A SIMULATION APPROACH TO THE STUDY OF ORGANISATIONAL DECISION PROCESSES IN THE CONTEXT OF CRIME INVESTIGATION

BY

G. L. MALLEN

PH. D. THESIS 1976

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I am pleased to inform you that the Council for National Academic Awards has resolved to confer on you the degree of

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The Council has asked me to convey to you its congratulations on your success and to express its interest in the programme of work which you have completed.

Yours sincerely,

Edwin Kerr

A Simulation Approach to the Study of Organisational Decision Processes in the Context of Crime Investigation

by

George Lauder Mallen

This thesis has been submitted to the Council for National Academic Awards in partial fulfilment of the requirements for the degree of Doctor of Philosophy.

The research described was carried out in the following research organisations:

1) System Research Ltd
2) System Simulation Ltd

with academic supervision from:

1) Department of Computing, Management and Cybernetics, Brighton College of Technology
2) Department of Design Research, Royal College of Art

It was supported by:

The Police Scientific Development Branch, Home Office

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Abstract

The development of a series of laboratory simulation models of the crime investigation department (CID) in a typical English police force is described.

The models, based on field studies of the functioning of real CID organisations, were designed to test aspects of the performance of such systems under varying conditions of input load and internal structure.

A series of experiments with the models is described and conclusions presented based on both quantitative analysis and qualitative judgement of the models' performance.

The structure and behaviour of a computer model based on the laboratory models is also described.

The methodology adopted is related to other organisational simulation studies and it is concluded that such models have roles to play in three areas relating to the functioning of organisations:

1) as education and training aids

2) as management and planning aids

3) as organisational design and evaluation aids

The concept of the "validity" of such models is discussed and related to the purposes for which they are designed.

Finally it is argued through analogies with neurophysiology and psychology that the evolution of organisational modelling technology is a necessary and important component in regulating the interaction between complex organisations and their environments.

Acknowledgments

Most of the work on the project was carried out at System Research Limited during the period 1964-1971 under contract to the Police Scientific Development Branch of the Home Office. I gratefully acknowledge the support of the Home Office for this work. I am deeply indebted to the staff of System Research Limited and particularly to Dr Gordon Pask, its director, for supervision and many formative discussions on the nature and development of the project, to the many policemen and scientists of the Home Office Police Scientific Development Branch without whose help and active encouragement the project could never have progressed. Deserving special gratitude are A G MacDonald, M A P Willmer, W Russell, Dr D Peace, Detective Chief Superintendent C Cudmore, Detective Chief Superintendent (now Assistant Chief Constable) D Needham, and Detective Sergeant Ron Evans. Many police forces helped with our field studies and we are deeply indebted for hospitality, advice and encouragement to the commanders and officers of the forces of Brighton, Hants., Accrington, Burton-on-Trent, Birmingham, City of London, Kent, Luton and Dunstable. The Police College, Bramshill, provided subjects for our earliest experiments and I am especially indebted to Dr John Tobias for his help.

Academically I owe a major debt to the late Richard Goodman who introduced me to the project and provided academic sponsorship for the doctoral programme through the Department of Computing, Management and Cybernetics at Brighton Polytechnic. On his death academic supervision passed to Professor Chris Higgins, then SIGMA lecturer in Operational Research at Brighton Polytechnic, now at Bradford University and I am very grateful for his support during a difficult period. My final academic debt is to

Professor Bruce Archer of the Department of Design Research at the Royal College of Art for housing my work in its final stages and for constant encouragement and advice.

Professionally my greatest debt is to the research team members, both temporary and permanent, who worked with me through many ups and downs but particularly to Dr Mike Elstob whose ideas, enthusiasm and far-sightedness did much to hold the project together during the leanest periods. His contribution is an integral part of the whole enterprise.

Finally my special thanks to my wife for proof reading, patience, sympathy, encouragement, criticism and all that made this work possible and enjoyable.

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Chapter 1

Introduction and guide to the thesis

1.1 Introduction

The unfolding pattern of human social development has reached a point of some drama. Never before has there been such a tension between the opposing forces of the human psyche manifest on the one hand by the need to belong to a group and to obey the rules of that group and on the other by the need for freedom. The developed world, often called the "free" world, has run into a paradox. Development and progress depends on the organisation of people to achieve objectives. The resultant division of labour seems to demand the ubiquitous hierarchical bureaucracy which so dominates most organisations. However if the bureaucratic organisation achieves efficient results in terms of economic growth it can also so reduce the scope of the individual enmeshed at its lower levels that this diminution of freedom of behaviour begins to deny the primary objectives of the organisation, by alienating its members. Thus the price of economic growth may be too high. The paradox in our current concept of society is that freedom and the achievement of human dignity require a technology and economic growth which in turn seems to require enslavement and exploitation.

Organisation, therefore, is a powerful, all pervasive factor in the human enterprise. Yet our knowledge of organisations, their beginnings and ends, their life styles, their needs and goals is still quite limited. The older social sciences are largely descriptive and empirical in their approach to organisations and the new sciences of systems, cybernetics and operational research are just feeling their way towards a theoretical understanding.

The thesis which follows describes a simulation approach to the study of organisational behaviour and tries to draw from this study tools which might aid management and planning processes generally. The major part describes the development and use of a series of simulation models of a crime investigation organisation, namely a typical small C.I.D. (Criminal Investigation Department) Unit in the police force of a medium sized English county town.

The project, commissioned by the Police Research and Development Branch of the Home Office was originally defined to explore the possibilities of using simulation methods as training aids for introducing detectives to the problems of manpower allocation and supervision. As the project developed however it was found that the particular simulation methods adopted could also have application as an evaluation and planning tool. This led directly to a computer simulation model and general considerations of organisational simulation.

The work is not social science nor yet is it pure cybernetics. It is not operational research, lacking the mathematical basis which characterises that field. Thus the work is difficult to label and yet labels are useful. The most apt that comes to mind is that of "applied social cybernetics".

At one level the work described is concerned with the particular technical problems of designing, developing, implementing and assessing simulation techniques applied to crime problem solving organisations. At a more general level however, it is concerned with the principles, practice and methodology of the techniques of organisational modelling and, at a third level, with understanding the nature and functions of models and modelling activities in the interactions between complex systems and their environments.

1.2 Guide to the thesis

The thesis is divided into two parts. The first part describes the development of the various police system simulation models made and the experiments carried out with them. This is contained in Chapter 2-7. Chapter 2 is a brief history of the development of police systems in this country as background to the study. Chapter 3 then summarises the main stages of the work to give an overview of the whole project. This chapter in conjunction with Appendix I which describes the detailed structure and mode of operation of the simulator will give the reader an understanding of the core of the work. Chapters 4, 5 and 6 describe the modifications and ext ensions to the basic model and the experiments carried out on these. Chapter 7 in association with Appendix III describes the computer model.

The second part of the thesis (Chapters 8, 9 and 10) discusses the relationships of this work to existing similar work and attempts to draw conclusions for the further development of organisational simulation.

Chapter 2

Police History and Development in the United Kingdom

The two main tasks for the Police in this country are the preservation of public order and the prevention and detection of crime. But in the course of time several other important tasks have accrued to the police role, including traffic duties, licensing of various sorts and tracing missing persons.

The first modern police force was founded in London in 1829 after a series of disorders and criminal outrages caused by periodic economic distress in industrial districts. It is clear that the preservation of public order was the main task of the London Metropolitan Police Force and, therefore, that the Police system was set up as a means of ensuring a measure of social stability at a time when the reverberations of the French revolution were still strongly felt in England, and trade union power was increasing. However, the creation of the Force was not a simple repressive measure; it was only one part of Sir Robert Peel's programme of reform which included penal reform, the mitigation of the severity of criminal punishment and speeding the judicial process. But this relaxation of the severity of the criminal law contributed to a crime wave in the late 1820's and Peel, the Home Secretary, insisted on the need for crime detection to keep pace with legal reform.

Peel replaced the discredited night watchmen with his "bobbies" and rationalised their basic operating system by introducing the "beat" system in which a policeman, or pairs of policemen, patrolled a specified area in a given time, checking property and attending to any suspicious events. Combined with a system of checks, such as written reports, the requirement to meet up with other beat patrols at certain points, and checks by sergeants, the beat system proved highly effective and has continued in use right up to the present day.

By the mid 19th century all local authorities had been empowered to appoint and maintain a force of full time, paid constables. There were significant differences between the structure of county forces and borough forces. These stem from the difficulties of setting up the administrative framework in the counties and, whereas borough forces were entirely responsible to the elected 'watch committee', county forces were responsible to the Chief Constable, who were appointed by the Justices of the Peace, but only with the Home Secretary's approval. Thus, theoretically, the Home Office had much more control over County Forces than it had over Borough Forces.

Though initially police work was almost entirely confined to riot squad duties and beat patrolling, the complexity of work soon increased and specialised departments began to appear. As early as 1842 a small Criminal Investigation Department (C.I.D.) was set up in the Metropolitan Force to solve crimes which were not prevented by the beat patrols. The use of plain clothes officers to find out about criminals and suspects was felt to be underhand and in the early years at least, detective work was equated with spying. By the 1880's the larger provincial forces also had C.I.D. units and in the more advanced forces, detection slowly became more scientific.

> "Fingerprints were collected by the Metropolitan police from 1901 and the system was general by 1907. Two years later Major Atcherley, later to be one of Her Majesty's Inspectors, began the system of classifying and identifying criminals by their methods and idiosyncrasies (modus operandi), in the West Riding. Detective training courses (mainly in criminal law) were instituted in the larger forces and in 1918 Metropolitan courses were opened to provincial officers."
> (Martin and Wilson 1969).

The development of specialised information systems for finger prints, modus operandi, and other records has continued to the present as has the development of scientific and technological aids leading from bicycles in the 1890's to pocket radios and computers in the 1970's. The post of Adviser on Scientific Aids was created in the Home Office in 1934, followed by the setting up of regional forensic science laboratories.

After the second World War, the rate of change in the Police Forces increased. Perhaps the most significant change has been in communications both through the very rapid increase in the use of cars and a corresponding increase in traffic duties and in the use of radio. The growing network of motorways has led to greater criminal mobility and more inter-force co-operation. The creation of regional crime squads and a new emphasis on crime prevention and public relations were attempts to deal with rising crime rates and falling detection rates. In many forces the older style beat system was replaced by the new Unit Beat Policing System. Under this scheme a force area was divided into a number of small areas. In theory, each area would have one permanent Area Constable who would live in the area and get to know it well and become well known in it, rather after the style of the old fashioned 'village bobby'. Motorised panda patrols (so christened because of the small blue and white cars used by the patrols) covered every two areas and, in many forces, a detective would be assigned to each pair of areas as well. In association with this new strategy a formalised local intelligence information system was introduced, based on a Collator's Office in the Police station. Area constables, other patrols and detectives were asked to report various categories of information to the Collator, whose job was to file these reports in a readily accessible information system and to circulate, each day, within the force, a bulletin recording the main intelligence items reported to him. This live local intelligence information system was designed to keep the force aware of what was happening both from the crime detection point of view, by providing data on the behaviour of known criminals, and also from the crime prevention point of view, by providing data on property and vulnerable sites in the area and any suspicious incidents.

Inevitably, the volume of information, including statistics, required by the individual collator and criminal records offices and the Home Office has grown. The strategic uses of information were encouraged by the creation in 1963 of the Police Research and Planning Branch in the Home Office. This was staffed by Home Office scientists and seconded police officers with the job of evaluating current police methods and equipment, publicising successful effort and evolving long term plans at the national level. For example, some of its projects have been evaluating the methods and results of both regional crime squads and unit beat policing systems. In 1966 the Select Committee on estimates recommended that the Home Secretary review its establishment with the intention of substantially increasing its size and expertise and in 1970 it became the Police Scientific Development Branch.

As a result of the increasing complexity of the information handling aspect of police work there has been a steady development of the use of computing techniques. Thus the mid 1960's saw the computer mainly as a research tool to help the Research and Planning Branch with calculations and statistics and as a back up to operational research studies. The early seventies saw the development of the Police National Computer (P.N.C.), investigations of computer based local intelligence systems and the development of computer aided command and control systems.

The simulation study described in this thesis was part of the investigation of possible ways in which operational research and computing related techniques could be useful for police systems.

Chapter 3

SIMPOL - Project History and Overview

The SIMPOL project (Simulation of a Police Unit) was a contract research and development project supported by the Police Scientific Development Branch (formerly the Police Research and Planning Department) of the Home Office. Its aims were to explore and develop the use of simulation techniques as aids to the operation of Criminal Investigation Departments (C. I. D.) in British police forces. The project evolved in three distinct phases each with its own specific goals. For convenience these phases have been called SIMPOL I, SIMPOL II and SIMPOL III respectively.

3.1 SIMPOL I

SIMPOL I, which was started in September 1964 and ended in August 1966, was essentially exploratory in nature.
It consisted of the development of a manual laboratory simulator, which created a realistic representation of the basic information and command structure of a small six-man C. I. D. unit. The rules, procedures and information used in the model were based on field studies carried out with the co-operation of several police forces and Home Office scientists. The simulator was designed so that the task of managing the simulated C. I. D. force, that is deciding which detectives to allocate to which complaints and for monitoring progress on investigations, could be carried out by one man, the subject (S), in the experiment. The system was run by three operators. The interface between the subject and the operators comprised written and verbal communication and also the communication of detective states. Detective states were

defined as on or off duty, busy or free, in or out of the station, contactable or not, and these states were communicable by means of push buttons and lights.

Subjects in the pilot experiments carried out with SIMPOL I were all Detective Sergeants and Detective Inspectors from a Staff Course at the Police College, Bramshill. These experiments were designed to test out the basic operation of the system using an adaptive control principle. This control principle, developed directly from work on teaching and learning (Pask & Mallen 1966) was introduced to try to avoid the situation which might arise if, for example, any one subject found all the cases to be solved too simple, therefore making the whole system appear trivial or, alternatively, finding them too difficult and being frustrated by impossible situations. The control rule adjusted the 'difficulty' of a case by adding or removing information; in this way, the success rate of the subject (S) could be controlled.

The pilot experiments carried out with this system are described in detail in Chapter 4. Broadly two conclusions emerged. The first was that such simulation systems could be used as a means of aiding the evaluation of the effects of various changes in structure and input on the performance of the system and the second was that the system could be used as a training aid.

The first conclusion rested on the fact that it was possible to measure various aspects of system behaviour. The second rested on less precise data, namely the judgments of subjects that the simulated situation was reasonably realistic and yet flexible enough to allow a wide range of circumstances to be simulated.

As a result of these conclusions and to prepare the system for future use the prototype hardware of the simulator was re-designed and made portable. At the same time, an 'Operator's Manual' was prepared describing the equipment and the operating procedures. This is attached as Appendix I. The reconstruction was completed with the co-operation of the Police Research and Planning Branch (PRPB) workshops and the final system delivered to the Home Office in late 1966.

The Research Team for SIMPOL I comprised Gordon Pask, Principal Investigator, the author as project leader and Messrs. Moore, Strachan and Watts as technical and operating assistants. The total expenditure of effort was approximately $1\frac{1}{2}$ man years graduate research effort.

3.2 SIMPOL II

In May 1967 the Police Research and Planning Branch asked the research team to expand the basic SIMPOL I simulator to include a local intelligence collator facility so that some system evaluation experiments could be carried out. This was part of the PRPB programme on evaluating the effects of unit beat policing and the associated collator systems then being introduced in many forces up and down the country.

The information system of the simulator was redesigned, basically by the addition of a model local intelligence collating system. As with SIMPOL I the new model was based on a series of field studies. The system and experiments carried out with it are described in detail in Chapter 5.

Twenty-four experiments were run during 1968 with fourteen senior police officers as subjects and ten Home Office scientists. The experiments were designed to show the effects on detection rate of two different modes of "collator" operation. The "collator" is a police officer whose job is to sift, file and disseminate local intelligence information. These two modes were called 'active' and 'passive'. A passive collator simply filed intelligence as it was reported and sent out the required Daily Bulletin. The active collator repeated the actions of the passive collator and additionally took into consideration the cases under investigation by the C.I.D. seeing that any obviously relevant information received from the simulated area constables and panda patrols was circulated to the appropriate investigating detectives. The experimental design allowed cross comparisons amongst these conditions and several hypotheses were tested. However only a limited number of experiments was possible and the small amount of data available for each cell of the experimental design meant that most of the results had low statistical significance. This led to some consideration of the concepts underlying the validity of models in general and the SIMPOL model in particular. These will be discussed more fully in Chapter 10. Nevertheless, the model was agreed to be realistic. It produced intuitively correct behaviour in that active collators with low delays on information supply produced higher detection rates than the other conditions with police subjects.

However the problems of low statistical validity due, in part, to difficulties in finding high calibre police subjects with time to devote to the project and the length of a series of experiments (it took six months continuous effort to run 24 experiments) indicated that the manual game type simulation system had only limited utility as a system evaluation tool.

