally produced log by 48 operational Chief Inspectors.
   ix A utility of the management efficacy of the final log, by 48 operational Chief Inspectors.

<u>Subjective Measures</u>

The rating scales produced during the experiment should perhaps be explained a little further. The two ratings provided by the actor were as follows:

1. The rating concerning the approach to the caller was made on the basis of the amount of reassurance, the general approach to the caller depending upon the circumstances and the degree of professionalism shown.

2. The rating concerning percentage of relevant information obtained was a subjective assessment by the actor who was in each case a senior police officer, of the percentage which the operator elicited from him, compared with the total information which he knew he would have provided if asked. Sheets concerning the categories of information which would have been provided were produced for each of the 24 calls.

Operational and MIS Value Ratings

The performance ratings concerning the final product of this exercise, namely the message log was conducted by using 48 Chief Inspectors throughout the Police Force as judges. This police rank was chosen because it is relatively senior, and in addition Chief Inspectors have considerable contact with the operation of the communications rooms. It was, therefore, felt to be an appropriate rank to provide both a stable and sensible professional evaluation of the logs from an operational and managerial view point. The procedure adopted was to have each of the logs manually typed onto a special format which gave no clue as to the method employed to produce the log. Each judge was then provided with the original transcript of 3 calls together with the message log of that call produced by each of the 24 operators who took part in this experiment. (A total of 72 calls per judge). This meant that each individual log was evaluated by six separate judges. The final two scores of efficacy given to each of the original logs was the mean of these 6 ranking scores. Measures of judge concordance and dispersal of judgments were also taken. The judgement procedure of the resultant 3,456 logs, took over three months to complete.

Each transcript was then given two ratings using a 0 - 7 Likert type scale. The first rating was based upon the value of the log to support immediate operational objectives. The second rating evaluated the log in terms of its utility as management information.

EXPERIMENTAL CONTROL

A sophisticated computer based experimental scheduling system was devised to control the allocation of subjects to the various treatment types on each day of the experiments. This system output printed daily schedules to each of the experimentors and also provided the subject with some briefing as his/her activities throughout the day. It was found to be of immense benefit in maintaining the coherent progress of a relatively complex set of experimental treatments. The system ensured that no two subjects followed the same pathway through the various treatment types.

RESULTS

Fig. 17.8

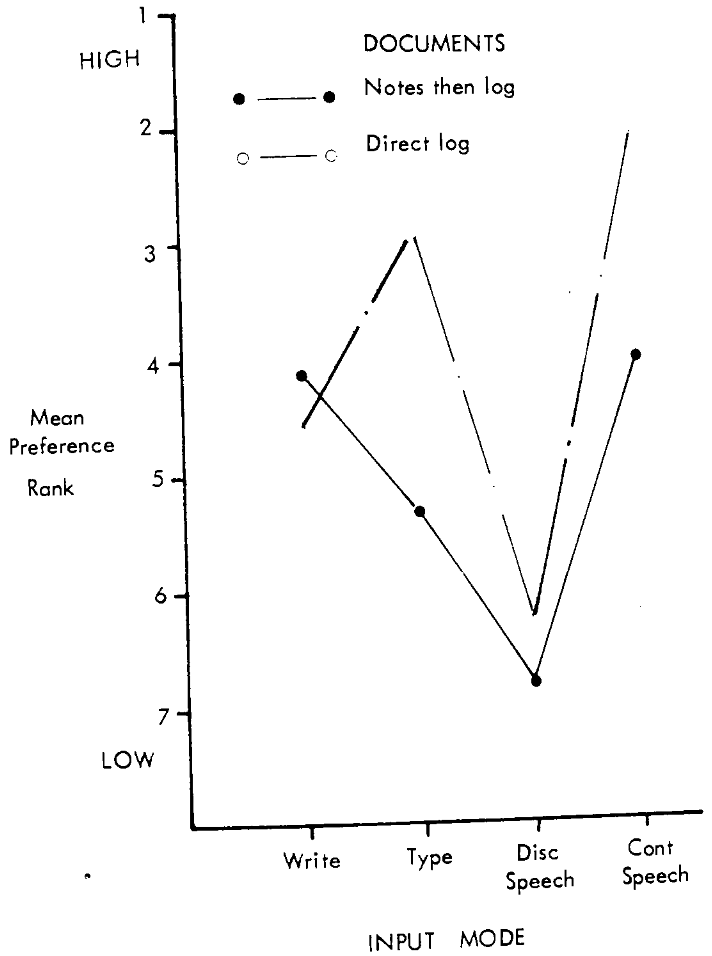


Fig 17.8 Operators preference for input modes.