The SIMPOL II project lasted from May 1967 to April 1969 and included an enlarged project team with the author as project director. Research Associate, C M Elstob, Research Assistants C Whitehouse, R Bailey, G Harrison, Technical Assistant D C A Watts, Clerical Assistant Miss W Lewis; the total allocation of graduate research effort being 4 man years.

3.3 SIMPOL III

At the end of the SIMPOL II development the only part of the C.I.D. system which was not modelled was the resource allocation system used by the Subject to allocate crimes to detectives and to monitor their investigations. In view of the limitations on its use in the area of system evaluation mentioned above, it was proposed that, using the data on resource allocation available from the experiments already carried out, it would be possible to model resource allocation as well. Therefore, the whole SIMPOL system could be programmed to run on a digital computer. This proposal was accepted and in May 1969 a third project was started. This had two parts; the first an investigation of the effects of crime load and detective numbers on the manual system performance, followed by the development of a computer model to run on the IBM 1130 single disc computer system in the Police Scientific Development Branch (PSDB) of the Home Office.

The experiments with the manual system were designed to provide data which might be compared with work load and task analysis studies being carried out by a PSDB team on a number of Police Forces and, therefore, provide further validation for the model. The data from this field study was not available at the end of the SIMPOL III contract period so the intended validation could not be carried out.

The computer model was designed to simulate the main features of the SIMPOL model. It operates on a data base comprising the coded cases used in the SIMPOL III manual experiments and the same set of active criminals. It is a discrete, event driven simulation in which time advances in a sequence of intervals of defined length. The main parameters of the system, such as crime rate, number of detectives, characteristics of detectives, time taken per activity, etc., are easily modifiable to allow a wide range of system evaluation studies to be carried out. However, as well as allowing convenient parameter changes, the programmes have been designed to allow the basic structure of the model to be changed. That is the numbers and types of activities executed by the detectives can be easily modified as can the decision criteria used by the model detectives for planning and the resource allocation algorithm for allocating cases to detectives. Thus, the computer model is modular allowing a wide range of organisation analyses and performance studies to be quickly and easily carried out.

The SIMPOL III study was carried out over the period June 1969 to July 1971 at System Research Ltd. by a Research Team directed by the author and comprising C M Elstob as Research Associate and R Bailey and G Harrison as Research Assistants. After July 1971 it was carried on by the author and Mr Elstob working independently in their own organisation System Simulation Ltd. and a working computer programme was available in January 1973.

3.4 Project Overview

In summary the SIMPOL project involved two main developments: First a manual game-type simulation was built which reproduced the structures and information flows in a typical Criminal Investigation Department (C.I.D.) of a British police force. Experiments were carried out with different versions of the model and various performance measures were studied.
Second as a result of the development of the manual model a computer model of the SIMPOL structure was programmed and implemented.

The main features of the simulator's hardware and software are presented in Appendix I. Experiments,results and conclusions from the three manual SIMPOL exericses are presented in Chapters 4, 5 and 6 respectively. The structure and behaviour of the computer model is outlined in Chapter 7 with more detail in Appendix III.

Chapter 4

The Design and Development of a CID System Model

4.1 Basic Model

As we saw in Chapter 2, criminal investigation units were set up to investigate complaints which were not prevented by the uniformed branch's beat patrol system. Initially, emphasis was on criminal investigation rather than crime investigation, which naturally enough led to the identification of plain clothes detectives as police spies (Martin and Wilson 1969). However, as systematic methods of storing and retrieving information were developed, and as forensic science came to have value, so it became possible to operate on crime information as the basis of the detection process leading to the identity of a suspect. Thus two types of activity are closely interwoven in the work of a modern detective. These are called "direct" and "indirect" activities respectively.

Direct activities are routine enquiries at the scene of a crime, interviewing complainants and losers and doing follow up enquiries like circulating stolen property lists and talking with second hand dealers and so on. Indirect activities are those not associated with any one particular crime but are in the nature of gathering general information about the movement and behaviour of known criminals and other suspicious persons.

Basically, therefore, the police system model was based on the concept of a detective as an information processing entity which carries out certain information gathering activities and carries out specific operations on the information gathered. Each such agent operates in the context of a CID team, which is backed by police force resources like scenes of crime officers (SOCOs) who specialise in collecting forensic evidence from scenes of crimes, records offices, which contain criminal records, finger print departments containing prints of local criminals and modus operandi files containing information about how known criminals usually execute their crimes.

Further the CID team members work within a resource allocation system that determines which complaints should be attended to by which detectives and roughly how much effort should be applied to them. In practice, it was found that the resource allocation system was based on the "Crime Book". This is a book kept in the Police Station in which is written the details of a complaint when it is received. The way in which the "Crime Book" is used varies from force to force. Sometimes detectives will deal with the complaints in the book in a purely first come first served basis. That is when a detective has time available, he will take the next complaint in the book. Other forces operate on an area basis and deal with crimes on a first come first served principle within their area. Still others operate a centrally controlled system in which a senior officer will decide which complaints are to be dealt with by whom.

A block diagram of this conceptualisation of a CID system is shown in Fig. 1.

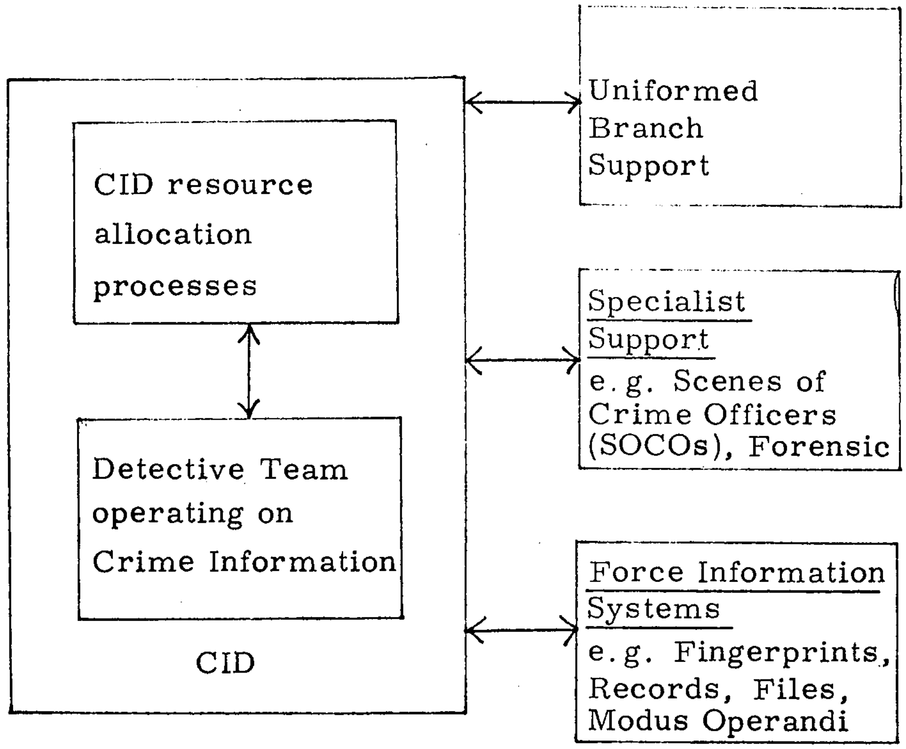


Fig. 1 CID System Block Diagram

Taking a 'systems' view of the organisation, we need to consider the environment with which the organisation carries out its transactions; that is the system we have postulated is an 'open' system (von Bertalanffy, 1950) and its major input requirement is for information both about complaints and about suspects. In input-output terms, the CID system receives crime complaints as input information, determines whether these are in fact crimes and if so operates on these with a variety of procedures aiming to output a set of names identifying the suspects associated with each of the crimes. This overall view of the Police system and other social systems to which it is related is shown in Fig. 2.

The sorts of procedures carried out by the detectives fall, as we have seen, into two main categories, direct activities and indirect activities.

Field studies, which consisted of informal interviews with detectives in Borough Forces and County Forces and an examination of over a hundred investigation reports, showed that there was a fairly small basic group of different procedures within the direct activity set but that indirect activities were more difficult to identify. The reasons for this latter difficulty are twofold. First there is the problem that a detective's stock of intelligence information is regarded as private. Simply this is necessary to protect contacts and informants and detectives were, in general, unwilling to divulge to outsiders the precise nature of their methods of collecting and using this information. Second, the cognitive processes themselves came in the category of human thinking behaviour which is certainly not procedural or algorithmic. They are 'non-programmable' in Simon's (1960) sense.

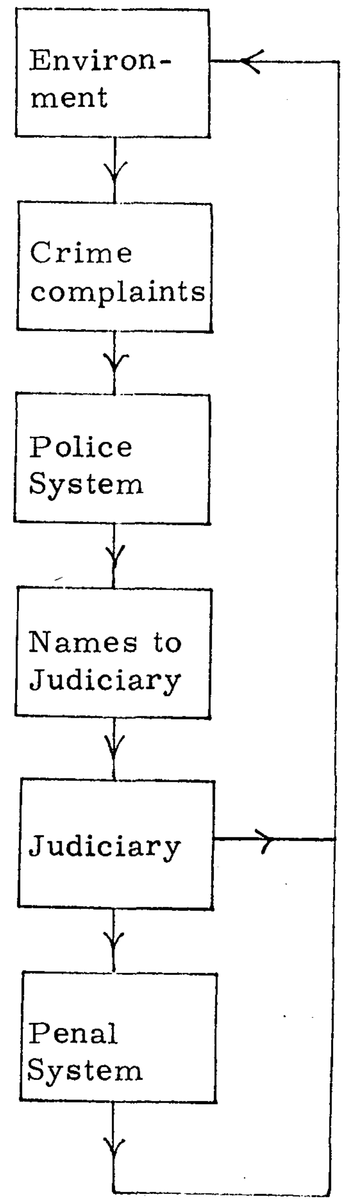


Fig. 2 Social System within which Police System Operates

Neither of these reasons preclude study but at this early stage of the project it was decided to treat the indirect activities as a 'black box' system and to leave the problem of filling in the black box to a later stage. This has since been tackled by C M Elstob and forms the basis for his thesis on the problem solving and decision making mechanisms of the detective. (Elstob 1974).

Thus, the first simple model of a detective which was derived treated him as an information processing agent, which tried to solve crimes by the application of routine procedures in the direct activity category. The identified routine procedures were - (1) attend the scene of the alleged crime and get general information about whether a crime has been committed and if so its type, value of property stolen, type of premises, time reported, by whom. This activity is often a process of confirming the information in the initiating complaint. (2) examine the scene for detailed forensic evidence and, if necessary, get a Scenes of Crime specialist to attend. (3) interview the loser and/or anyone else at the scene, and, (4) carry out local enquiries in the vicinity of the crime to find if any suspicious persons, vehicles or activities had been observed.

Should these procedures fail to produce information to help identify a suspect, the detective would turn to indirect activities, labelled for convenience, 'contacts and informants'.

This simple sequential or procedural detective model is shown in Fig. 3.

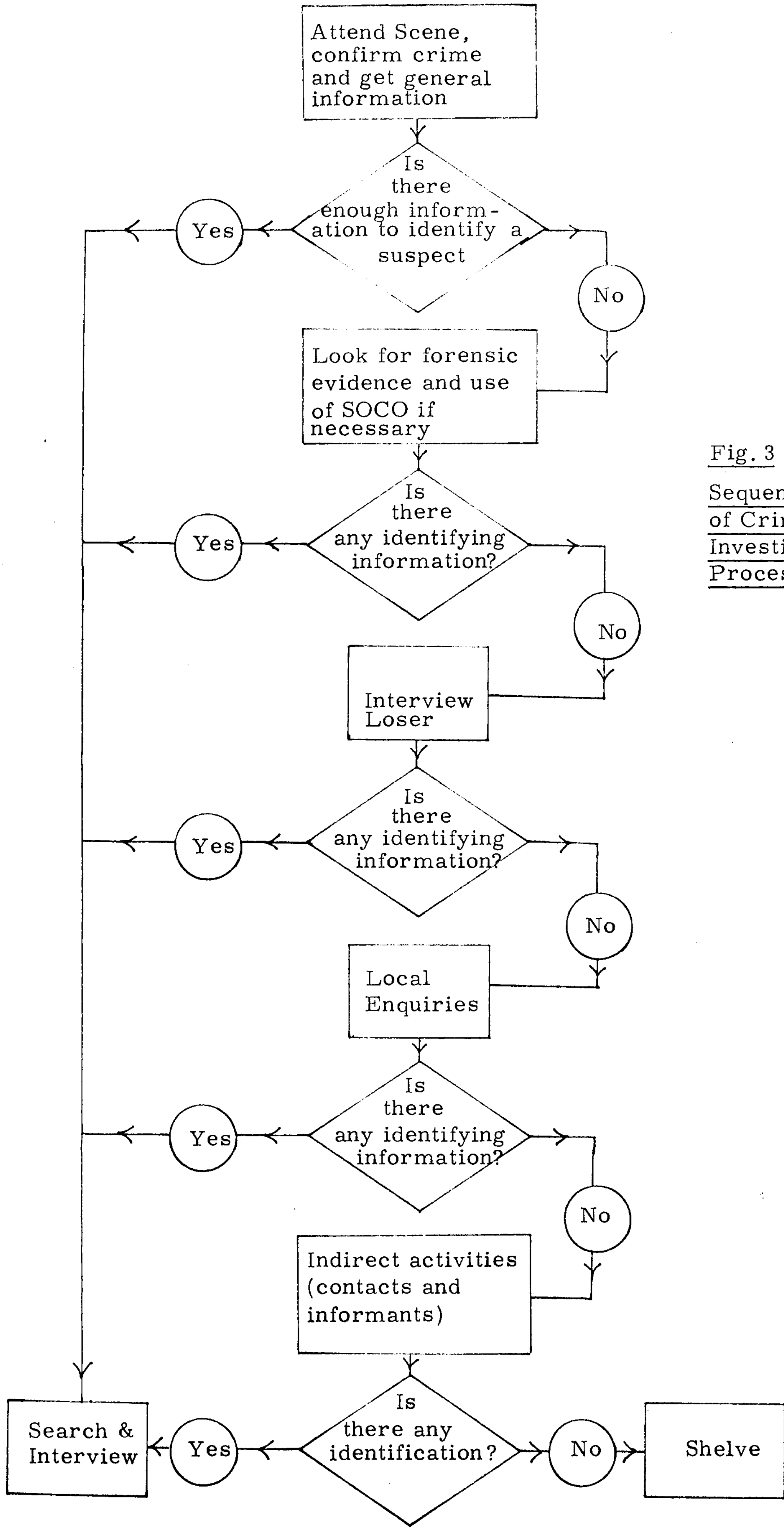


Fig. 3

Sequential Model of Crime Investigation Process

4.2 The Design and Development of the Prototype Simulation System

4.2.1 Design Criteria

Our objectives with the first system were to design a laboratory set up in which a practising detective could be presented with a realistic information and decision environment; that is, a system was required which would respond to a detective's commands and queries with approximately real behaviour and information. A force command structure was adopted in which the participant in the simulation had the approximate command role of a Detective Inspector. He was asked to 'manage' a team of six detectives, four detective constables and two detective sergeants, but the management function was restricted to allocating detectives to investigations and directing the sequence of investigation procedures to be carried out. This command role is approximate for two reasons - 1) in some real forces observed, at least for routine crimes, detectives operated a system of self management, i.e. a detective decides for himself when to curtail an investigation or when to begin a new activity. Therefore, introducing an explicit separate management procedure was a departure from reality but deliberately so in order to 'externalise' the actual procedure used by detectives; 2) no D.I. (Detective Inspector) is purely office bound, most of his detective work will be out of the office on investigations.

These departures from reality are justified on two counts. First by creating a situation in which subjects had to make explicit decisions which, in reality, would only demand an implicit decision, it was hoped to find out something about the structure of these decision processes. Second, by designing in a degree of unrealism, subjects might be encouraged to point out 'deficiencies' and thereby contribute to the eventual evolution of a more realistic model.

There are three parts to the simulation system. First is the Police system model, which has already been outlined, second is the environment within which the Police model operates, that is the community containing criminals and complaints, and, third, is the hardware and software of the simulator apparatus itself.

4.2.2 The Community and Crime Information Models

As can be seen from Fig. 2, the crime investigation sub-system can be viewed in input-output terms. Its input is a series of crime complaints and its output is a series of suspected criminals, who are passed to the judiciary.

"Crime complaints" arise when suspected crimes are discovered by the public and consist of general information about the "crime". "Crimes" are committed by a subset of the local community known as "active criminals". The types of crimes which were selected for use as the input data to the model were based on the requirement to look at routine aspects of CID operation. This meant that the crimes had to be, in the main, serious enough to warrant the attention of the CID but not serious enough to require the focussing of a major part of CID effort on any one. Table 1 shows the relative numbers of the most common reported types of crime. (Greenhalgh, 1964(a)). These were used as the basis for the SIMPOL crime library and are offences against property "with violence". They are known as Class II offences and the average number dealt with per CID office per year is 20 (Greenhalgh 1964(b)).

These figures were used as a guide for generating a crime programme, that is a sequence of crimes and their associated complaints to be fed to the simulation system as input. However, bearing in mind the degree of abstraction of the simulation which left out time consuming activities like report writing and court sessions, the loadings for the simulation were increased so that a figure of between 1 and 2 crimes per day per CID man was adopted as a typical input load.

A continuous simulated period of six days was chosen as the length of an experiment in a real time period of two hours for each simulated day. Thus, in three 2-hour sessions, during a real day, three simulated days could be covered. This choice of time scale was based on two main factors: 1) the length of time for which we could get appropriately experienced

Table 1 Relative Numbers of Common Crimes

(source Greenhalgh 1964(a))

No. in Home Office List	Offence	Percentage of Offences
28	Burglary	3
29	Housebreaking	29
30	Breaking into shops, warehouses, offices, etc.	45
31	Attempts to break into shops, warehouses, offices, etc.	6
32	Entering with intent to commit a felony	16
34	Robbery	1
		100

subjects and 2) the rate of information flow between simulator and subject required in order to maintain interest. The first criterion was fixed at a maximum of two real days and was the major determinant. The second criterion was more difficult to assess. Thinking of the information flows to the subject in terms of reports and complaints and from the subject in terms of reports and complaints and from the subject in terms of commands and queries, an average real time rate of one message every five minutes would be a high rate and one every fifteen minutes would be a low rate.

The crime library was created first by inventing a population of active criminals and then drafting scenarios of their behaviour over the simulated six day period. These scenarios were quite simple summaries of behaviour and were used during the simulation to determine what a criminal was doing and where he was located at any time. Some criminals were more active than others, committing up to five crimes during the simulated period, though the majority committed only one or two.

Once the occurrence of a crime had been specified, 'crime information' cards were prepared containing the information which might be obtained by the investigating detective In this first system, the cards were organised into four groups corresponding to the different detective activities: 1) general enquiries, 2) detail (forensic enquiries, 3) loser interview, and 4) local enquiries. Within each group information was graded according to 'difficulty' defined as amount of work which would have to be done to get that information. For example, in the local enquiries group one card might specify that the lady next door saw the criminal leaving the house carrying a parcel but is not able to give a very good description. This would then count as an "easy-to-get" piece of information. However, the driver of a paraffin delivery van, which was making a delivery a hundred yards round the corner, might have seen a man fitting the previous description, carrying a parcel get into a car, which he is able to describe. This piece of information is more difficult to retrieve because it involves enquiries further afield from the scene of the break-in and would take more time.

Thus, to summarise, information about a crime was coded into four groups of data corresponding to the types of direct activity carried out by the detective. Within each information group, data was arranged in order of its difficulty of retrieval. In this way, a highly structured crime library was prepared based on the criminal scenarios.

Once the crime library had been prepared, a set of complaints, one for each crime, was prepared. In most cases this was a simple statement again on a card that at a certain time someone had reported a break in and that property of a certain type and certain value was missing. The sequence of complaint cards formed the crime programme, which was the basic input to the simulation system. Since it was possible for a criminal to commit crimes over the whole six day period, it was necessary to provide a procedure for ensuring that if a criminal was arrested early in the simulation and therefore removed from the active criminal list, then the crimes he 'committed' after his arrest were removed from the crime programme. This was done using a simple crime-criminal logical map.

Details of the community and criminal population used in the simulation are given in Appendix I.

4.2.3 The Simulation Equipment and Operating Procedures

The simulator hardware and the methods of operation are described in detail in Appendix I. The first experiments, which will be described in the next section, were carried out on prototype equipment. After the experiments, this equipment was dismantled and, without fundamental redesign, reconstituted in the form described in the Appendix.

The main operating principles of the simulator were:-

1) the subject (Detective Inspector) sat at a table with a console which showed him simulated time, detective states (indicating whether each of his six detective officers were on or off duty,

busy with an investigation or not, in or out of the office, and if out of the office, whether or not he was able to contact him by telephone or radio) and a telephone communication system allowing him to speak to the 'officers'.

2) The inputs to the D. I. were typed crime complaints and telephoned reports from his detectives.

3) As well as attending to complaints and controlling the detective team, the D. I. had to carry out a paper work task intended to simulate routine office work. This task consisted of crossing out specified letters where they appeared on a sheet containing a random sequence of several hundred letters.

4) The simulator operators sat in a separate room and communicated with the D. I. only over the telephone. Two operators represented the six man detective team and a third operator controlled the simulator, a) by scheduling the delivery of complaints and investigation reports and b) by directing the construction of investigation reports from the crime data base.

5) In the first experiments a mode of operation was adopted in which the amount of information about a crime in the data base was varied in each experiment in order to achieve a prespecified

detection rate for that particular subject. That is, if it was found that a subject was not detecting enough cases then the amount of information about crimes was increased for the next sampling period and if the subject was making too many detections, then the amount of information allowed was decreased. This performance control strategy was adopted to prevent the possibility that subjects either might find it too easy to run the system and, therefore, get bored or that they might find it too difficult and give up. The disadvantage of this method, of course, is that the measure of performance is the degree of difficulty of the crimes which allowed the subject to achieve the predetermined detection rate rather than the simpler direct measure of detection rate. Nevertheless, because these were the first pilot experiments and few subjects were available, it was decided to adopt the more complex controlled approach, thus decreasing the chance of wasting subjects at the cost of an indirect, less easily interpretable, performance measure. Details of the control rule operation are given in Appendix I.

4.3 Pilot Experiments

4.3.1 Background, Objectives and Experimental Design

The objectives of the first experiments with the SIMPOL system were mainly concerned with the development and testing of methods of operating the simulator and methods of measuring performance. However, the experiments were organised to give some insight into the relationship between loading (i.e. crimes per day per detective) and system performance. The use of the control rule meant that performance was measured indirectly in terms of the amount of crime information required to achieve a prespecified detection rate.

These pilot experiments were carried out with a group of eight subjects from the Police College, Bramshill. Five of the subjects were Detective Sergeants, three were Detective Inspectors. The distribution of subjects among County, Borough and Metropolitan Police Forces was as follows:-

County	-	three subjects
Borough	-	three subjects
Metropolitan	-	two subjects

Each of the subjects attended the laboratory on two consecutive days over an 18-day period. Three simulated days were presented during each real day with the exception of Saturdays, when only one was presented. A simulated day required a period of approximately two hours real time, so the time table was arranged as follows:

1st period	:	10 a.m. - 12 a.m.
2nd period	:	12.45 p.m. - 14.45 p.m.
3rd period	:	15.15 p.m. - 17.15 p.m.

One week prior to the beginning of the simulation runs the subjects were issued with copies of 'SIMPOL - the Simulation of a typical Police (CID) unit, Subject's Briefing Data (Appendix I). They were also given brief outline talks about the simulator and its objectives by members of the Research and Planning Branch of the Home Office.

A 2 x 2, four, cell experimental design was adopted to allow a comparison of both crime loadings (i. e. number of crimes input per day) and detection rate levels. The performance measure adopted was the number of information categories in the crimes required by the subject in order to achieve the specified detection rate. Because of the small number of subjects available (eight), it was decided that best use would be made of the experiments by running four subjects in the standard condition cell in order to fully 'debug' the system and distributing the other four subjects in the other cells as shown below:

Table 2 Experimental Design for SIMPOL I

		Detection Rate	
		40%	70%
Crime Input Rate	10 per day	4 subjects ($P_1P_2P_3P_4$)	2 subjects (P_6P_7) Final Part
	15 per day	2 subjects (P_5P_8)	2 subjects (P_6P_7) First Part

Two subjects P_6 and P_7 were started in the 15 crimes per day, 70% detection rate cell then after two simulated days, the input rate was dropped to 10 crimes per day. In this way some feeling for the performance of the system in all four parts of the performance space could be obtained and its utility assessed.

Two hypotheses were proposed for testing with these experiments. These were:

<u>Hypothesis 1</u> For a constant detection rate higher input crime rates will be associated with a higher number of information categories in the input crimes.

<u>Hypothesis 2</u> For constant input crime rate higher detection rates will be associated with a higher number of information categories in the crimes.

These hypotheses ask that the behaviour of the model should in very broad terms be intuitively sensible. That is they require that, as we would expect in a real CID system, the model should produce higher success rates when it is dealing with "easy" crimes (i.e. those with a high number of information categories) or a low rate of case input than with "difficult" crimes or high input crime rates.

The daily crime programme for the 10 crimes per day programme is shown in Figs. 6a - f in Appendix I. The programme for the 15 crimes per day programme is shown in the Tables 3a - d below

Table 3 15 per day, Crime Programme, a) day 1 b) day 2

(a)

CRIME NO.	CRIMINALS	TIME REPORTED
1	Crook(1) Herring(11)	Overnight
6	Wright(14)	Overnight
3	Bristoll(3) Prior(4)	0905 hrs.
4	Bristoll(3) Prior(4)	0910 hrs.
7	Wright(14)	0915 hrs.
5	Wright(14)	1030 hrs.
8	Teegan(7)	1045 hrs.
25	Crook(1)	1120 hrs.
12	Dixon(5)	1135 hrs.
14	Wright(14)	1205 hrs.
18	Teegan(7)	1230 hrs.
16	Milligan (No Record)	1410 hrs.
10	Bristoll(3)	1530 hrs.
9	Dixon(5)	1637 hrs.
29	Dixon(5)	1715 hrs.

(b)

CRIME NO.	CRIMINALS	TIME REPORTED
23	Crook(1)	Overnight
27	Prior(4)	0900 hrs.
11	B. Fitzgerald(16) K. Fitzgerald(17) Kavanagh(19) Fairfax(N. R.)	0901 hrs.
21	Dixon(5)	0905 hrs.
20	Teegan(7) Jarrow(N. R.)	0915 hrs.
28	Prior(4)	1000 hrs.
17	Robinson(N. R.)	1047 hrs.
22	Sullivan(18)	1125 hrs.
31	Teegan(7)	1130 hrs.
13	Mason(20)	1135 hrs.
15	Mason(20)	1415 hrs.
2	Dixon(5)	1550 hrs.
19	Miller(N. R.)	1615 hrs.
37	Fell(8)	1630 hrs.
36	Bushby(2)	1630 hrs.

Table 3 Cont'd. c) day 3 d) day 4

(c)

CRIME NO.	CRIMINALS	TIME REPORTED
24	Crook(1) Herring(11)	Overnight
26	Bristoll(3)	Overnight
30	Teegan(7)	Overnight
34	Butler(6)	0830 hrs.
35	Kimber(9)	0900 hrs.
33	Kimber(9)	0935 hrs.
40	Butler(6)	0945 hrs.
41	Kimber(9)	1015 hrs.
43	Bushby(2)	1045 hrs.
44	Bushby(2)	1215 hrs.
45	Bushby(2)	1320 hrs.
39	Kavanagh(19)	1400 hrs.
52	Lycett(15)	1445 hrs.
53	Rushman(12)	1500 hrs.
55	Newton(13)	1545 hrs.

(d)

CRIME NO.	CRIMINALS	TIME REPORTED
32	Herring(11)	Overnight
38	Rushman(12)	Overnight
57	Butler(6)	0900 hrs.
46	Rushman(12)	0900 hrs.
49	Butler(6)	0905 hrs.
42	Kimber(9)	0915 hrs.
48	Rushman(12)	0915 hrs.
60	Lycett(15)	0930 hrs.
47	Herring(11)	0945 hrs.
50	Sullivan(18)	1030 hrs.
56	Newton(13)	1115 hrs.
51	Newton(13)	1430 hrs.
58	Lycett(15)	1430 hrs.
54	Newton(13)	1510 hrs.
59	Lycett(15)	1615 hrs.

and the relation between crimes and criminals in Tables 5a - c in Appendix I.

4.3.2 Pilot Experiments Results

As discussed in section 4.2, the adoption of a feed-back control using detection rate as the controlled variable and information content of the crimes as the control variable means that the performance of the system is defined by the trajectory of 'information content' over time.

The variable 'information content' was defined on an ordinal scale simply by the number of basic information categories which were allowable information for that crime. 'Information content' was defined as having three values, S_1, S_2 and S_3, where $S_1 > S_2 > S_3$.

A crime had information content value S_1 when it contained 'general information', 'loser information', 'local enquiries information' and 'detailed scene information'.

It had 'information content' value S_2 if it contained only 'general information', 'loser information' and 'local enquiries information'.

It had information content value S_3 if it contained only 'general information' and 'loser information'.

Note that S_1, S_2 and S_3 are defined on an ordinal scale only. However, with some care, we can attach numbers to these values and make some deductions from some arithmetic combinations. For example, if we let $S_1 = 1$, $S_2 = 2$ and $S_3 = 3$, we cannot meaningfully add, subtract or multiply these values. But if we count the number of intervals during which the variable had value S_1 and let this equal n_1, then count the number of intervals it had value S_2 and let this equal n_2 and the number of intervals it had value S_3 and let this equal n_3, then these can be combined to give an average measure S, as follows:

$$S = \frac{n_1 + 2n_2 + 3n_3}{n_1 + n_2 + n_3}$$

This can be interpreted as giving a measure of the likelihood of the variable most often having value S_3, or having value S_1. For example, if S = 3, the 'information content' variable always had value 3. If S = 1, it always had value 1. But because of the ordinal nature of the scale, a value of S = 2 does <u>not</u> tell us that the value was always 2. It may have been or it may have spent half the time at value 3 and half at value 1, i.e. it may have been very unstable. Nevertheless S was taken as a performance measure and computed for each subject's trajectory. The results for all 8 subjects are shown in Table 4 and typical trajectories from which S measure was calculated shown in Fig. 4a, b, c.

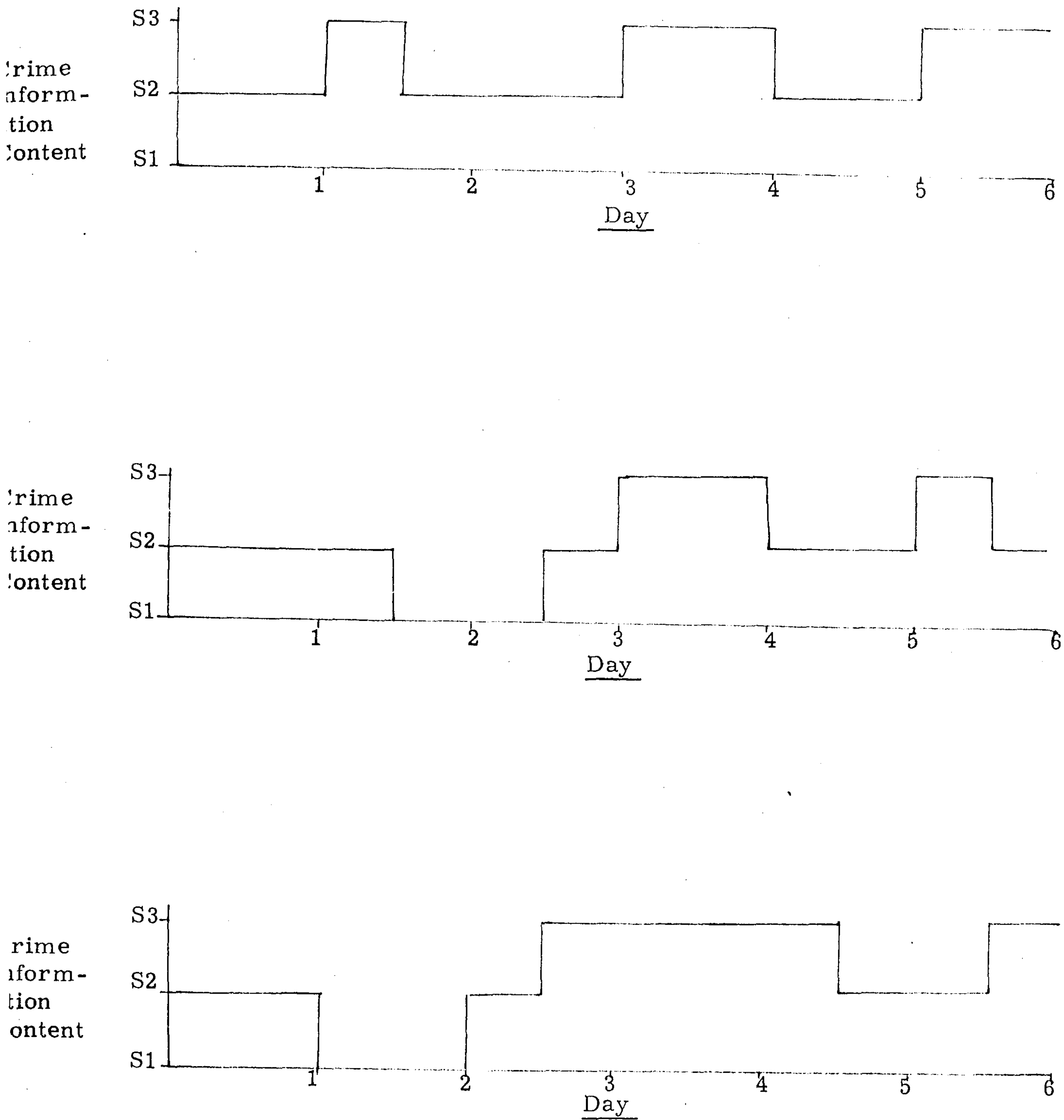


Fig. 4 S-Level Trajectories And Associated Detection Probabilities For Subjects (a) P_1, (b) P_2, (c) P_3

Table 4 Overall Performance Index S for all Subjects

Subject	P_1	P_2	P_3	P_4	P_5	P_6	P_7	P_8
S	2.5	2.5	2.5	1.7	2.0	1.0	1.4	1.3

Now the first hypothesis asked that the average value of the information content variable for subjects P_1, P_2, P_3, P_4 (which is 2.3) should be greater than the average for subjects P_6 and P_7 (which is 1.2), which it is. Hypothesis 2 asked that the average value of information content variable for the first group of subjects should be greater than the average for subjects P_5 and P_8 (1.6), which it is.