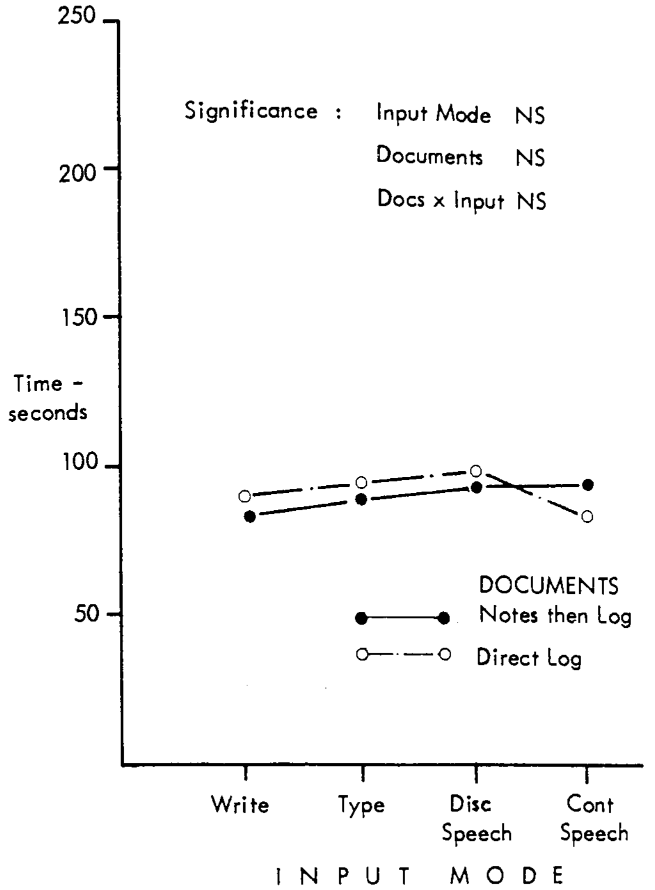


Fig. 17.9 Time taken to complete 999 call

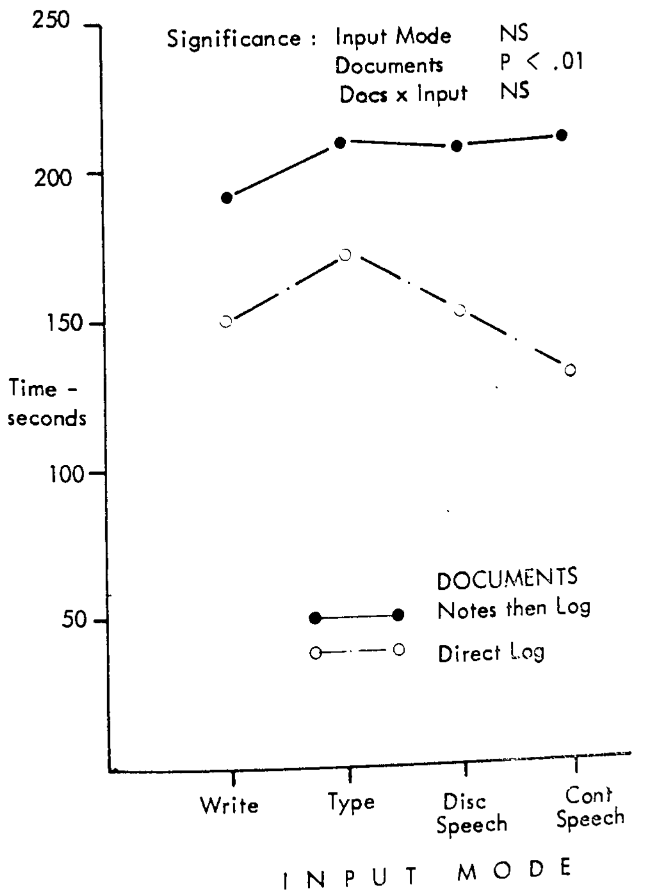


Fig. 17.10 Time taken to complete initial phase of call

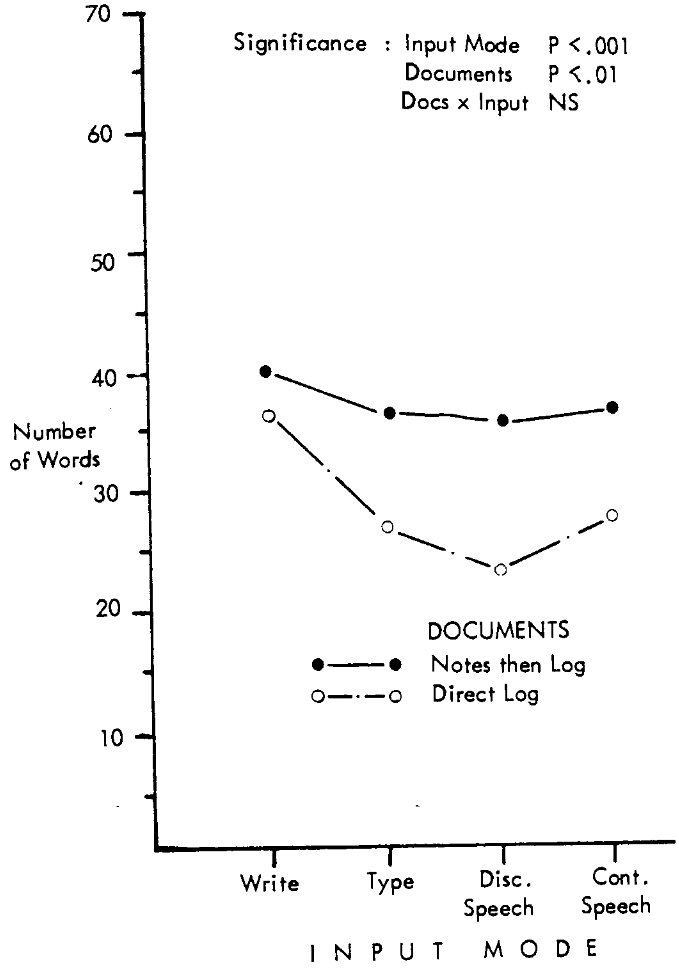
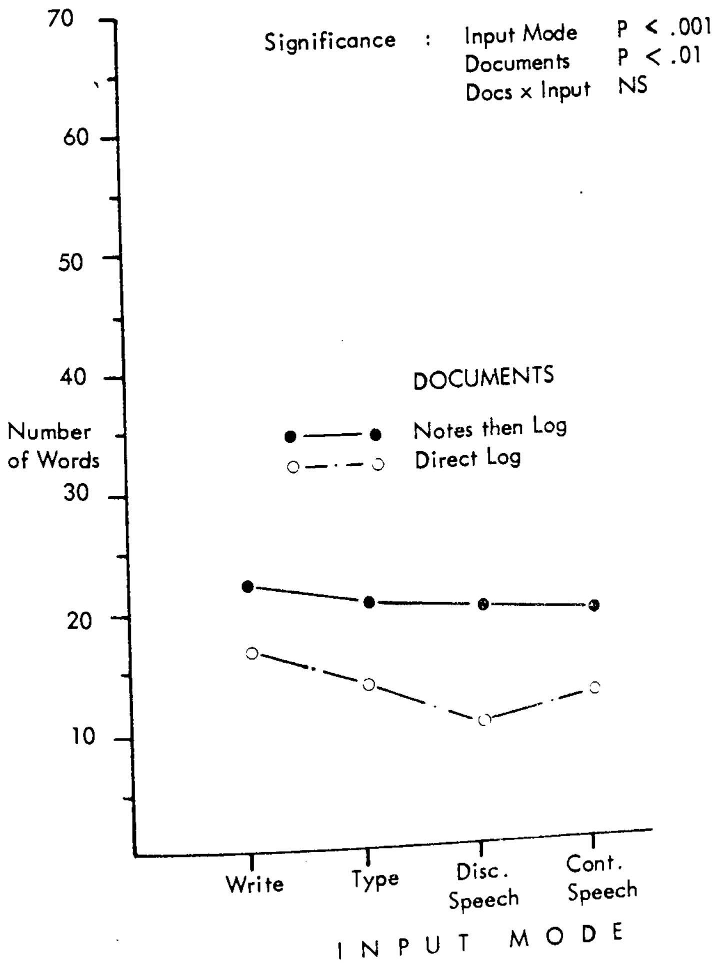