Thus the performance data supports the loading hypotheses advanced in the previous section and it was concluded that the overall behaviour of the model was intuitively sensible.

As well as measuring the performance control variables, all communication between subjects and simulator operators was tape recorded. These recordings were then transcribed onto record sheets as shown in Fig. 5.

Mess. No.	Call- er.	Rec' vr.	Crim No.	Durat- ion(s)	Time	Message Contents	Class
31	S	Sub	58	100	1600	Mrs Dixon has identified Lycett. Terrel also wants him.	Rd
						O.K. Get his address from registry and bring him in. Look over his place. If you see Sgt. Pavey tell him to give me a ring.	C
32	Sub	S	59	27	1614	Before you go to find Lycett go to 18 Eltham Rd. There's been a break. Take Jenkins, then get him to give you a hand to bring in Lycett.	C
33	Sub	Ops	37	22	1625	Send a patrol car to the Public Baths immediately. A wallet has been stolen and a suspect seen.	C

Fig. 5 Sample of Typical Message Transcription, subject P_2, day 5

The resulting protocols were then analysed in two ways. First the number of messages passing between the subject and each of the simulated detectives was counted and the relative proportion of messages to and from each of the detectives then calculated. Some of these message distributions are shown in Table 5 below.

Table 5 Proportion of messages between each of the simulated detectives and subjects P_1, P_4, P_5 and P_8

Detective / Subject	Brown	Pavey	Salmer	Hawkes	Terrel	Keath
P1	.24	.10	.22	.16	.16	.12
P4	.12	.17	.17	.21	.21	.12
P5	.33	.17	.08	.25	.04	.12
P8	.20	.20	.18	.20	.09	.12

A measure of the tendency of the subject to concentrate on communicating with one or other of the detectives was then devised as follows. This measure, R, was based on some concepts from information theory. The extreme situation, in which a subject communicated with only one detective, is analogous to a situation of certainty in information theoretic terms.

The opposite extreme, in which the subject communicates with all detectives equally, is analogous to a situation of maximum uncertainty. The standard measure of information, or rather its complement uncertainty, is defined as

$$H = - \sum_{i=1}^{n} pi \log pi$$

where p_i is defined as the probability of occurrence of the i^{th} event of n possible events. This achieves a maximum value when $p_i = 1/n$ for all i. That is when all events are equally probable:

$$H_{max} = - \sum_{i=1}^{n} 1/n \log 1/n$$
$$= - \log 1/n$$

This gives a basis for scaling the uncertainty measure to vary between 0 and 1 so that a value of 0 corresponds to minimum certainty (maximum uncertainty) and 1 corresponds to maximum certainty. This new measure R, called the redundancy of the distribution, is defined as

$$R = 1 - \frac{H}{H_{max}}$$

Note H = 0 if one of the $p_i = 1$.

Applying this to the message number distributions and letting p_i = proportion of messages sent by the subject to the i^{th} detective we see that:

R = 0 signifies that all n detectives exchanged the same proportion of messages with the subject.

R = 1 signifies that only one detective exchanged messages with the subject.

Organisationally, therefore, R can be interpreted as giving an indication of the extent to which the subject placed himself at the centre of the organisation, communicating with all his subordinates (this situation being associated with a low value of R) or distancing himself by channelling his communication through a small number of selected detectives (corresponding to a high value of R). The measure R was calculated for each subject and the values obtained shown below.

Table 6 Measure R for All Subjects

Subject	P_1	P_2	P_3	P_4	P_5	P_6	P_7	P_8
R	.03	.04	.06	.01	.10	.01	.03	.03

The second analysis of the protocols was based on the content of the discourse between the subject and the simulator.

On examination of the message transcriptions, it was apparent that the discourse comprised four different types of statement. These were:
(1) Commands from the subject to his detectives;
(2) Reports from the subject to his detectives;
(3) Queries from the subject to his detectives;
(4) Reports from the detectives to the subject.

The following are typical examples of the types of statement:

Command (c) - "Sgt. Brown, take Jenkins and go to 12, Cannon Place. There has been a break, some silverware missing; see what you can do".

<u>Query (Q)</u> - "Constable Keath, what have found out from the dealers about those musical instruments?"

<u>Report from Subject (Rs)</u> - "Sgt. Pavey, Constable Hawkes is bringing in a suspect whose description fits one of your cases. Hawkes wants him for three jobs".

<u>Report from Detective (Rd)</u> "Salmer here sir, regarding this break at 12 Melrose Rd. I have a Mrs Cranston who saw a suspicious character hanging around during the afternoon. I'm bringing her down for an album check".

An example of message classification is shown in Fig. 5. Tables 7a-h show the counts of statement types for each day for each subject. Note that a message may comprise several statements. From this data, a measure, T, was computed, defined as follows:

$$T = \frac{Q + Rs}{C + Rd + Rs + Q}$$

T then is the ratio of the number of queries and reports from the subject to the total number of messages of all types.

Table 7 Message Composition a) Subject 1 b) Subject 2 c) Subject 3 d) Subject 4

(a)

DAY	Cs	Rs	Rd	Qs
1	48	12	29	12
2	43	2	28	5
3	49	0	26	17
4	40	1	29	10
5	36	1	35	9
6	35	5	26	11

(b)

DAY	Cs	Rs	Rd	Qs
1	37	8	20	12
2	27	1	32	10
3	26	6	29	11
4	32	1	36	13
5	26	2	29	8
6	27	6	19	6

(c)

DAY	Cs	Rs	Rd	Qs
1	30	4	18	3
2	27	0	23	7
3	20	2	22	1
4	20	2	15	4
5	22	2	15	4
6	26	6	16	7

(d)

DAY	Cs	Rs	Rd	Qs
1	28	9	22	5
2	20	0	23	8
3	23	1	27	11
4	19	1	22	4
5	9	0	16	9
6	19	9	20	2

Table 7 (Cont'd) e) Subject 6 f) Subject 7 g) Subject 5 h) Subject 8

(e)

DAY	C	Rs	Q	Rd
1	42	13	0	21
2	41	2	0	25
3	45	3	10	32
4	40	0	5	25
5	34	3	9	24
6	49	3	12	29

(f)

DAY	C	Rs	Q	Rd
1	38	5	15	31
2	24	5	9	24
3	25	3	12	18
4	37	6	8	29
5	19	2	4	14
6	31	2	7	25

(g)

DAY	Cs	Rs	Rd	Qs
1	34	9	27	25
2	20	2	21	6
3	19	10	28	10
4	18	5	18	4

(h)

DAY	Cs	Rs	Rd	Qs
1	40	3	31	18
2	39	3	27	1
3	37	4	27	16
4	30	5	20	9

Now if we suppose that in an ideal world the role of the subject is to issue commands and receive reports only, then the number of subject queries and reports gives some indication of how far the subject departed from that ideal. More accurately the ratio T gives the extent to which any subject modified the basic command-report communication pattern in order to achieve his goals. That is, the lower the value of T the less the subject modified the procedures and organisation of the given simulated CID force, and the higher the value, the more he modified these basic procedures.

The values obtained are shown below:

Table 8 T Measure for Subjects P_1 to P_8

	P_1	P_2	P_3	P_4	P_5	P_6	P_7	P_8
T	.16	.18	.18	.20	.25	.10	.19	.23

Finally, the number and accuracy of completed auxiliary task sheets were recorded. Histograms of numbers completed for all the subjects are shown in Fig. 12.

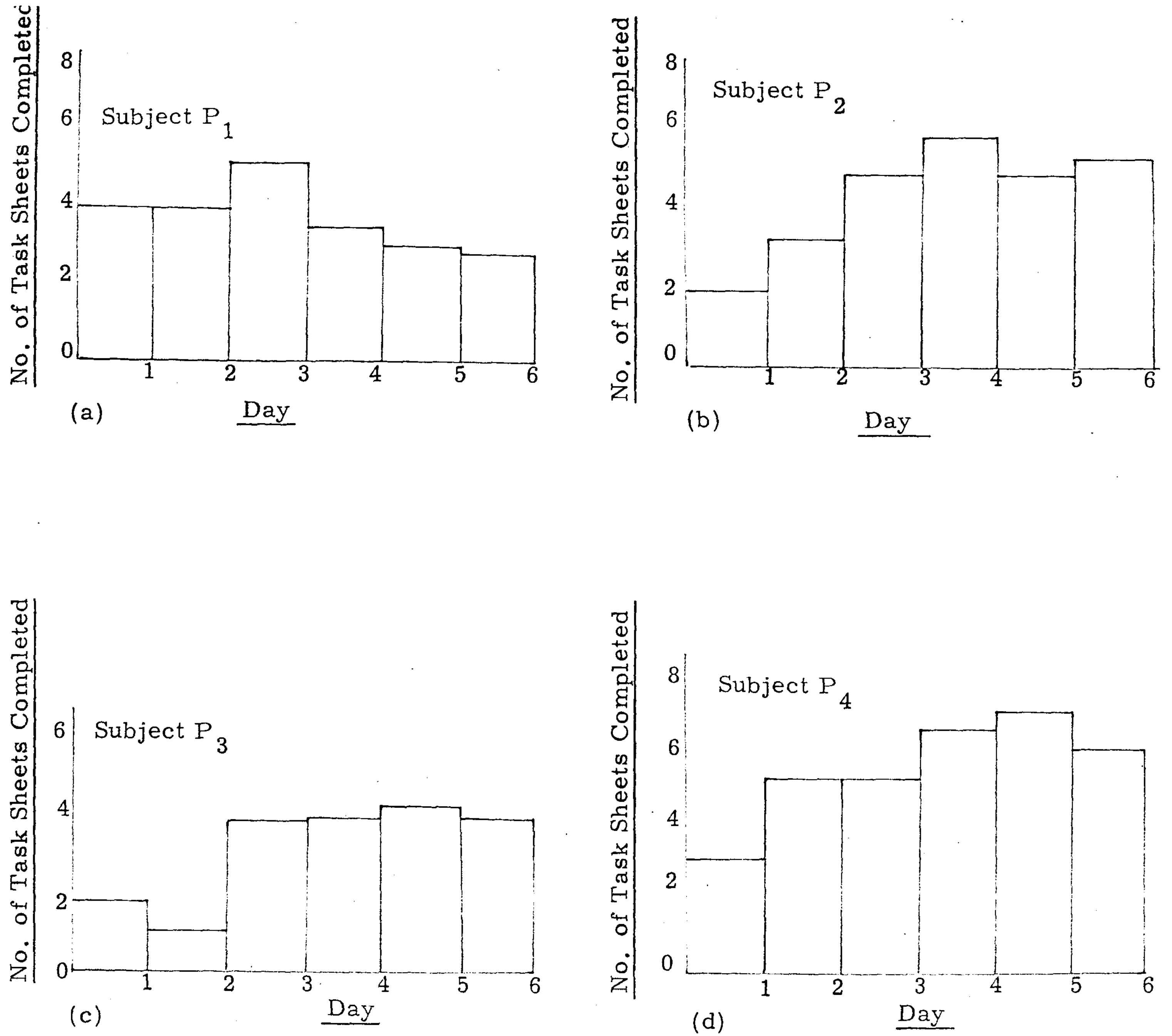


Fig. 6 Auxiliary Task Sheets Completed Per Day For Subjects (a) P_1, (b) P_2, (c) P_3, (d) P_4

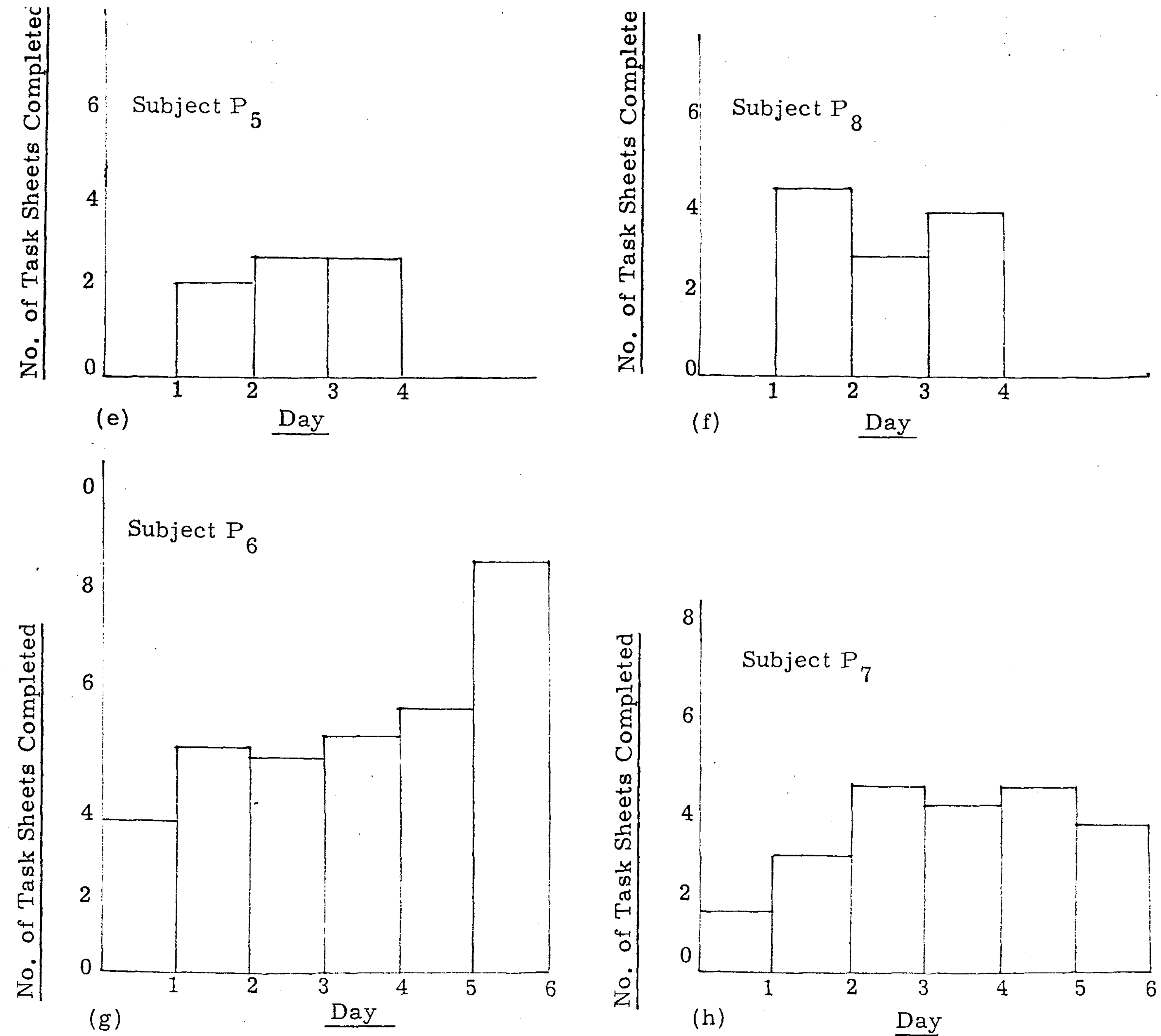


Fig. 6 Auxiliary Task Sheets Completed Per Day For Subjects (e) P_5, (f) P_8, (g) P_6, (h) P_7

4.4 Review of Results

4.4.1 General Conclusions

The most general conclusion from this pilot study was that the simulator provided a potentially useful environment for the study of organisational processes. Professional detectives acted as subjects in the experiments and, though initially all were uncomfortable in the laboratory situation, after acquiring some familiarity with the system, they were all engaged by the game-like attributes of the interaction and concluded that the system was usefully realistic and could have immediate pay-off as a training device. At this stage we did not probe in detail subject's attitudes to the system. The reason was that co-operation of forces with this type of work, and to scientific work generally in the Home Office, was being very carefully developed and so we had to avoid giving the impression of analysing and testing our subjects on their detection abilities, an impression which could very easily convince the subjects and the co-operating forces that there were ulterior motives of a performance assessment kind. We, therefore, emphasised informality, did not do a questionnaire study and generally encouraged the view that their co-operation was required to help develop a tool which would have clear pay-off for their own forces. Therefore, we cannot provide empirical evidence for the conclusion that subjects were highly motivated by the simulation beyond the qualitative assertion that, after familiarisation by running two of the simulated days, subjects became very involved in the exercise and 'off-duty' time would be spent discussing in a very personal way the merits and demerits of the various modelled detectives and criminals. In this way we, the experimenters, acquired some insight into the folklore and methods of real detective operations. It, thus, became clear that a simulation model provided useful common ground, a focussing device, for communication between the professional and the scientist. This is a point we shall return to in discussing the role of simulation in organisations.

Technically, the information system and the procedural rules and parameters representing the detectives worked well. The main problems in operating the system arose from the lack of familiarity of the operators with police jargon. That is, subjects liked to have short precise reports from the detectives and it took a short learning period for an operator to grasp the skill of associating several information cards in his hands to produce an acceptable report. However, operators soon became skilled in this and another problem arose, namely that operators began to identify with the detectives they were representing and sought to maximise their own performance occasionally by 'cheating', i.e. by using disallowed information. This did not happen often enough to affect the overall results and it was effectively prevented by exchanging operator's roles and by instituting a checking procedure by the controller prior to the delivery of a reply.

The feedback method of varying the information content of crimes to stabilise a detection rate measure worked but the difficulty of quantitative interpretation of the information content variable argued against its further use.

4.4.2 Detailed Conclusions

Three sorts of measure were obtained from the experiments. First there was the measure relating crime input rate, detection rate and crime information content; second there were measures on communication exchange between the subject and the operators and, third, performance on the auxiliary task measured.

The information content variable, S can be interpreted as an indication of how much crime information a subject needed to achieve a specified detection rate, i.e. as a measure of the 'god-given' assistance the subject required to achieve and maintain a defined performance level. Remembering that, because of the model detective information retrieval characteristics, not all detectives could detect every crime even if it had the highest information content, we can see that detection, especially of crimes in the lowest information content category, S_3, depends upon allocating an appropriate detective. The detection rates, for crimes in the different information content categories are shown in Table 9 below.

Table 9 Average Detection Rates for the Different Crime Information Categories

% of S1 category crimes detected	% of S2 category crimes detected	% of S3 category crimes detected
67	40	23

This supports the view that S3 crimes were in some sense more 'difficult' than S2 crimes which, in turn, were more 'difficult' than S1 crimes. Therefore, a subject who achieves a detection rate overall of 40% with a high S can be regarded as receiving less 'assistance' from the system than a subject who achieves the same detection rate with a low S. We have already seen that this performance measure supports the two loading hypotheses.

The protocol analysis measures, on the other hand, are not concerned directly with performance. Rather we were seeking information about the way the subject used the given organisational structure and whether he attempted to change it. The measure, R, for example, measured how much the subject concentrated on one detective. That is, whether he treated all detectives effectively alike or whether he tended to favour one. If the former, we could say that the subject was favouring a different organisational structure than if the latter obtained.

The measure T, as we have suggested, measured the degree to which subjects modified the routine command-report communication scheme by making queries of, and giving information to, the modelled detectives.

The relationship between R and T could, therefore, provide some clues about the organisation structure favoured by the subject. For example, if we find low values of R associated with low values of T, this would support the hypothesis that that subject favoured the given hierarchic mode of operation, i.e. he used his detectives only as agents for getting and supplying <u>him</u> with crime information. He would make all decisions about allocating detectives to crimes and which activities should be carried out. However, high values of R and T should indicate a tendency to a more polyarchic structure in which more information was shared and more authority for choosing activities was delegated to other detectives.

First the relationship between R and T is given in the table below:

Table 10: Measures R and T for all Subjects

	P_1	P_2	P_3	P_4	P_5	P_6	P_7	P_8
R	.03	.04	.06	.01	.10	.01	.03	.03
T	.16	.18	.18	.20	.25	.10	.19	.23

The computed product moment correlation between R and T is + 0.63.

Thus, we can say there is a tendency for subjects who do not discriminate amongst the detectives to stick more closely to the routine command-report form of communication and for those subjects who are more selective also to request and supply more information to his detective team. The picture which emerges, therefore, is that of a continuum of organisational structure ranging on the one hand, from an hierarchic, procedure oriented form in which communication is formal, consisting almost entirely of commands given and reports received by the subject and, on the other, a more flexible form or organisation, in which the subject was more forthcoming and open in his communication with his detectives. A detailed examination of the extreme examples of the continuum subjects, P_5 and P_6, revealed these different structures rather clearly.

Thus, P_6 was almost totally procedure dominated. His communication style with the simulated detectives was terse and unexpressive. He seemed quite happy to confine his responsibilities to an initial allocation of crimes to detectives and then to let things take their own course. By doing this, he was able to concentrate on the auxiliary paper work task where he achieved the very high score of 6.8 per day with an accuracy around 97%. Further, he tended to use a fixed repertoire of instructions. Thus, he automatically called for a dog-handler to visit the scenes of crimes in spite of the fact that the simulator didn't provide this facility (field studies had shown that this was ineffective for the types of break-in offences dealt with). Hence, we can conclude that there was no attempt to learn the characteristics of the force at his disposal, and to discriminate against the less effective detectives or to try to organise the force in a more effective manner.

In contrast, subject P_5, was characterised by the lowest number of paper work tasks completed and low accuracy (2.2 tasks per day with an accuracy of 79%). Examination of his message distributions showed a tendency to use detectives Brown and Hawkes, both good detectives according to their retrieval characteristics. The following is a message to Hawkes taken from Day 3 of his experiment:

"Prior has been identified on prints evidence on both cases 27 and 28. Sort him out, will you? Dixon has been identified on prints for case 21. Now Salmer has been told to have a go at Dixon with reference to cases 3 and 4. Will you tie up with Salmer on these three cases?"

"Did you go to case 18? (Yes, but I passed it over to Pavey) O.K. but Teegan's prints have been turned up for this. I think Brown has some identification from the photo albums. Will you sort this out for me and tie it up with Brown and Pavey?"

The following is a message to Brown, also from Day 3:

"Reference case 19. Shorehaven police have a vagrant. Who shall we send? (Send a patrol car) Yes, O.K."

From these, we can see that P_5 has tried to off load some of his information processing and decision making duties on to these two detectives and because of the characteristics of the detectives chosen this is an effective procedure.

A comparison of the main external performance measure, S, for subjects P_5 and P_6 (S for P_5 = 1.0 and for P_6 S = 2.0, see Table 4) shows that P_5 was more effective, i.e. was dealing, on average, with more difficult crimes. (Note this comparison is not strictly legitimate since P_5 and P_6 were in different cells of the experimental design, i.e. P_6 was controlled at 70% detection rate with an input of 10 crimes per day and P_5 was controlled at 40% detection rate with an input of 15 crimes per day.)

4.5 Summary and Discussion

A simulation model of a small CID unit was designed and set up in the laboratory. The structure and data for the model were based on field studies carried out with a variety of Police forces. The model allowed a subject, in these experiments a professional CID officer, to command the detective team. The resulting organisation had to process a sequence of realistic crime complaints and by allocating detectives to various allowed activities to arrive at a suspect name. If a detective with 'good interrogation' characteristic was allocated to interrogate the suspect <u>and</u> if the suspect actually had committed the crime, then the crime was detected. The types of crime dealt with were break-ins to homes, shops, offices and commercial premises with low value of stolen property.

Pilot experiments were carried out with eight subjects and an experimental regime tried in which the information content of crimes was varied by a defined control rule in order to fix an observed measure, detection rate, at a defined level. The indirect performance measure was, therefore, the average information content of the crimes dealt with by the subject. This measure could only be defined on an ordinal scale. Each experiment lasted two real days, each day containing up to three simulated days. As well as carrying out the command role in the CID force, each subject had to carry out a series of auxiliary paper work tasks. The numbers completed and accuracy of these was measured. Also all verbal communication was recorded both by tape recorder and on detective log sheets. (See Appendix I for complete physical and operating details.)

Three types of performance measure were taken from the results analysis.

The first of these was the control variable 'information content of crimes' and can be interpreted as a measure of the amount of 'assistance' needed by the subject in order to achieve the defined detection rate. Using this measure, two hypotheses concerning the effects of loading were confirmed. These were: (1) For a constant input crime rate higher input crime rates will be associated with higher values of the crime information content variable.

The second type of measure was derived from an analysis of the verbal communication between subject and simulator. Two measures were examined, R, a measure of the tendency of the subject to communicate selectively with his detectives and, T, a measure of the tendency of the subject to extract and disseminate information over and above the routine command-report procedures 'programmed' into the simulator. It was found that R and T were positive correlated ($r = 0.63$) and seem to provide a measure of the type of organisation (or management style) set up by the subject. Two extreme types of organisation were identified, one was procedure oriented hierarchic and relatively ineffective; the other more flexible in willingness to delegate and to ask advice of his better detectives. This less authoritarian, more delegation conscious form was more effective.

The third type of measure was the number and accuracy of auxiliary paper work tasks carried out. This measure was found to substantiate the organisation types defined above. The procedure oriented hierarchic mode paid more attention to and, therefore, did more tasks accurately than did the delegation oriented mode, lending substance to the belief that sticking strictly to set procedures and secondary but obligatory tasks is not the most effective style of organisation for crime detection.

Overall, the pilot study showed that simulating an organisation was a useful way of studying decision making and information processing behaviour. Not only was the simulated situation a rich source for theoretical studies of different organisation structures and management strategies but it also had clear potential as a training system and also as an operational tool for evaluating alternative system configurations.

Subsequent development of the project concentrated on the system evaluation potential of the simulator because this subject promised most fruitful pay off to the aims of the Scientific Branch of the Home Office. It therefore has not been possible to develop further either the theoretical uses or the training uses.

Chapter 5

SIMPOL II - Experiment to test the effects of Local Intelligence Collation

5.1 Extensions to the basic model: SIMPOL II

During the 1960's and beginning in Lancashire, a new form of beat patrolling was introduced in police operations. The necessity for new methods arose from the combination of rising crime figures and decreasing man power. There was also a feeling that, at least, in urban areas police-public relations were deteriorating.

The new system combined several innovations to form a new policing strategy. From the public's viewpoint the most noticeable effect was the introduction of small, light blue and white patrol cars, the so-called 'panda patrols'. This was a manifestation of the new Unit Beat Policing system in which each Police divisional district was divided up into a number of Unit Beats, typically a division would have 6 -10 Unit Beats. Each Unit Beat was divided into two areas and each area had a resident area constable. The main function of the area constable was to get to know and be known by the people in his area and to try to build up the dependable, humane, helpful image of the 'village bobby'. Each unit beat was patrolled by one panda patrol, part of whose job was to maintain a visible presence and also to liaise between the two area constables in a unit and the police station. Further in many forces, CID operations were rearranged so that a detective constable would deal in the main with one unit.

Area Constables thus operated away from the main police station and communication was maintained via vhf radios and the panda patrols.

Another innovation associated with the Unit Beat Policing (UBP) system was local intelligence collation. The main objective of this facility was to provide organised, easily accessible, current information on known criminals living in the area. Thus area constables, panda patrols and other officers report relevant information and sightings to the collator who files them. As well as filing this incoming intelligence data, the collator also circulates a daily record bulletin to CID and uniformed branch members. This bulletin contained selected important intelligence items, which were relevant to current patterns of crime or possible future crimes.

The SIMPOL system was modified to include the collator facility and a series of experiments was designed to provide answers to the following questions:-

1) What sort of criminal intelligence should a collator seek?
2) How should the collator work?

The main modification to the SIMPOL I model required in order to attempt to answer these questions was the addition of simulated local intelligence gathering and collating facilities. These were based on conventional unit beat policing methods and usual collator operating principles, i.e. a system of area constables, who report intelligence to a collator, who keeps a daily record of incoming data and updates cross indexed files from the daily record entries.

The addition of this intelligence collating facility to the model police system necessitated the corresponding addition of criminal intelligence to the model information system. Whereas SIMPOL I criminals existed as rather sketchy characters, for SIMPOL II it was necessary to have detailed accounts of active criminals' behaviour during the simulated period. Codified versions of these criminal-behaviour scripts then formed the main data base from which crime information was generated.

The next section contains a description of the experimental design adopted and this is followed by a detailed description of the modified information system and associated operating techniques.

5.2 Experimental Design

In the last section we distinguished two parts of the intelligence system, a part concerned with information gathering, (the UBP system) and a part concerned with storage, cross-indexing and disemination for use in the overall police system (the collator system).

Our objectives can be defined in terms of these two parts as follows:-

1) What is the effect on system performance of changing the characteristics of the information gathering subsystems so changing the properties of the information flowing to the collator?
2) What is the effect on system performance of changing collator operating characteristics?

In determining the experiments to be carried out, we regarded the information gathering subsystem as analogous to the detective model used in the main CID systems. Thus, it has a time parameter, determining the delay between the observation of an event and the moment at which it is reported to the collator and a quantity parameter determining how many separate items of information are retrieved.

Two values of each of these parameters were selected as settings at which to measure the system's performance. These were, 1) Short delay, where the delay between observing and reporting was not greater than one day. 2) Long delay, where the delay was not greater than $1\frac{1}{2}$ days. 3) Small quantity, where retrieval characteristics were set to result between 11 and 13 (mean 12) reports per day. 4) Large quantity, where retrieval characteristics were set to result in between 23 and 25 (mean 24) reports per day.

Two extremes, almost parodies, of collator operating methods were designed. Any real collator system would fall somewhere between the chosen extremes. We felt that, rather than simulate an existing real set up and then introduce variation, we could get more useful data by modelling an ideal and comparing this with something known to be far from ideal. Hopefully, this approach results in upper and lower performance limits within which we would expect real system performance to occur. There were designated active and passive collators respectively. Active corresponds to an ideal in which the collator knows what information CID is seeking, and actively tries to get relevant data from his system to help the CID. Passive corresponds to the situation in which the collator acts mainly as a storage system and has to be interrogated by the CID on specific matters to elicit immediately relevant data.

The complete experimental plan was the eight cell design shown in Table 11 below.

Table 11 SIMPOL II Experimental Design

	Fixed Quantity		Fixed Delay	
	Short Delay	Long Delay	Small Quantity	Large Quantity
Active Collator	3	3	3	3
Passive Collator	3	3	3	3

The number in each cell specifies the number of experiments to be carried out in that condition. Each experiment consisted of six simulated days. The first three days were run without the intelligence/collator system and the last three days with it.

The reasons for this were:-

1) To provide comparative data on the effect of introducing the intelligence/collator system,

and,

2) To allow the operator to fix the difficulty level of input crimes to produce a realistic stable basic detection rate for each subject.

The intention of this method was to introduce the intelligence/collator system to a stabilised situation (stabilised in the sense that the subject was dealing with a constant difficulty situation), so that performance changes, measured after the introduction, could be attributed to the system's change and <u>not</u> to any underlying long term trends. Experiments with SIMPOL I showed that using a simple control rule, stabilisation was usually achieved after 2 simulated days and, therefore, we specified a 3 day stabilisation period to allow for a check on the stability condition.

The hypotheses to be tested by this experimental design were as follows (taking detection rate to be a good measure of system performance):-

1) Detection rate with intelligence/collator system $>$ detection without intelligence/collator system.

2) Detection rate with an active collator system $>$ detection rate with a passive collator system.

3) Detection rate with short delay and active collator $>$ detection rate with a long delay and active collator.

4) Detection rate with short delay and active collator $>$ detection rate with short delay and passive collator.

5) Detection rate with short delay and passive collator $>$ detection rate with long delay and passive collator.

6) Detection rate with long delay and active collator $>$ detection rate with long delay and passive collator.

7) Detection rate with large quantity and active collator $>$ detection rate with small quantity and passive collator.

8) Detection rate with small quantity and active collator $>$ detection rate with small quantity and passive collator.

9) Detection rate with large quantity and active collator $>$ detection rate with large quantity and passive collator.

10) Detection rate with large quantity and passive collator $>$ detection rate with small quantity and passive collator.

Both civilian and police subjects were to be used in the experiments and so a further hypothesis was that for any experimental condition, police subjects should show a higher benefit from intelligence information than civilian subjects because, by hypothesis, a policeman should know how to use it.

5.3 The Information System

The information system of SIMPOL II consists of two parts:-

1) The Crime Information data base, which contains all the information directly associated with the crimes or the scenes of the crimes,
2) The Criminal Information data base, which contains all the information in the simulation about the active criminal population.

This information system differs from the SIMPOL I system mainly in the addition of the Criminal Information data base, which provides realistic intelligence information suitable as input to the collator system.

5.3.1 The Crime Information Data Base

The Crime Information Data base of SIMPOL II has the same basic structure as the Crime Data base of SIMPOL I, with the addition of three more crime information categories.

Seven categories of information were sufficient to define a crime within the context of SIMPOL II. These were:-

1) General scene of crime information.
2) Detailed scene of crime information (usually) only available to a specialised scenes of crime officer).
3) Loser information.
4) Local enquiries information.
5) Uniformed branch information.
6) Witness information.
7) Fortuitous information.