Fig. 17.11 Number of Words in Whole Message Log



Figs. 17.13 and 17.14

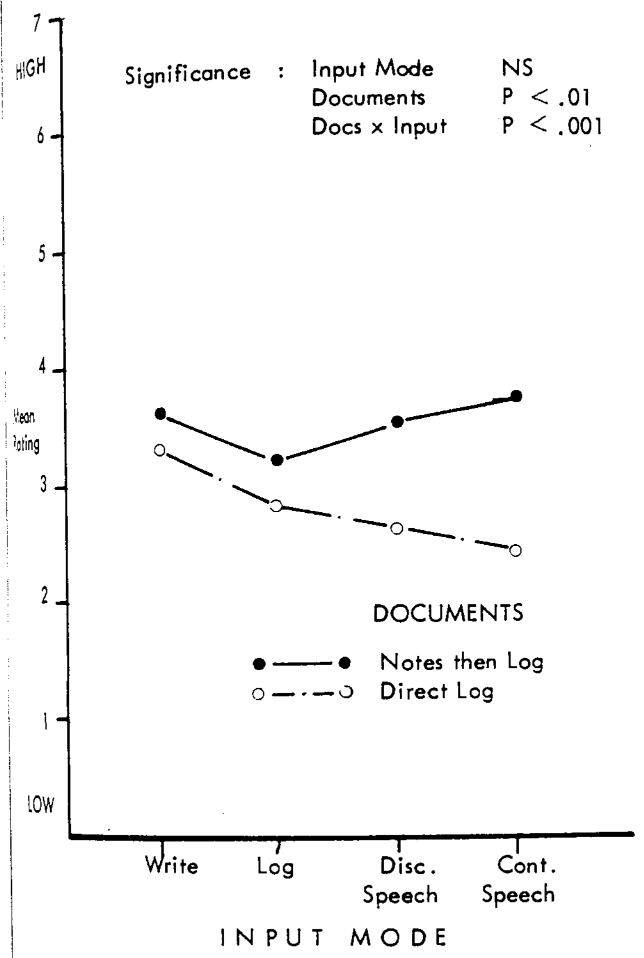


Fig. 17.13 Rating of Operational Value given to completed Message Logs.

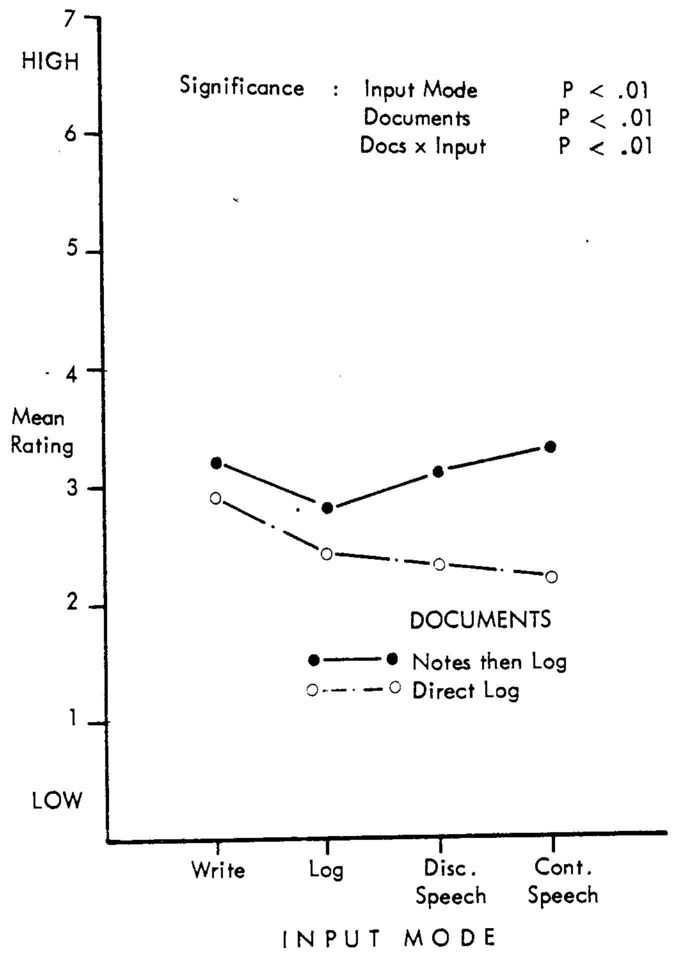


Fig. 17.14 Rating of Management Value given to completed Message Logs.

DISCUSSION

Operators' Preferences for Input Modes

The operators' preferences to the various modes is extremely marked. With there being an overall preference for immediate input onto a log from a call and also the use of the continuous speech mode. There are, however, quite heavy interaction effects between the two independent variables. In particular, as can be seen from Fig. 17.8, a comparison between the write and continuous speech modes shows that writing notes was preferred to writing logs, whereas for continuous speech a direct input onto the log was preferred.

The finding concerning discontinuous speech is that all of the operators, almost without exception, disliked this form of input. That is quite an important finding as the discontinuous speech system is currently available on the market at a price which is compatible with standard visual display units. It therefore would inevitably have been considered for use in operational control rooms.

Call Time

The two major independent variables in this experiment seem to have significant effects over most of the range of dependent variables chosen for measurement. The exception was on the call time (Fig. 17.9). There are appreciable differences in the mean call time, but the background variance caused by differential operator ability and different call subject matters which we used as the error variance, were large enough to prevent the differences being statistically significant. There is, however, a moderate indication that the discontinuous speech mode does have an elongating effect on call time.

Initial Phase Time

This is the time until the end of the completion of the initial phase of the log. It would naturally be anticipated that the difference between the two document forms of input, would be highly significant, because with direct log input one whole stage of operation is omitted (namely that of making notes). As one might suspect therefore, the time until the completion of the initial phase shows very considerable differences between the note input and the log input. These differences are highly significant (Fig. 17.10).

There are also substantial differences in phase time between the various input modes, with typing being the slowest overall, followed by discontinuous speech, writing and then continuous speech. Continuous speech was highly variable between the two documents with the note input being the slowest of all eight modes whereas the continuous speech log was the fastest. An important point to note is that in both document modes typing takes longer than written input.