The Crime Data base for SIMPOL II was built up in the following manner:-

a) The crimes were "Breaking Offences', as in SIMPOL I, (house and shopbreaking, burglary, petty theft, larceny from vehicles etc.)

b) A population of 50 typical criminals, with records involving 'breaking offences', was generated.

c) 20 of these criminals were chosen to be criminally active during the 6 day simulated period.

d) A time and place distribution was selected for the offences committed by each active criminal to ensure that an even but unpredictable spread of 'breaking type' offences would be reported throughout the simulated period.

The resulting Crime Input Programme consisted of 65 crimes.

The activity of each one of the 20 active criminals during the 6 day simulation period was completely specified by a script. Clearly, the script was constrained (largely determined) by the time and place of offences, as specified by the Crime Input programme. Detailed crime descriptions were written on crime cards by going through the seven categories of information listed above and generating entries under each category heading. This procedure yielded 65 <u>sets</u> of cards (one set for each crime, one card for each crime information category). In addition, summary information (used in the systems accessing routines) was put on each card. This information was crime number, loser's name and address, property stolen and its value. Figure 10 in Appendix 1 shows a typical crime information card.

5.3.2 The Criminal Information Data Base

1) Historical (or Static) Criminal Information

This is the information about criminals, which, in real life, exists in the Records Office of the Police Force. It mostly consists in 'defining characteristics' for the criminal concerned (name, age, marital statue, home address, type and place of work, vehicle owned, if any, criminal record, photographs, fingerprints and modus operandi). This information is called 'historical' because it is embedded in the police system and normally is only as up to date as the last conviction.

2) Intelligence Information

This is information about the current activities of a criminal (places the criminal has recently frequented, sightings of the criminal in the police district, information concerning recent changes of home address, or job, etc., current associates and any other information concerning his recent activities).

The chief difference between SIMPOL I and SIMPOL II is that the former system had very little intelligence information. It was not designed to simulate a close interaction between the police and the criminal population, so it had no intelligence gathering/ collating facility. In contrast, SIMPOL II does have a collator facility and is designed to simulate close interaction. As a result, its data base contains a great deal of Intelligence Information in addition to the Static material.

5.3.3 Construction of Intelligence Information Data Base

The Intelligence Information data base was generated from the scripts described in Section 5.3.1. It was necessary to encode this information in a format that could be accessed:-

1) By specific geographical areas (or by specific area constables, panda patrols in the area, etc.).

2) In time sequence.

3) With respect to the criminal and the activity the information refers to.

4) In such a way that either all the information could be made available or only part (having certain characteristics).

To achieve this objective, the intelligence information was written on 5 x 3 cards of the sort normally used in the system. One card is assigned to each activity and one to each hourly time interval in the simulation. Thus, if an activity lasts for longer than an hour, its information is encoded on two or more separate cards.

The cards were sorted (with their time sequential order retained) into those referring to a particular geographical area of which there are 8. Any one ordered collection of cards is called an Area File. A block diagram of the process is shown in Fig 7. Each card in an Area File has the following reference data:-

For Active Criminals

Prepare detailed behaviour scripts for each active criminal

↓

Code activities in scripts on to cards for each criminal

↓

Sequence all cards to make total criminal behaviour data base

↓

Write a Daily Record Sheet Entry slip for each observable activity

↓

Assemble these in time sequence for each simulated day

For Inactive Criminals

Prepare outline behaviour scripts for each inactive criminal

↓

Select proportion of observable activities and write associated "noise" Daily Record Entry Slips

↓

Assemble these in time sequence for each simulated day

Fig 7 Block Diagram of Intelligence Information Generation Process

1) Number stating sequential position in the Area File.

2) One or more numbers representing the criminals involved in the activity.

3) A 'Suspiciousness' value (1 - 6), to be described in the next Section.

4) An 'Observability' value (1 - 4), to be described in the next Section.

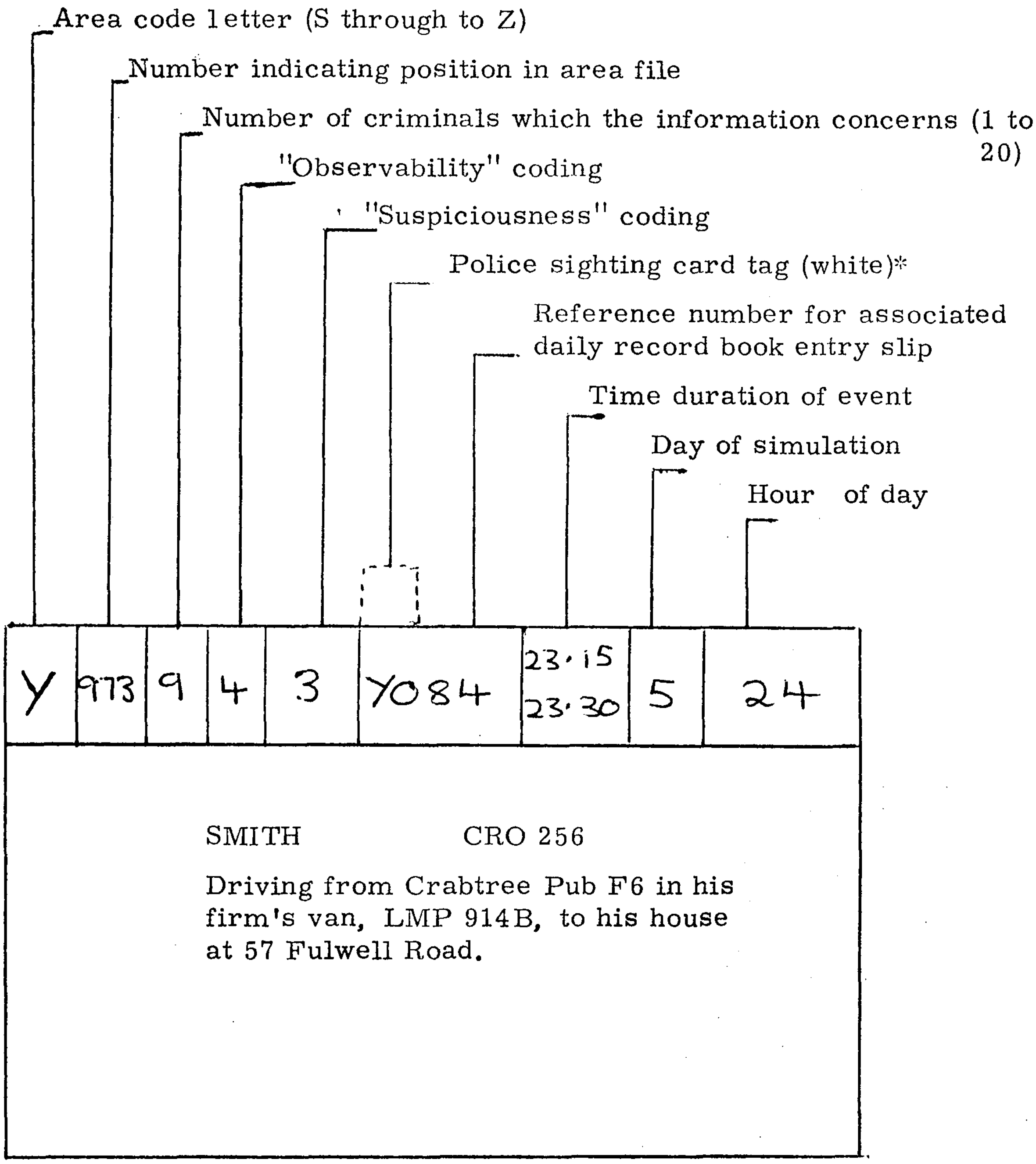
5) The time and the duration of the activity.

Cards containing information which could form the basis of a collator report were tagged with a white marker so that they could be withdrawn easily. For each tagged card, a collator report of the information contained on the card was written on a slip of paper. Each collator report had a code number put on it to associate it with its data base card. These collator report slips were arranged sequentially to form the Collator Reports File. A typical Intelligence Information data base card is presented in Fig 8.

5.3.4 'Observability' and 'Suspiciousness'

Two features of an activity were distinguished:-

1) How observable is the activity to the police? A scale from 1 - 6 was chosen. Observability was defined as: 1 for activities taking place outside Alderton; 2 for activities in places not normally visited by police, e.g. in a private



*White tags are attached to police sighting cards to make them easily recognizable in the data base. The area constables only get information on these cards. Also, only these cards and noise cards have daily record book reference numbers.

Fig 8 A Typical Example of an Intelligence Information Data Base Card house or a cinema; 3 and 4 for activities indulged in by a criminal in a part of town he did not normally frequent; 5 and 6 for activities occurring in areas where the criminal was known.

2) How suspicious is the activity to the police? A scale from 1 - 4 was chosen. Suspiciousness was defined as 1 for normal activities of non-criminals; 2 for an activity by a criminal which did not allow his next activity to be committing crime, e.g. sleeping; 3 for an activity which allowed a criminal's next activity to be committing a crime; 4 for two criminals together, or for any other highly suspicious activity.

5.3.5 Noise Information

As so far described, the criminal intelligence information data base contained only information about the active criminals in the simulation. To allow non biassed daily record sheets to be produced, some criminal intelligence concerning the activities of 30 inactive criminals was included.

For each of the 30 inactive criminals, an outline script of his activities during the simulated period was written; these scripts were examined and a proportion of the observable activities were associated with collator reports. These 'noise' collator reports were filed in sequence to form a separate collator file, called the 'Noise Report' file (see Fig 7).

5.4 The Operating System

5.4.1 Development of the Operating System

As originally planned, the simulator was to be operated using the system developed in SIMPOL I. This system used four operators; an overall controller and three operators, representing the simulated detective team and force facilities. For SIMPOL II, it was envisaged that another operator would be required to work the collator facility.

The first three simulation runs in the present experimental series used this system. However, it became apparent that this method of operation had some disadvantages:-

1) Five operating staff would be expensive over a series of 24 simulation runs.

2) There were communication difficulties between the operators, particularly when two detectives, represented by different operators, were instructed to co-operate on a number of crime investigations.

This last disadvantage would probably have disappeared as the operators became more skilled. The first disadvantage was more serious.

It was decided to modify the operating system so that it could be run by two operators.

The modified operating system worked as follows. One operator represented the six primary detectives of the CID team. This operator carried out the phasing and controlling of his detective's activities and all their reporting. He did not rely on the overall controller, as in the original system, to do this for him. This meant that he was largely a self-contained unit (thus avoiding communication problems). The second operator represented the collator and the other departments of the police force. He also set the system up before each simulation period and took charge of all data recording during a run.

The new system of operation was aided by the introduction of detective activity logs. These logs enabled the operators to conrol and phase the activities and reporting of their detectives. Fig 9 shows a partly completed activity log.

An instruction from the subject to a detective is marked in abbreviated form on the detective's log sheet opposite the time on the log corresponding to the simulated time at which the instruction is received. The operator computes the time required by the detective to carry out the instruction (by referring to the detective's parameters) and marks a vertical line, corresponding in length to this time, extending downwards on the log from the time of the instruction. An abbreviated form of the detective's report on carrying out the instruction is marked on the log next to the end of this line.

DETECTIVE. BROWN DAY. 3		DETECTIVE. SALMER DAY. 3.	
0900	« Att. 21 »	0900	
20	L + G	20	« Att. 22 »
40	Report L+G. « Att. 23 » ALSO	40	L + G
1000	(Do L.G. 21 23) L+G	1000	
20	Report L+G 23	20	Report L+G (Do L.E's)
40	L.E. on 21 + 23	40	
1100		1100	L.E's
20	Report L.E's 21 + 23	20	
40	(Trace T.V. van)	40	Report L.E's. (Check Records office
1200		1200	Re. Lt. Coloured Ford Consul)
20	Report Van is T.V. Rentals Ltd.	20	
40		40	Report 3 villains with Consuls.
1300		1300	
20		20	
40		40	
1400		1400	
20		20	
40		40	
1500		1500	
20		20	
40		40	

Fig. 9. Two partly completed detective activity log sheets.

To phase delivery of detective reports to the subject, the operator scanned all of the detective activity logs and delivered the one due. This arrangement allowed the operator to anticipate his loading.

5.4.2 The Final Operating System

As the operators became familiar with the information in the crime information data base, it became possible for one operator to carry out the functions of both the operators described in Section 5.4.1. 14 of the 24 simulation runs were controlled by a single operator.

5.4.3 The Collator Operating System

The collator daily record sheets for the simulation are generated from the criminal intelligence information data base, via the collator reports file. The data base is coded to allow precise selection of the type of entries appearing in the collator's daily record sheet. It was originally intended that the 8 area constables in Alderton would be given separate information retrieval and reporting characteristics and that the simulation runs would assess the effects of these different characteristics on performance. However, on running pilot experiments incorporating the collator, we realised that a prohibitively large series of experiments would be required to get results sensitive enough to detect differences between different conditions. It was evident that only gross changes in area constables characteristics could be examined in a series of 24 experiments.

5.4.4 Preparation of Daily Record Sheets

The procedure of preparing the daily record sheet is shown in the flow chart in Fig 10. The daily record sheet is prepared in the rest period between each simulated day. The correct parameter for the experimental conditions being used is selected. This fixes the time section of the collator's report file and the noise report file from which slips are to be selected to make up the daily record sheet. The quantity parameter is then selected according to the experimental conditions. Next, the correct ratio of noise reports to useful reports is determined. This is done by referring to the ratio of active to inactive criminals left in the simulation. For example, by day 4, if five active criminals have been caught, this proportion is 15/30. In this case, twice as many daily record entries referring to inactive criminals as to active criminals are required. Having got this ratio, it is used to compute how many slips must be extracted at random from the correct time section of the collator reports file, rejecting those referring to apprehended criminals, until the required number is obtained. The remaining slips required to meet the quantity condition are extracted, at random, from the correct time section of the noise reports file. All the selected slips are then arranged on a page format and copied. The resulting daily record sheets are numbered and stapled together. Two copies of the daily record sheets are made. At 10.00 simulated time, one copy is given to the subject and the other is made available to the simulated police force.

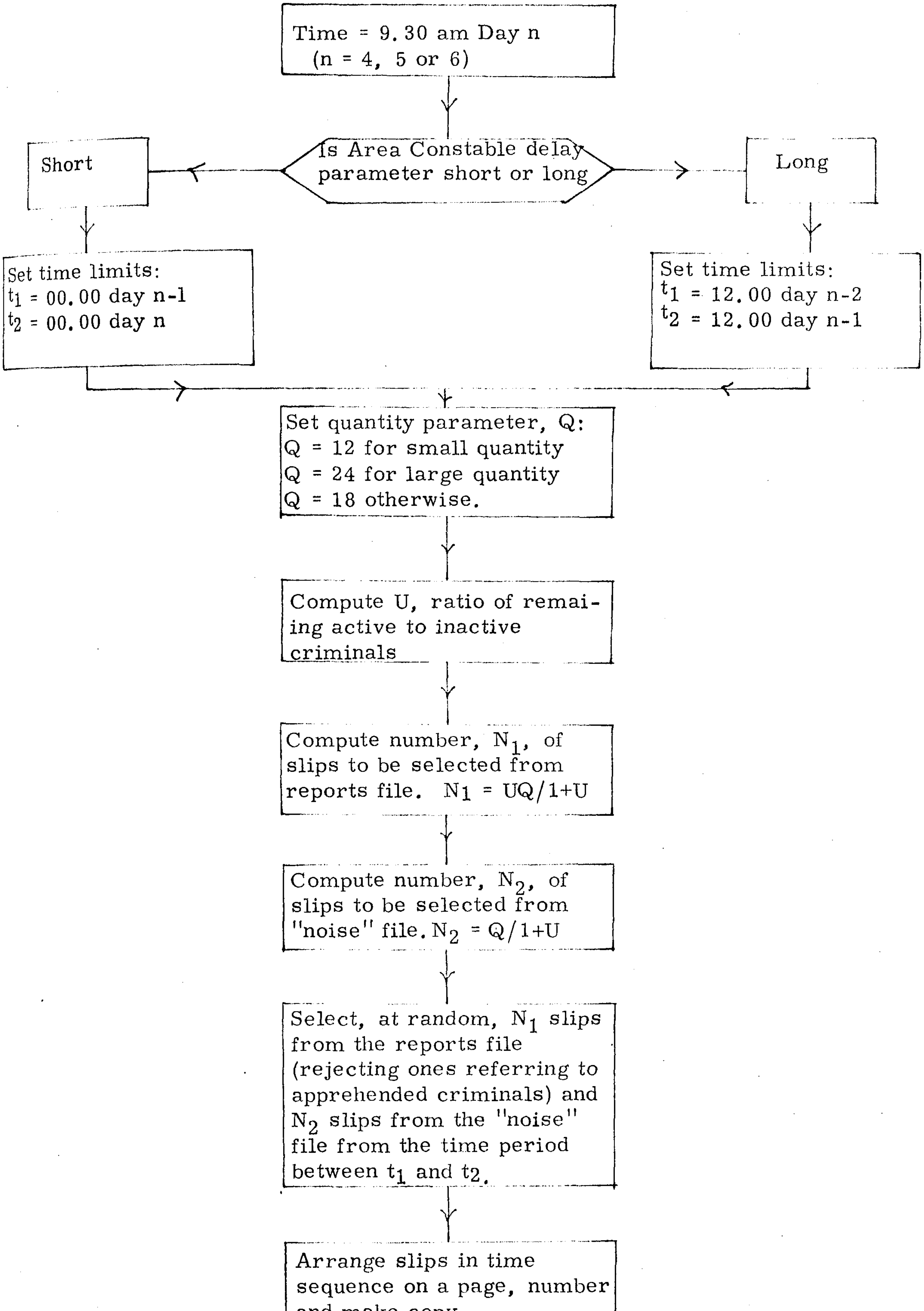


Fig 10 System for Generating Daily Record Entries

5.4.5 Summary of the Simulated Collator's Function

1. He collates all local intelligence information and produces a daily record sheet at 10.00 a.m. each 'day'; recording items of information reported to him since his last daily record sheet.

2. He maintains files of information relating to the criminals, the population and the area of Alderton. He updates these files with the incoming information.

3. He supplies information from his files in reply to queries from other departments of the police, including the CID.

   The three functions above are carried out in all experimental conditions (active or passive collator).

   The passive collator performs <u>only</u> these functions.

   The active collator has a fourth function -

4. He monitors crime investigations in order to provide the CID with information which might contribute to a successful outcome.

Whilst acting in the passive mode, the collator does not offer information unless he is prompted by the subject (or the subject via his detective). He does, however, answer queries when asked.

In contrast, the active collator offers unprompted information. This consists in calling the attention of the CID to a particular item of current intelligence information on the daily record sheets, or in offering background information from his files. Of course, the active collator also answers queries.

5.4.6 Performance Stabilisation

Since the subjects in this series of experiments ranged from civilians unfamiliar with police procedures to very expert policemen, it was necessary to adjust the apparent difficulty of the system to match the capabilities of each subject. This avoids the situation, which could arise with a fixed difficulty set up, in which an expert policeman might become bored by situations which are too simple for him, whereas the same situations could prove too difficult for the unskilled man.

The technique which was used in the SIMPOL I system, withheld varying amounts of crime information according to subject's performance, measured by detection rate. Simulation time was split up into a number of sampling periods. The difficulty of all crimes, measured in terms of the amount of information potentially available, input during a sampling period was constant. Re-adjustment was carried out at the end of a sampling period.

Though this method worked for the narrow samples of subjects used in these first experiments (they were all Detective Inspectors or Detective Sergeants, in transition to D.I.), it had the disadvantage that, periodically, the structure of the problems being presented to the subject was radically changed. Over a long period this could prevent the subject from learning to perform the task effectively but, in the short term, it had the desired effect.

Considering the wider range of subject ability to be used in the SIMPOL II system, it was evident that the control mechanism used previously would have to operate in its extreme settings rather too often. For example, good senior detectives would be dealing with a system which yielded a tiny proportion of local enquiry information, most of which would be useless. Conversely, inexperienced civilians would get a large proportion of very useful information. In these extreme conditions, the system is unrealistic. Therefore, it was decided to modify the control principle for SIMPOL II.

This principle was based on the assumption that, for any subject, there should be three categories of crime -

1. Easy
2. Routine
3. Difficult

Which category a particular crime comes in depends on what the subject can do about it, as well as how much information about the crime is potentially available. The control rule was then modified to ensure that the proportions of crimes in each category was roughly the same for all subjects. The operator did this by keeping a count of crimes which were either very easy or very difficult and keeping these within the limits by allowing or withholding data on particular crimes.

5.5 The Experiments

The experiments were run, according to the design of Section 5.2, from September, 1968 - January, 1969. Individual experiments and subjects are identified by numbers 1-24. 14 of the subjects were policemen, varying in rank from Detective Sergeant to Detective Chief Superintendent; these are numbered 3, 4, 8, 9, 11, 12, 13, 16, 17, 18, 20, 21, 22, 24, respectively. 10 subjects were civilian scientists from the Home Office Research and Development Branch. These are numbered 1, 2, 5, 6, 7, 10, 14, 15, 19 and 23. Table 12 shows the assignment of subjects to the cells of the design. By mistake, an extra subject, 5, was run in cell 1 instead of cell 4.

Table 12 Allocation of Subjects in SIMPOL II Experimental Design

	Short Delay	Long Delay	Small Quantity	Large Quantity
Passive Collator	Subjects 2, 3, 4, 5 Cell 1	Subjects 1, 9, 10 Cell 2	Subjects 14, 17, 24 Cell 5	Subjects 16, 19, 22 Cell 6
Active Collator	Subjects 7, 11, 12 Cell 3	Subjects 6, 8 Cell 4	Subjects 13, 21, 23 Cell 7	Subjects 15, 18, 20 Cell 8

A few days prior to his experiment, each subject was issued with briefing data describing the system and his role, and containing a list of villains known to the Alderton police system.

Each experiment lasted 2 real days, 3 simulated days being presented in each real day. The first 3 simulated days of each experiment were run without the intelligence/collator system. This system was introduced between simulated days 3 and 4 in the mode specified by the experimental design of Section 5.2

As well as the main work of detecting crimes, each subject was asked to do as much of the auxiliary task as he could. This task consisted of crossing out selected letters in a random sequence as in SIMPOL I.

As in SIMPOL I, all conversations between subject and operating system were tape recorded. This provided a complete record of each experiment and formed the main source of data for subsequent analysis. Records were made (1) of individual detective activity on the detective logs, (2) of the crime input pattern and of whether or not the crimes were detected, (3) of collator activity logs and copies of the daily record sheets, and, (4) of the number of auxiliary task sheets completed. Finally, the complaint sheets given to the subjects - and on which the subjects made notes about the progress of an investigation - were retained.

5.6 Results and Analysis

5.6.1 Measures Used

The following quantities were measured for each subject:

1. Average detection rate over the 6 day simulation experiment.
2. Average detection rate over first 3 days of each simulation experiment (i.e. without collator detection rate).
3. Average detection rate over last 3 days of each simulation experiment (i.e. with collator detection rate).
4. Percentage of crimes solved with explicit collator assistance (i.e. collator assisted detection rate).
5. Average number of man hours expended per crime input during first 3 days.
6. Average number of man hours expended per crime input during second 3 days.
7. Average number of man hours expended per solved crime input during first 3 days.
8. Average number of man hours expended per solved crime input during last 3 days.
9. Average number of man hours expended per unsolved crime input during first 3 days.
10. Average number of man hours expended per unsolved crime input during last 3 days.
11. Average number of man hours expended per collator assisted solved crime.
12. Percentage of man hours expended on criminal information leads during first 3 days.
13. Percentage of man hours expended on criminal information leads during last 3 days.
14. Percentage of crimes solved using criminal information leads during first 3 days.

15. Percentage of crimes solved using criminal information leads during last 3 days.

16. Average number of suspects generated per crime during first 3 days.

17. Average number of suspects generated per crime during last 3 days.

18. Percentage of suspects generated from criminal information leads during first 3 days.

19. Percentage of suspects generated from criminal information leads during last 3 days.

20. Ratio of number of messages initiated by subject to total number of messages during first 3 days.

21. Ratio of number of messages initiated by subject to total number of messages during last 3 days.

22. Total number of messages during first 3 days.

23. Total number of messages during last 3 days.

24. Average number of collator slips per day during last 3 days.

25. Percentage of collator slips mentioned by subject per day during first 3 days.

26. Percentage of collator slips mentioned by subject per day during last 3 days.

27. Percentage of collator slips which were fruitful.

These measures were defined as follows -
Detection rate for period t was defined as the ratio of the number of crimes input during t, which were cleared up to the total number of crimes input during t.

Collator assisted detection rate was defined as the ratio of the number of crimes cleared up through following a lead initiated from the collator to the total number of crimes input.

Man hours per crime was defined as the number of detective hours spent specifically upon that crime.

Criminal information leads were defined as leads stemming from the criminal data base or records office.

A suspect was defined as any person whose name was generated as a possible culprit and who was questioned.

A fruitful collator (daily record entry) slip was defined as a slip which initiated a successful line of enquiry i.e. it led to the solution of the crime.

The values of each of the 27 measures for each of the 24 subjects are shown in Table 13.

5.6.2 Subject Classes

44 different subject classes were distinguished. These are shown with the subjects assigned to each class in Table 14.

Table 13 SIMPOL II Performance Matrix

MEASURE \ SUBJECT	1	2	3	4	5	6	7	8
1	60	59	67	67	82	82	48	78
2	51	48	58	61	79	80	43	68.5
3	72	74	79	77	87	84	52	86.5
4	5	37	16	7.7	27	16	26	27.2
5	3.5	5.3	5.4	7.2	5.1	6.5	4.8	5.9
6	4.8	4.0	5.2	5.1	5.5	6.0	3.9	5.75
7	4.1	5.9	6.7	9.2	5.8	7.8	6.3	6.8
8	5.0	4.4	5.6	5.6	5.9	5.2	5.0	5.6
9	3.0	4.8	3.6	4.85	2.5	3.5	3.6	3.2
10	3.6	2.6	3.1	1.0	3.0	4.0	2.95	3.9
11	6.0	3.4	6.1	3.5	4.5	6.1	5.9	3.5
12	0	0	0	5.1	2.4	0	0	12
13	6	13.2	16	26.4	8.4	10.4	15.5	11.4
14	0	0	0	0	0	0	0	0
15	6.0	41	16	7.7	27	16	26	27.2
16	.45	.68	.92	.96	.71	1.25	.57	1.22
17	1.0	.65	1.21	1.1	.93	.72	.44	1.18
18	0	0	0	9.1	5.9	0	0	21.8
19	28	36	52	43	21.4	27.8	40	23
20	.52	.20	.50	.42	.29	.34	.48	.5
21	.50	.24	.43	.31	.39	.52	.47	.6
22	87	91	123	106	93	122	73	112
23	81	46	90	67	74	106	92	109
24	12	23.5	14.3	15.5	14.6	19.3	16	16
25	16	9.5	35.6	31	15.3	7.3	20	29
26	13	6.5	28	19	13	1.6	6	22
27	10	3.5	1.6	2.5	2.3	5.3	13	16

Table 13 cont.

SUBJECT / MEASURE	9	10	11	12	13	14	15	16
1	64.5	84	75	90.5	54	69	57	61.5
2	63.5	74	67	82	39	64	48	55
3	65.5	94	84	100	71	75	66	68
4	13	5.5	31.5	60	38	15	33	27
5	5.9	7.3	4.6	6.1	5.9	5.3	4.5	5.1
6	5.0	7.0	6.6	6.0	5.6	5.6	5.1	6.0
7	7.0	8.4	6.2	6.6	8.6	6.6	6.7	6.4
8	5.7	6.8	6.5	6.0	5.2	5.5	5.0	6.4
9	3.1	3.8	3.0	4.0	4.2	3.1	2.5	3.4
10	3.8	5.8	7.0	3.75	5.8	4.6	5.5	5.0
11	9.3	0	6.5	5.5	6.0	2.5	3.1	7.4
12	6.1	3.3	3.6	0	2.2	2.1	6.8	2.7
13	20.6	9.5	18.7	24.4	33	9.0	15.8	21.6
14	0	0	0	0	0	0	0	0
15	13	0	31.6	60	38	15	33	27.3
16	.63	1.63	.92	1	0.7	0.59	0.52	0.55
17	.78	1.5	1.84	1.15	1.1	0.6	0.9	1.13
18	21.4	3.2	4.5	0	6.0	0	13	0
19	67	29.6	48.5	52	95	33	47	80
20	.54	.60	.58	.35	0.58	0.52	0.37	0.43
21	.50	.70	.64	.36	0.46	0.57	0.35	0.56
22	106	106	98	72	114	103	90	102
23	97	87	117	63	69	117	80	107
24	16	17.3	17	17.3	12.3	12.3	23.3	24
25	29	23.1	25	28.7	45.8	16.5	23	17
26	28	18	13.5	15.7	24.3	5.3	4	14
27	9	13.4	15.5	13.7	24.3	5.6	10	7

Table 13 contd.

MEASURE \ SUBJECT	17	18	19	20	21	22	23	24
1	57.5	72	62	59	58	63	57	60
2	54	70	59	52	48	59	52	63
3	61	74	65	66.5	70	67	62	57
4	30	35	15	33	35	33	26	19
5	5.6	6.0	6.7	6.3	5.7	5.4	5.8	7.4
6	4.9	6.8	7.2	6.4	5.7	6.2	7.3	5.5
7	7.1	7.5	8.1	8.0	8.2	7.0	8.7	8.5
8	6.5	6.4	6.6	5.8	6.3	6.3	7.1	4.7
9	4.2	2.7	4.3	4.5	3.5	3.0	2.5	5.9
10	2.0	6.5	5.5	7.0	4.8	3.9	6.1	6.0
11	5.4	5.2	4.8	4.4	4.7	7.3	8.0	3.5
12	0	2.5	4	3.8	15	11	6.3	7.0
13	17.2	37	27	25.4	29	24	30	39
14	0	0	0	0	0	23	0	0
15	30.4	35	15	33	25	50	26	19
16	0.79	0.85	0.86	1.0	0.91	0.73	0.78	1.3
17	0.52	1.48	1.2	1.24	1.35	1.0	1.21	1.5
18	0	12	0	4	43	37	5.6	14
19	75	83	75	70	48	50	70	72
20	0.55	0.48	0.61	0.65	0.52	0.58	0.78	0.66
21	0.46	0.51	0.68	0.54	0.43	0.49	0.71	0.66
22	117	99	128	98	79	66	155	134
23	98	94	141	95	69	77	158	113
24	12	23	22	23	12.7	23.3	12.3	12
25	49	38	42	45	31.3	17	36	47.3
26	30	23	35	30.4	16	15.7	14	44.7
27	17	3	2	3	7.7	7.2	5.4	10.7

Table 14 Subject Classes

CLASS NUMBER AND DESCRIPTION	COMPONENTS OF CLASS (i. e. Subjects)
1 - Civilian	1, 2, 5, 6, 7, 10, 14, 15, 19, 23
2 - Police	3, 4, 8, 9, 11, 12, 13, 16 17, 18, 20, 21, 22, 24
3 - Passive Collator	1, 2, 3, 4, 5, 9, 10, 14, 16, 17, 19, 22, 24
4 - Active Collator	6, 7, 8, 11, 12, 13, 15, 18 20, 21, 23
5 - Passive Collator: Police	3, 4, 9, 16, 17, 22, 24
6 - Passive Collator: Civilian	1, 2, 5, 10, 14, 19
7 - Active Collator: Police	8, 11, 12, 13, 18, 20, 21
8 - Active Collator: Civilian	6, 7, 15, 23
9 - Short Delay Passive Collator	2, 3, 4, 5
10 - Short Delay Active Collator	7, 11, 12
11 - Short Delay Passive Collator: Civilian	2, 5
12 - Short Delay Passive Collator: Police	3, 4
13 - Short Delay Active Collator: Civilian	7
14 - Short Delay Active Collator: Police	11, 12
15 - Long Delay Passive Collator	1, 9, 10
16 - Long Delay Active Collator	6, 8
17 - Long Delay Passive Collator: Civilian	1, 10
18 - Long Delay Passive Collator: Police	9
19 - Long Delay Active Collator: Civilian	6
20 - Long Delay Active Collator: Police	8
21 - Small Quantity Passive Collator	14, 17, 24
22 - Small Quantity Active Collator	13, 21, 23
23 - Small Quantity Passive Collator: Civilian	14
24 - Small Quantity Passive Collator: Police	17, 24
25 - Small Quantity Active Collator: Civilian	23
26 - Small Quantity Active Collator: Police	13, 21
27 - Large Quantity Passive Collator	22, 16, 19
28 - Large Quantity Active Collator	15, 18, 20
29 - Large Quantity Passive Collator: Civilian	19
30 - Large Quantity Passive Collator: Police	22, 16

Table 14 Subject Classes (contd.)

31 - Large Quantity Active Collator: Civilian	15
32 - Large Quantity Active Collator: Police	18, 20
33 - Short Delay	2, 3, 4, 5, 7, 11, 12
34 - Short Delay: Civilian	2, 5, 7
35 - Short Delay: Police	3, 4, 11, 12
36 - Long Delay	1, 6, 8, 9, 10
37 - Long Delay: Civilian	1, 6, 10
38 - Long Delay: Police	8, 9
39 - Small Quantity	13, 14, 17, 21, 23, 24
40 - Small Quantity: Civilian	14, 23
41 - Small Quantity: Police	13, 17, 21, 24
42 - Large Quantity	15, 16, 18, 19, 20, 22
43 - Large Quantity: Civilian	15, 19
44 - Large Quantity: Police	16, 18, 20, 22

The averages of each measure over all the subjects in a class were computed for all classes. These are shown in Tables 15 a, b.

Pairs of classes were then compared to test the hypotheses cited in Section 5.2.

The significance of differences in certain measures between classes was computed using the Mann Whitney U-Test, and within classes using the Wilcoxon Matched Pair Signed Rank Test*.