There are also considerable interaction effects between the two major independent variables on the measure of phase time.

Number of Words in the Log

The number of words in the message log can be seen in Fig. 17.11. This dependent variable is considerably affected by the various modes. Written input produced the most loquacious style and also the note mode increased verbeage. The finding concerning the difference between the two documents is understandable. If an operator is under a degree of pressure there will be a tendency to reduce the amount of input. As has previously been stated in other chapters, this is not a transcription exercise but a composition exercise and that therefore allows the operator the freedom to produce a more distilled precis if he is under some time pressure.

There was a distinct tendency for the mechanical forms of input to reduce the size of the final message log.

It is interesting to note that a move from the present manual system of writing notes to the system used by many of the present day police computer systems, would according to these findings, produce a reduction in the overall size of the log in something in the order of 33%, most of this reduction taking place in the content part of the log.

Number of Words in Message Section of Log

The finding that mechanical forms of input tended to reduce size of the final message log prompted me to hypothesise that the degree of reduction would be larger in the message section of the log than for the areas which refer to addresses, names, times and actions etc. This hypothesis being based upon the work done in the previous chapter on note analysis (Chapter 11) wherein it was suggested that redundant message information, and non-redundant address type information, might be dealt with differently.

An evaluation of this area is shown in Fig. 17.12. It can be seen here that the results which were noted in the preceding section on overall logs are to a large extent exaggerated in the message area of the log.

In other words, any factor which increased the difficulty of data input is likely to have a greater effect upon the message (information) content of the log, than it has upon the other sections, such as address, action taken, etc.

A comparison between the present manual system of writing notes and then producing a log, and the most widely used computer based input method, showed a reduction (based on these experimental findings) of approximately 45% in terms of number of words used. In all cases, forcing the operator to input the message directly onto the log rather than make notes prior to inputting the message onto the log reduced the number of words used.

Efficiency Ratings of the Logs

Figures 17.12 and 17.13 demonstrate the judgement ratings of the finalised logs under the eight different treatments. There are differences in the absolute numerical values, but in all cases the relationships between the eight cells are the same for both the Operational rating and the MIS rating.

It is obvious from these tables that in every case, that is under every mode, allowing an operator to write notes rather than forcing him to type directly onto a log, produces a final log which is given a higher operational rating. In all cases, the mode which produced the highest operational and MIS rating was the production of notes using continuous speech. The next most effective system was as one might expect, the mode employed at the present time, that is to write notes and then produce a log.

An interesting point was that the mode of operation which was most preferred (by quite a large margin) by the operators did in fact produce the lowest operational and management ratings, that is continuous speech to produce a log. It is difficult to explain this particular finding other than the possibility that the concentration required to both operate a continuous speech mode, and to find their way round a message log format, so occupied the operator's attention that they perhaps reduced their concentration on the content of the information which was being obtained.

Conclusions

The major conclusion concerning the design of man/machine communication systems in this environment is that the best logs are produced when operators are allowed to produce notes during the emergency telephone call, and then subsequently transcribe the information, rather than forcing them to directly use a message log format.

Comparison of the number of words in the log under the type-log mode (26.8) compared with the phase time for the same situation (174 seconds) gives approximately 9.24 words per minute which is very close to the ten words per minute noted by Tom FARR in his Live Observations of the Glasgow Control Room. This tends to support the findings and also gives some additional credibility to the effectiveness of the simulation.

The situation in this simulation was somewhat different from that of CHAPANIS so far as the operators were attempting to complete a finished article when they were using the voice modes. Therefore the high verbiage which he noted during his experiments was not a factor in this particular simulation. This is an interesting point as it does tend to negate the hypothesis that voice modes would produce a particularly loquacious output.

CHAPANIS's finding that written input (in our circumstances, the present manual system) was significantly faster than typed input was supported by the findings of this experiment. In addition, as he also noted continuous mode speech input was faster than typing. In our situation, however, the document mode had a dramatic effect on this latter category.

The results also demonstrate that operators are quite capable of dealing with speech input under the simulated operating conditions, even though the operators were not practiced in them. It is a reasonable conclusion that, with practice, performance will improve, and this therefore makes speech input into a computer using the continuous speech mode a viable prospect for the future.

The low MIS and Operational ratings of the logs generated by typed input, indicate that this form of input must be carefully considered when designing control rooms. This is a particularly important finding, as typed input is currently the most common form of man/machine communication in computer based Command and Control systems.

An ancillary major conclusion is the fact that the overall efficacy of the logs as measured by their rating for both operational and management information purposes was low. The judges performing these ratings considered that the overall utility of the logs evaluated, fell below an acceptable level. This is a finding which links in with earlier statements concerning both the training of operators, the lack of any definite statement of their job requirements and objectives, and subsequently their very different attitude concerning the requirements of data collection during emergency calls. This experiment is probably the first occasion upon which operational managers have been given the facility to evaluate the type of output they are receiving in message logs against a relatively common standard of input. It is difficult to over emphasise just how shocked many of the senior supervisory officers have been concerning the product (message logs) they were asked to judge. I have been deluged with notes and comments from judges and their colleagues throughout the Force on this subject.

This ancillary finding of the experiment is of great interest to the senior management of the Force and will certainly result in revised training schemes, considerably greater supervision in control rooms and a move towards some form of cohesive terms of reference for control room operators.

I think that it would be too easy to complain that these findings are due to poor control room operator standards. Essentially, many of the operators are extremely able, but they have not been given any coherent instructions and therefore their procedures have grown up on an ad hoc and individual basis.

Postscript

The Force have made a video film of this simulation which is being used for training purposes. A training simulator is also planned for the Technical Training wing of the Police College, based on our experimental design.

SUMMARY TO PART IV -

SOLUTION EXPLORATION

The three chapters in this section of the thesis have the overall objective of exploring some of the potential solutions to the problems which have been uncovered in the preceding investigations.

A major difficulty which was noted in the early part of the thesis has been the adequate logging of information under emergency circumstances. One approach to the data logging problem is to reduce the amount of information which is input into the system. Chapter Fifteen had as its main orientation the evaluation of some of the potential uses of the message log information. To do this, an embryo management information system was set up employing the message log as its source of data. The operational managers were then asked to use the system and to comment on the types of information they required. From their comments concerning the type of data they required to assist them in their management functions, it was possible to produce deductions concerning the type of information which would be required to be input into a computer system in order to support those management information functions.

It should be noted that this investigation was aimed solely at the use of the information for management purposes, the information is of course naturally used in the immediate operational vein and that would place additional demands on the type of data to be entered in order to support the system as a whole. However, the results from the management use of data was sufficient to suggest, in qualitative terms at least, that there should be no reduction of the input as this was likely to reduce the utility of the information to support management functions. The general conclusion of Chapter Fifteen is that any design strategy aimed at aiding the operator by reducing the number of keying operations is not an approach which is open to us in these present circumstances.

Given that one has not the option of reducing the total amount of data which is required to be entered during a critical phase, then an alternative is to seek ways of facilitating the entry of information into the computer system. Two particular aspects are relevant:-

i) the ease of data entry, and

ii) methods to check the validity of certain types of data which is entered.

Given that written and typed input systems are providing some problems, the natural approach is to explore other possible data entry techniques which may allow information to be entered with greater facility. The main communication mode which readily springs to mind is that involving voice input into computer systems. Unfortunately, such systems are in their infancy, and generally can only operate with relatively small vocabularies. Therefore, in order to ascertain the validity of further examining such an approach, the investigation in Chapter Sixteen was mounted to ascertain the general vocabulary size used normally in this limited domain. The results tend to show that a relatively small vocabulary size is employed, and in addition there are pointers which suggest that it would be possible under operational circumstances to select an even smaller vocabulary than that currently used providing a judicious use of key words was employed. Therefore, from a technical point of view, there seems to be some possibility that voice input into a computer system could be usefully employed in a control room and therefore the further investigations into the viability of such a system from an ergonomic viewpoint was justified.

Earlier investigations also ascertained that non-redundant information was a particularly critical aspect of the data entry problems in this area. It was noted that the largest non-redundant category of information (Chapters Nine and Ten) was that which involved addresses. An investigation was therefore mounted to ascertain whether it would be possible to check such information using a relatively simple computer data base. The rationale behind this approach was that if the data was of a localised nature, then it should be economically and technically possible to build a local computer street index which should be able to check any data which was entered whilst the caller was still on line to the 999 operator. This facility would provide a very valuable degree of security for this important category of non-redundant information.

The investigation which was mounted in this particular respect indicated the very surprising result that, in general, addresses passed to the police were of a very local nature and well within the technical capabilities of moderately priced computer systems.

The major simulation experiment in Chapter Seventeen was aimed at both evaluating the current input modes and some which might potentially be available in the near future, such as speech input. In addition, the two most common forms of data entry, namely one which employed a note which was then transcribed onto the final log, and the official system wherein the message was immediately transcribed onto the message log, were both evaluated under the four input modes of written input, typed input, discontinuous speech input and continuous speech input.

The present system in the Devon and Cornwall Constabulary is to employ a written note which is then transcribed onto a written log. The most normal form of computerised input used in all of the current command and control systems, is to type the information directly onto a message log format whilst at the same time speaking to the caller on the 999 system. This approach, therefore, involves a change in both document type and input mode. It was noted that any move away from the use of the note form tended to reduce the utility of the logs for both operational and management purposes. It was hypothesised that in the main this was because the final message on the log had to be composed and was often a considerable precis of the information which was produced in the call. Obviously, this activity imposes a mental load on the operator and if he is forced to carry out a composition load at the same time as his other tasks of interrogating the caller and remembering a relevant plan of action, then his other activities, mainly those of interaction with the caller, are likely to suffer. The result, therefore, is a log of reduced value. In addition, it was also noted that any move towards a mechanical form of input away from the presently operated written input also produced a decrement in the value of the log for operational management purposes.

Therefore, the presently used system for most of the command and control currently employed by the police incorporates two changes, both of which have had adverse effects on the value of the log. It was noted that the change from the present manual system to the most normal form of computer typed input caused a reduction in the number of words used in the log as a whole of approximately 33%. However, the non-redundant information suffered less than the very important story of information which is used to actually describe the incident and this latter information was reduced by a massive 45%. It can therefore easily be seen why the judges in this experiment considered that the operational management value of the log had been seriously affected. The general point seems to be that any increase in the difficulty of operators' tasks, particularly any aspect which increases the cognitive load on the operator, will tend to decrement the value of the log. This suggests that the operator during this short time is already operating at or close to the limit of his cognitive abilities.

Tentative hypotheses concerning the possibility of operators using voice input, whilst at the same time using other voice channels (e.g. telephone and radio), seem to suggest that they would not evince any difficulty in this respect. There was a marked preference for continuous speech over discontinuous speech, with the latter system being universally condemned, both on the subjective ratings of the operators and from the results of the various efficiency measures. It is, therefore, apparent that although discontinuous speech systems are currently available, they will not be useful in the design of control room complexes, and we will have to await the provision of continuous speech facilities.

One other finding which was very forcibly made by the judges, was that there seemed to be a generally low standard in the recording of message information and that this pointed to a need for greater training of operators in the type of information that they should gather. This is very much in line with the findings of previous chapters where the same sort of comment has been made in the operational sphere.

THESIS PLAN

CHAPTER EIGHTEEN

DISCUSSION CHAPTER

There can be very little doubt about the important position of present day police control rooms in supporting the efficiency of the Police Service. Yet, historically, the job of the Control Room operators seem to have been thought of as a relatively simple and uncomplicated task.

The likely reason for this is that until the recent advent of computer based command and control systems, very few Control Room tasks had been designed simultaneously. Control Rooms had usually developed gradually as the control functions of a police force in society gradually increased in complexity. Initially, when radio and telephone systems were sparsely distributed, a simple room was just set aside to cater for the one wireless set and telephone, with very little thought that this facility could grow to assume a central and controlling function. Consequently, when demand did increase, in most cases additions were made to existing police Control Rooms on an ad hoc basis. This situation continued until recently when some forces noted that their control procedures were not as efficient as they would like. That revelation led directly to the current spate of newly developed police command and control systems.

In some ways, these systems have provided useful assistance to the controller, but generally they have failed to live up to their promise. The major problems derive from designers simply attempting to computerise the existing manual system, and they have implicitly incorporated many of the shortcomings of those old manual systems. Unfortunately, these new systems demonstrate a considerable lack of insight into the task of a modern Control Room operator. In particular, the task of a 999 operator has been considered as a simple transcription task, which could easily be computer aided. Problems which were noted in the manual systems, which were the direct stimulus for the implementation of the computer systems, were assumed to derive from limits on the operators' writing speed ability.

This present study has shown that those simplistic design premises are manifestly wrong. The evidence accumulated in this study indicates that the job of a controller in acquiring information on an emergency incident is complex, and that the major limits on his effectiveness, are mediated by his cognitive capacity and not by his motor performance. The job makes significant social, linguistic and decision making demands on the operator, which the presently implemented computer systems complicate rather than aid.

The study, in addition to emphasising some of the problems of the manual data capture systems, has also provided some pointers to the origin of these difficulties, together with tentative solutions.

The primary and most serious problem discovered by this investigation concerns the gross changes of meaning which can occur to the 999 call message, during its reception in the Police Control Room.

Changes in Message Content from Call to Log

The first major finding of this investigation is that during its transmission from the person making the 999 call through the police operator to the message log (data base), considerable changes occur to the message content.

Using the manual system presently employed by the Devon and Cornwall Constabulary, the majority of calls are logged in a verbatim style, purporting to be the actual words used by the caller. Despite this use of the verbatim style, our research shows that virtually none of the surface structure of the call is accurately represented in the log. In other words, the argument that the log, when written in a verbatim style, contains the actual words used by the caller is a fiction. In fact, upon examination of the call transcripts, it was difficult to find a single clause which is exactly replicated in the log; only one per cent of the verbatim style messages contained a single clause which also occurred in the call. There is therefore an almost total surface structure change, as the call information is transferred from the conversation into a message log format.

This inaccuracy at the linguistic surface structure level is important if the message log is going to be used as a document in evidence to prove the actual words used by the caller. While this is a relatively infrequent event, it may be that the Constabulary, in view of these significant findings, should consider the possibility of removing any spurious impression of versimilitude which this verbatim style may imply.

A more serious finding, with respect to the use of data both operationally and as a management resource, was that gross changes in meaning occurred in addition to the simple surface structure changes. The investigations using the Open University system of proposition analysis and the simpler enquiry using judgements yielded almost identical results. So as well as demonstrating that the majority of message logs suffered a number of semantic changes, there was also a considerable reduction in the amount of information in the log compared with that in the call, with only about 35% of the propositions in the call being represented in the log. Changes in meaning had also occurred as exemplified by the finding that 45% of the logs had no single proposition which was identical to one in the call. In addition, eight per cent had no proposition which was judged to be similar.

Both the judgement and proposition investigations also showed that some of the information which appeared on the log was distorted, as distinct from the omissions discussed above. In the case of the proposition analysis this could be quantified in so far as 34% of the logs had 50% or more of their propositions as inventions. These findings are very similar to the work on meaning which derives from the early work of BARTLETT. Many of his ideas of rationalisation, sharpening and levelling can be demonstrated in these logs and was discussed in detail in Chapter Twelve. Certainly the logs have been 'cleaned' and changed in their meaning to a considerable degree.

However, one area of the log which does not suffer any gross changes is in that part which contains simple factual information. In the investigations on the type of notes made by operators (Chapter Eleven) I hypothesised that there were two distinct methods by which information passed from a caller to the message log. If the information is of a non-redundant character, such as addresses, telephone numbers, car numbers etc., then in most cases, the method involves an almost verbatim note being taken by the operator. On the other hand, story information, i.e. that which makes up the bulk of the message content of the log, is usually recalled only in terms of key words. The resultant log then tends to be made up of the relatively accurate non-redundant information which is simply transposed from call to notepad, to message log and a message section largely recreated from the key words on the notepads. The expansion ratio of the number of words in the notes to the number of words in the logs is much greater and more variable for redundant (story information) than for non-redundant information.

The findings of the research point to at least two major reasons why these changes should take place. Firstly there is some element of cognitive overloading which makes it difficult for the operator to fully comprehend the full purport of the spoken message from the caller, and to transcribe it accurately. Secondly, there are indications that the mental models of the external world used by the operators to understand the incoming information may be both deficient and unduly variable. These issues therefore need elaboration before going on to consider the effects of any computerisation of these systems.

Cognitive Loading

The second major finding of the research is that, when given freedom to choose a means of input, the majority of operators produce a note form, which they later translate into a message log. This procedure has even been observed in systems which are officially computerised. The normal argument is that operators tend to write down the notes because there is a motor or writing speed limitation which inhibits their completion of a message log whilst on-line to the caller. It is likely that there is some degree of motor limitation in this respect, the findings of the activity analysis chapter (Chapter Nine) indicate that the time taken to complete a message log is generally very much longer than the time taken to complete the call. A similar observation was made by FARR (see Chapter Eight). Normally therefore, it would not be possible to complete a log during the period of a telephone call without unduly lengthening the call. It is also likely that for most operators typing will be a slower means of input than writing. This point is made independently by CHAPANIS and IZZETT and is supported by the findings of the Simulation Experiment. The majority of the operators using the easier manual system still tend to make notes rather than directly write a log. The Simulation results show that when forced to directly produce a written log (i.e. without using any notes) their performance deteriorates. Yet we have an anomoly: in current computer based command and control systems, the operator is expected to be able to input directly into a log when the change is made to the more difficult means of input, i.e. using a keyboard, even though operators prefer to adopt an easy strategy of note taking when using a simple manual writing input method. They are expected to maintain performance, whilst at the same time coping both with a different, more difficult input method - the keyboard, and a more difficult input strategy - direct input without note taking.

An interesting aside in this respect is that, in the main, the respondents to the interviews and surveys did not regard writing speed as a major limitation, but the cognitive or mental elements of their task were often the subject of their comment.

PEACE et al (1974), in their treatise on Communications Rooms Operators, argued that there was likely to be a workload problem for operators at certain times of the day. Their view was that this overload would be caused by a large number of incidents occurring contemporaneously, and therefore producing a total heavy workload situation which might be above the operator's capability and this is indeed likely to be the case. However, I would suggest that there is also the prospect of mental overload, even when an operator is attempting to deal with a single call.

In Part II I outlined the activities that an operator needs to carry out during the initial phase of an emergency telephone call. Briefly, these include:-

1. controlling the call,
2. understanding the incoming information,
3. classifying the incident type,
4. producing a strategy for initial action,
5. noting salient information,
6. reassuring (and informing) the caller,
7. making out a full description of the incident on a log,
8. despatching resources or confirming initial action,
9. supplying back-up support information,
10. supervising the running of the incident, and logging the results of action.

The first six of these items all take place whilst the call is being received, and most of them involve a considerable cognitive element. If a system is designed which insists that the message log be completed during the course of a call, then, in addition to the other mental tasks which the operator has to carry out during the call, he would also have to include the editing of the often jumbled information and the composition of a coherent message for the log. It would seem that even using the present manual note taking system, the cognitive load on an operator is likely to be very high. Imposition of direct input to a message log is likely to add two more quite difficult mental tasks to an already overloaded cognitive system with a consequential decrement in performance. It is just this type of decrement in performance which has been evidenced in the results of the simulation experiment.

The cognitive element of the task is well demonstrated by anecdotal reports on a number of exceptional situations, particularly those involving bomb hoaxes. On at least three occasions it was noted that serious bomb hoax calls seemed to stun the operators for a number of minutes before they were able to initiate any sensible courses of action. While this is an extreme case, it does seem to support the proposition that there is a considerable cognitive element to the operator's task. In the same vein, the findings of the simulation experiment indicate that the more difficult input modes reduce the efficiency of the finalised log. This suggests that the additional loading required to deal with a difficult input mode degraded the amount of mental effort which could be applied to the task of understanding and translating the meaning content of the logs.

The gravitation of operators towards the operational practice of a note input form, is their attempt at a partial solution to their cognitive load problems; by deferring the composition elements of their tasks, they are more able to concentrate on controlling the call and extracting the relevant information.

Mental Models

If the information content of a message is changed, then obviously some cognitive effort must be put into generating such a change. The operator must have some processes which mediate the semantic changes. In order to understand the incoming information and to take appropriate action the operators must have mental models of their world outside the control room. This area was examined in the chapters which dealt with protocols and constructs.

The section on protocols indicated that many of the operators held models concerning the incident, the informants and the resources, with which they had to deal. They also had anticipatory models concerning the probability of events over both time and location. There seemed to be indications that on occasions these mental models were used to tailor and adapt the incoming information to make sense of the world - the remote world - which it was their job to aid and manipulate.

The more specific and subtle evaluation of mental models, for which Kelly's Construct Theory was used, was aimed solely at the area of evaluating concepts connected with the incoming 999 call. Here it was found that whilst there were surface similarities in the models used by the different operators, their definition of terms such as 'urgency', 'scale and type of resource required', 'injuries' etc. were variable. The indications here are that the operators do not have uniform models of their task environment, and this would lead almost inevitably to highly variable responses to similar 999 calls.

In addition to their lack of uniformity, the models seemed to be somewhat deficient in so far as there were no constructs concerning information difficulty, the different types of information needed for different incident categories, or the difficulty in dealing with various incident types etc. This poverty in model differentation was shown at a more operational level by the findings of the ETTA analysis in Chapter Ten and the note analysis in Chapter Eleven.

The ETTA and Note Analysis revealed an almost total concentration upon caller information, with very little interest on the part of the operators in obtaining full details of the incident. Details of offenders, for instance, was rarely asked of the caller (even when known) and these investigations showed that the operator adopted a relatively passive role in the acquisition of information, in the main, simply concentrating on obtaining address details. This was shown to be true even when the caller volunteered information about the subject matter as the opening gambit of the call. The emphasis of the operators seems to be on obtaining an address and semi-automatically despatching resources. There was very little indication that any careful matching of incidents to resources took place.

The judges in both the semantic chapter (12) and also the officers who judged the results of the simulation experiment, all commented very forcefully on the poor interrogation carried out by the majority of operators. Given the very different sources of the data, the one being the operational environment and the other being a simulation experiment, these arguments increase our confidence in the finding that the operators' lack of skilled interrogation techniques is a serious operational problem.

The cost of poor interrogation by the operator can be expensive, both in terms of the cost of providing resources to incidents which may not require them, and also in terms of the efficiency of the Force in dealing with incidents. Proper interrogation should lead, if coupled with intelligent allocation procedures, to an economical use of resources. The cost of placing a police officer, with a vehicle, at the scene of an incident is quite considerable. In addition, unnecessary deployments may well prevent the dispatch of a resource to another more urgent incident should that occur subsequent to an unnecessary deployment. A disturbing factor which was noted <u>frequently</u> during the observational periods early in this research, was that Control Rooms literally ran out of resources to send to incidents during busy periods.

Poor interrogation can also indirectly have dangerous consequences for both police personnel and members of the public. Defective comprehension by the controller of the nature of the incident can easily result in the incorrect matching of resources to that incident, which in cases such as large scale fights or hold-ups can have obvious perilous consequences. Similarly a poorly briefed officer attending a serious incident may be unprepared for the situation which he finds at the scene. In such circumstances the patrol officer rarely has much opportunity to amend his plans once he is on the scene. He should therefore be given the best available information before he arrives at an incident.

Good interrogation is an essential pre-requisite of good resource matching decisions and adequate incident briefing and it seems therefore that there is an urgent need to properly train operators to adequately gather information from the emergency calls.

This present lack of adequate training can be traced back to the lack of objectives which was noted in the investigation of Chapter Five. Also, the structure of the operator's job is such that he receives very little feedback concerning deficiencies in his performance of the information gathering task. Errors at this point in the task do not result in any cost to the operator himself. They are, in the main, accommodated by the patrol officer who is sent to the scene. The fact that patrol officers are resourceful and effective means that to a large extent they can adjust to poor briefings. But this adaption to the situation means that the Control Room officer is deprived of information concerning the effectiveness, or otherwise, of his task performance, so there is no opportunity for strategy modification or improvement.

Future Influences on Message Acquisition Effectiveness

The main changes which are likely to occur in this system will be as a result of:-

1. The new policing policies which are being introduced by the Devon and Cornwall Constabulary Chief Constable, and
2. The advent of a computer system.

These new policing policies will reduce potentially available resources in terms of the number of response vehicles available to operators for despatch to deal with incidents. It therefore becomes imperative to accurately assess incidents so that these diminished resources can be more effectively allocated.

Secondly, in terms of the implementation of a computer system, the simulation experiment anticipated what is likely to occur when a computer system is introduced into the control room. In the currently most commonly method - transferrence from a written note input mode to a typed log input - there is a considerable reduction in the number of words used to describe the message and a very much reduced value of the resulting log in terms of judged utility for both management and operational purposes. In every case using a mechanical systems for data input (viz keyboards) resulted in a worsening of the management and operational value of the resulting log. In other words, according to the findings of our simulation experiment, transfer using keyboard input, of the present already relatively poor logs to a computer system, is likely to further reduce the usefulness of the message logs at both operational and management levels.

Solutions

The main shortcoming of information loss during the course of message taking activity is naturally bound to occur during the critical phase whilst the caller is on the line. The two major areas of difficulty derive from cognitive overload of the operator and limitations on motor performance (that is physical ability to input the information at a high enough data entry rate).

It is therefore sensible to suggest that solutions should be aimed at each of these two limitations.

Motor Performance

The motor performance limitation has been recognised for some considerable time and the general response of computer systems designers has been to attempt to reduce the amount of data input into the system. The initial findings of our embryo (Paignton) management system would, however, suggest that this course of action is inappropriate and counter-productive, in so far as it is likely to reduce the overall utility of the computer system. The alternative therefore is to seek some method which will facilitate data recording.

A relatively simple way of logging the information would be to provide each operator with a simple, individually based, tape recording system. I feel that this is viable, but it has a number of drawbacks, the main one being that it is not possible to quickly share the data with other operators within the Control Room, so as to aid resource despatch actions. However, I would strongly recommend the use of individual tape recorders as a backup facility.

Another possibility is that the input of data could be facilitated by using some form of communication which is faster and more fluent than either writing or typing. The Utopian ideal of direct speech input to computers potentially fulfills this objective. There presently exists stilted, but nonetheless effective, means of communication with computers using voice, and the technical viability of these systems is bound to increase over the years. The findings of the simulation experiment demonstrate that operators would not experience any real difficulty in adapting to a direct speech input mode; despite the fact that they are already using speech as a communication to the caller. In the simulation experiment, the number of mistakes and errors which they made in directing their communication to either the caller or computer were very low indeed. It is likely that, with training, they could use a continuous speech system with as much facility as the normal human being can carry out a conversation with two of his fellows. The operators rated continuous speech as one of their most preferred means of computer input, which augers well for its easy implementation and acceptance.

There was an equivocal result concerning continuous speech in so far as that mode, when used in conjunction with note taking was given a rather low rating, yet this same strategy resulted in the best message logs in terms of their utility for both management information and operational use. To some extent, the lack of enthusiasm of the operators for continuous speech using notes was due to the experimental situation. This forced the operators to produce notes using the speech system, which they then had to transcribe on to a final message log. I feel that it would be possible to produce a system which removes this cumbersome dual process. It should be possible to insert the address part of the notes directly on to the address field, whilst at the same time leaving the message section of the log in an initially note form. In other words, we could produce a computerised log-note format. Experiments using such a format might yield very interesting results.

The conjunction of a continuous speech mode and the notes document is the best of both worlds, it provides for a relatively easy form of data input whilst at the same time reducing the cognitive load on the operator.

The work on the vocabulary and address systems indicate that it should be quite possible to produce data bases which are within the anticipated range of continuous speech systems (for limited vocabulary domains) within the next few years.

Cognitive Loadings

Earlier in this thesis I hypothesised that some of the cognitive difficulties experienced by the operator included controlling the call, understanding the content of the information which was being passed to him, classifying the incident, and developing a plan to match available resources to that specific incident.

The findings of the various investigations suggest that, in so far as controlling the call is concerned, the operator maintains a relatively passive role, and the major (wrong) emphasis in his activity is to ensure that he at least gets address information. The work on the meaning of message logs would suggest that his understanding of call content is not always as good as it could be, and although there is no direct evidence on the erroneous classification of incident types, there are suggestions that an undue number of vehicles are unnecessarily despatched to incidents which may not require such action.

The primary requirement is the development of the necessary cognitive skills to handle the 999 call situation, operators should be fully trained to both control calls and to elucidate salient details from the discourse. In addition, they should be clearly educated in the operational requirements of every type of incident to ensure that they can both recognise situations and also ensure that they direct their interrogations with some purpose.

Supplementary solutions could involve the provision of facilities in the Control Room to assist operators in this highly critical task of message acquisition. The controlling aspect of the operator's task could be supported by the use of aide memoir check lists, and other computer based facilities. This could lead the operator coherently through the types of information which he would normally require for each of the various incident categories. To some extent, of course, a properly constructed VDU display format can function as an aide memoir list. The major objective of this would be to reduce any memory load on the operator in trying to recollect all of the types of questions which he should ask of callers under different operation circumstances.

The understanding of the information which he receives could be aided by the integration of incoming information with various backup resources. In this respect, details of previous incidents of a similar character, and also facilities for the checking of information details which he obtains, such as names and addresses, numbers of vehicles etc. There are potential computer based facilities which could check on these features for him. Our research indicates that the data sizes and therefore the computer costs are within viable limits. The classifying of incidents and developing the strategies to deal with them could, in addition to being supported by the type of backup information mentioned above, be assisted by up to date and effective resource availability displays, stored plans of action and clear and relevant map displays for certain types of incidents, particularly those involving the geographical deployment of resources.

The majority of the facilities mentioned in the preceding paragraphs are of a relatively simple and unexceptional character and can easily be provided by computer facilities which are currently available. In the future, there is always the prospect of providing more sophisticated assistance to control room operators. In this sphere, the apprentice type systems based on expert advice giving programmes such as those being developed by MICHE and his colleagues at Edinburgh University, could provide valuable aid to emergency operators. Such systems have been successfully incorporated into systems used for medical diagnoses and oil rig emergency/disaster control. Research to implement these techniques in the Control Room domain has great potential.

The essential requirement is that the various tasks of the operator, and indeed the control room staff as a whole, should be considered as an aspect of an overall command control system. This means that the design of a computer based control system should consider the Control Room and its personnel as its primary focus. Attempting ad hoc changes to small parts of an operators' task without doing so in a systems context is unlikely to be successful and could make matters worse.

In so far as the emergency operator himself is concerned it is important to recognise the extremely critical phase of his task which occurs during the actual course of the emergency telephone call. It should be borne in mind by designers that the premise that operators merely transcribe information is unduly naive. A more rounded approach which supports the overall task of the operator will provide relevant and accurate data for both the immediate operational requirements and the subsequent management information systems.

THESIS PLAN

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