5.6.3 The Effect of the Stabilising Procedures

The stabilisation procedure discussed in Section 5.4.6 is used to control detection rate. Therefore there should be low between group differences on detection rate. Generally, this is true. However, variation is introduced between the first group of 12 subjects used in the Short Delay - Long Delay group of experiments and the last group of 12 subjects used in the Small Quantity - Large Quantity group of experiments. Several of the subjects in the first group achieved overall detection rates above 80% - notably, Subjects 5, 6, 10 and 12. Since these detection rates are unrealistic, the control procedure was made more stringent during the second series of experiments for subjects 12 - 24. This achieved

*The significance is given in the form of a probability measure, P, which must be interpreted as follows: The value of P is the probability that the observed difference could have arisen if there were no statistical differences between the processes producing the results.

TABLE 15(a) CLASS AVERAGES. CLASSES 1-8 : MEASURES 1-27

Measure \ Class	1	2	3	4	5	6	7	8
1	66.0	66.2	65.9	66.4	63.0	69.3	69.5	61.0
2	59.8	60.0	60.7	59.0	59.1	62.6	60.9	55.8
3	73.2	73.3	72.4	74.3	67.8	77.8	78.9	66.3
4	20.6	29.0	19.3	32.8	20.9	17.4	37.1	25.3
5	5.5	5.9	5.8	5.7	6.0	5.5	5.8	5.4
6	5.6	5.8	5.5	5.9	5.4	5.7	6.1	5.6
7	6.8	7.4	7.0	7.4	7.4	6.5	7.4	7.4
8	5.7	6.0	5.8	5.8	5.9	5.8	6.0	5.6
9	3.4	3.8	3.8	3.4	4.0	3.6	3.6	3.0
10	4.4	4.5	3.8	5.2	3.5	4.2	5.5	4.7
11	4.4	5.6	5.0	5.4	6.1	3.5	5.1	5.8
12	2.5	5.1	3.4	4.8	4.6	2.0	5.6	3.3
13	14.5	24.6	18.3	22.8	23.5	12.2	25.6	17.9
14	0.0	1.6	1.8	0.0	3.3	0.0	0.0	0.0
15	20.5	29.5	20.6	31.9	23.3	17.3	35.7	25.3
16	0.8	0.9	0.8	0.9	0.8	0.8	0.9	0.8
17	0.9	1.2	1.0	1.2	1.0	1.0	1.3	0.8
18	2.8	12.3	7.0	10.0	11.6	1.5	13.0	4.7
19	40.8	61.3	51.0	55.0	62.7	37.2	60.0	46.2
20	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
21	0.5	0.5	0.5	0.6	0.5	0.5	0.5	0.5
22	104.8	101.9	104.8	101.1	107.8	101.3	96.0	110.0
23	98.2	90.3	91.9	95.6	92.7	91.0	88.0	109.0
24	16.9	17.0	16.8	17.5	16.7	17.0	17.3	17.7
25	23.0	33.5	26.8	30.0	32.3	20.4	34.7	21.6
26	13.7	23.1	20.8	15.6	25.7	15.1	20.7	6.4
27	8.1	11.0	8.2	10.7	1.0	6.1	11.9	8.4

TABLE 15(a) CLASS AVERAGES (Contd.) CLASSES 9-16: MEASURES 1-27

Measure \ Class	9	10	11	12	13	14	15	16
1	68.8	71.1	70.5	67.0	48	82.8	69.5	80.0
2	61.5	64.0	63.5	59.5	43	74.5	62.8	74.3
3	79.3	78.7	80.5	78.0	52	92.0	77.2	85.3
4	22.0	39.1	32.0	11.9	26	45.8	7.8	21.6
5	5.8	5.2	5.2	6.3	4.8	5.4	5.6	6.2
6	5.0	5.5	4.8	5.2	3.9	6.3	5.6	5.9
7	7.0	6.4	5.9	8.0	6.3	6.4	6.5	7.3
8	5.4	5.8	5.2	5.6	5.0	6.3	5.8	5.4
9	3.9	3.5	3.7	4.2	3.6	3.5	3.3	3.4
10	2.4	4.6	2.8	2.1	3.0	5.4	4.4	4.0
11	4.4	6.0	4.0	4.8	5.9	6.0	5.1	4.8
12	1.9	1.2	1.2	2.6	0.0	1.8	3.1	6.0
13	16.0	19.5	10.8	21.2	15.5	21.5	12.0	11.0
14	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
15	22.9	39.2	34.0	11.0	26.0	45.8	6.3	21.6
16	0.8	0.8	0.7	0.9	0.6	0.1	0.9	1.2
17	1.0	1.1	0.8	1.1	0.4	1.5	1.1	1.0
18	3.8	1.5	3.0	4.6	0.0	2.3	8.2	11.0
19	38.1	46.8	28.7	47.5	40	50.3	41.5	25.4
20	0.4	0.5	0.2	0.5	0.5	0.5	0.6	0.4
21	0.3	0.5	0.3	0.4	0.5	0.5	0.6	0.6
22	103.3	81.0	92.0	114.5	73	85.0	99.7	117.0
23	69.3	90.7	60.0	78.5	92	90.0	88.3	107.5
24	17.0	16.8	19.1	14.9	16	17.15	15.1	17.7
25	22.9	24.6	12.4	33.3	20	26.9	22.7	18.2
26	16.6	11.7	9.8	23.5	6	14.6	19.7	11.8
27	6.2	14.1	2.9	9.5	13	14.6	10.8	10.7

TABLE 15(a) CLASS AVERAGES (Contd.) CLASSES 17-24: MEASURES 1-27

Measure \ Class	17	18	19	20	21	22	23	24
1	72.0	64.5	82.0	78.0	62.2	56.3	69.0	58.8
2	62.5	63.5	80.0	68.5	60.3	46.3	64.0	58.5
3	83.0	65.5	84.0	86.5	64.3	68.0	75.0	59.0
4	5.3	13.0	16.0	27.2	21.3	33.0	15.0	24.5
5	5.4	5.9	6.5	5.9	6.1	5.8	5.3	6.5
6	6.0	5.0	6.0	5.8	5.3	6.2	5.6	5.2
7	6.3	7.0	7.8	6.8	7.4	8.5	6.6	7.8
8	6.0	5.7	5.2	5.6	5.6	6.2	5.5	5.6
9	3.4	3.1	3.5	3.2	4.4	3.4	3.1	5.1
10	4.7	3.8	4.0	3.9	4.2	5.6	4.6	4.0
11	3.0	9.3	6.1	3.5	3.8	6.2	2.5	4.5
12	1.7	6.1	0	12.0	3.0	7.8	2.1	3.5
13	7.8	20.6	10.4	11.4	21.7	30.7	9.0	28.1
14	0.0	0	0	0	0.0	0.0	0.0	0.0
15	3.0	13.0	16.0	27.2	21.5	29.7	15.0	24.7
16	1.0	0.6	1.3	1.2	0.9	0.8	0.6	1.0
17	1.3	0.8	0.7	1.2	0.9	1.2	0.6	1.0
18	1.6	21.4	0	21.8	4.7	18.2	0.0	7.0
19	28.8	67.0	27.8	23.0	60.0	71.0	33.0	73.5
20	0.6	0.5	0.3	0.5	0.6	0.6	0.5	0.6
21	0.6	0.5	0.5	0.6	0.6	0.5	0.6	0.6
22	96.5	106.0	122	112	118.0	116.0	103	125.5
23	84.0	97.0	106	109	109.3	98.7	117	105.5
24	14.7	16.0	19.3	16.0	12.1	12.4	12.3	12.0
25	19.6	29.0	7.3	29.0	37.6	37.7	16.5	48.2
26	15.5	28.0	1.6	22.0	26.7	18.1	5.3	37.4
27	11.7	9.0	5.3	16.0	11.1	12.5	5.6	13.9

TABLE 15(b) CLASS AVERAGES (Contd.) CLASSES 25-32:MEASURES 1-27

Measure \ Class	25	26	27	28	29	30	31	32
1	57.0	56.0	62.2	62.7	62.0	62.3	57.0	65.5
2	52.0	43.5	57.7	56.7	59.0	57.0	48.0	61.0
3	63.0	70.5	66.7	68.8	65.0	67.5	66.0	70.3
4	26.0	36.5	25.0	33.7	15.0	30.0	33.0	34.0
5	5.8	5.8	5.7	5.6	6.7	5.3	4.5	6.2
6	7.3	5.7	6.5	6.1	7.2	6.1	5.1	6.6
7	8.7	8.4	7.2	7.4	8.1	6.7	6.7	7.8
8	7.1	5.7	6.4	5.7	6.6	6.4	5.0	6.1
9	2.5	3.9	3.6	3.2	4.3	3.2	2.5	3.6
10	6.1	5.3	4.8	6.3	5.5	4.5	5.5	6.8
11	8.0	5.4	6.5	4.2	4.8	7.4	3.1	4.8
12	6.3	8.6	5.9	4.4	4.0	6.9	6.8	3.2
13	30.0	31.0	24.2	26.1	27.0	22.8	15.8	31.2
14	0.0	0.0	7.7	0.0	0.0	11.5	0.0	0.0
15	26.0	31.5	30.8	33.7	15.0	38.7	33.0	34.0
16	0.8	0.8	0.7	0.8	0.9	0.6	0.5	0.9
17	1.2	1.2	1.1	1.2	1.	1.1	0.9	1.4
18	5.6	24.5	12.3	9.7	0.0	18.5	13.0	8.0
19	70.0	71.5	68.3	66.7	75.0	65.0	47.0	76.5
20	0.8	0.6	0.5	0.5	0.6	0.5	0.4	0.6
21	0.7	0.5	0.6	0.5	0.7	0.5	0.4	0.5
22	155	96.5	98.7	95.7	128	84.0	90.0	98.5
23	158	69.0	108.3	89.7	141	92.0	80.0	94.5
24	12.3	12.5	23.1	23.1	22.0	23.7	23.3	23.0
25	36	38.6	25.3	35.3	42.0	17.0	23	41.5
26	14	20.2	21.6	19.1	35.0	14.9	4.0	26.7
27	5.4	16.0	5.4	5.3	2.0	7.1	10.0	3.0

TABLE 15(b) CLASS AVERAGES (Contd.) CLASSES 35-40:MEASURES 1-27

Measure \ Class	33	34	35	36	37	38	39	40
1	69.8	63.0	74.9	73.7	75.3	71.3	59.3	63.0
2	62.6	56.7	67.0	67.4	68.3	66.0	53.3	58.0
3	79.0	71.0	85.0	80.4	83.3	76.0	66.2	69.0
4	29.3	30.0	28.8	13.3	8.8	20.1	27.2	20.5
5	5.5	5.1	5.8	5.8	5.8	5.9	6.0	5.6
6	5.2	4.5	5.7	5.7	6.0	5.4	5.8	6.5
7	6.7	6.0	7.2	6.8	6.8	6.9	8.0	7.7
8	5.6	5.1	5.9	5.6	5.7	5.7	5.9	6.3
9	3.8	3.6	3.9	3.3	3.4	3.2	3.9	2.8
10	3.4	2.9	3.7	4.2	4.5	3.9	4.9	5.4
11	5.1	4.6	5.4	5.0	4.0	6.4	5.0	5.3
12	1.6	0.8	2.2	4.3	1.1	9.1	5.4	4.2
13	17.5	12.4	21.4	11.6	8.6	16.0	26.2	19.5
14	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
15	29.9	31.3	28.8	12.4	7.3	20.1	25.6	20.5
16	0.8	0.7	1.0	1.0	1.1	0.9	0.8	0.7
17	1.1	0.7	1.3	1.0	1.1	1.0	1.1	0.9
18	2.8	2.0	3.4	9.3	1.1	21.6	11.4	2.8
19	41.8	32.5	48.9	35.1	28.5	45.0	65.5	51.5
20	0.4	0.3	0.5	0.5	0.5	0.5	0.6	0.7
21	0.4	0.4	0.4	0.6	0.6	0.6	0.6	0.6
22	93.7	85.7	99.8	106.6	105.0	109.0	117.0	129.0
23	78.4	70.7	84.3	96.0	91.3	103.0	104.0	137.0
24	16.9	18.0	16.0	16.1	16.2	16.0	12.3	12.3
25	23.6	14.9	30.1	20.9	15.5	29.0	37.7	26.3
26	14.5	8.5	19.1	16.5	10.9	25.0	22.4	9.7
27	9.6	6.3	12.1	10.7	9.6	12.5	11.8	5.5

TABLE 15(b) CLASS AVERAGES (Contd.) CLASSES 41-44: MEASURES 1-27

Measure \ Class	41	42	43	44
1	57.4	62.4	59.5	63.9
2	51.0	57.2	53.5	59.0
3	64.8	67.8	65.5	68.9
4	30.5	29.3	24.0	32.0
5	6.2	5.7	5.6	5.7
6	5.4	6.3	6.2	6.4
7	8.1	7.3	7.4	7.2
8	5.7	6.1	5.8	6.2
9	4.5	3.4	3.4	3.4
10	4.7	5.6	5.5	5.6
11	4.9	5.4	4.0	6.1
12	6.1	5.1	5.4	5.0
13	29.6	25.1	21.4	27.0
14	0.0	3.8	0.0	5.8
15	28.1	32.2	24.0	36.3
16	0.9	0.8	0.7	0.8
17	1.1	1.2	1.1	1.2
18	15.8	11.0	6.5	13.3
19	72.5	67.5	61.0	70.8
20	0.6	0.5	0.5	0.5
21	0.5	0.5	0.5	0.5
22	111.0	97.2	109.0	91.3
23	87.3	99.0	110.0	93.3
24	12.3	23.1	22.7	23.3
25	43.4	30.3	32.5	29.3
26	28.8	20.4	19.5	20.8
27	15.0	5.4	6.0	5.1

the desired effect of reducing the inter-subject variability of detection rate. For the first 12 subjects, overall detection rate varies between 48% - 90%, whereas for the second 12 subjects, the range of variation was 54% to 72%. However, the mean overall detection rate was also lowered from 71% over the first 12 subjects to 62% over the second 12. Since civilians and policemen were distributed fairly evenly between the two halves of the experimental series, (6 civilians, and 6 policemen in the first 12 and 14 civilians and 8 policemen in the second 12) the two halves have not been treated separately when dealing with classes of subjects, if classes are such that membership is drawn from one half only.

Measure No. 7 - the average man hours expended per solved crime - is a good indication of system difficulty and, therefore, of subject capability. However, the emphasis in this analysis of the results has been on comparison of classes of subjects in order to get gross system behaviour. Individual subject behaviour will not be considered in any further detail here.

5.6.4 Organisation of the Results

Results are presented under three separate headings. Firstly, the class of civilian subjects - Class 1 - and the class of all police subjects - Class 2 - are examined and measures within the classes compared for the 'with' and 'without' collator system conditions. Secondly, active and passive collator systems are compared and, thirdly, the results for all the cells in the experimental design are presented. In the latter two cases, results for civiliana and police subject classes are tested separately.

5.6.5 Results

1) A 'Within Class' Analysis of Civilian Subjects (Class 1) and Police Subjects (Class 2)

A Civilian Subjects - Class 1

a) Detection Rates

Detection rate without collator = 59.8%

Detection rate with collator = 73.2%

An increase of 13.4% significant at P = 0.005 level.

b) Man Hours per Solved Crime

Without collator	= 6.84 man hours
With collator	= 5.65 man hours

The difference of 1.2 is significant at P = 0.005 level.

c) Man Hours per Unsolved Crime

Without collator	= 3.36 man hours
With collator	= 4.37 man hours

An increase of 1.0 man hours significant at the P = 0.032 level.

d) Percentage of man hours spent on criminal information leads increases from 2.5% in the 'without collator' condition to 14.5% in the 'with collator' condition.

e) <u>Number of Suspects Generated per crime</u>

Without collator	= 0.8
With collator	= 0.91

This increase of 0.11 is significant at the P = 0.116 level.

f) <u>Percentage of Suspects Generated via Criminal Information Leads</u>

Without collator	= 2.77%
With collator	= 40.78%

g) <u>Subject Initiated Message Ratio</u>

Without collator	= 0.47
With collator	= 0.51

This difference is not significant.

h) The percentage of collator daily record slips retrieved by the subject was 13.7% and the percentage of fruitful collator slips was 8.1%.

To summarise this civilian data, there is an increase in detection rate on introducing the collator system of 13.4%.

There is a reduction of man hours per solved crime of 1.2 hours and an increase of man hours per unsolved crime of 1.0 hours. The percentage of man hours spent on criminal information leads and the percentage of suspects generated through criminal information leads increases. The average number of suspects generated per crime increases from 0.8 to 0.9 with the collator system. The subject initiated message ratio stays approximately constant over the two conditions.

B Police Subjects (Class 2)

a) Detection Rates

Detection rate without collator = 60%

Detection rate with collator = 73.3%

An increase of 13.3% significant at the P = 0.004 level.

b) Man Hours per Solved Crime

Without collator = 7.41 hours

With Collator = 5.9 hours

A decrease of 1.5 hours significant at the P = 0.004 level.

c) Man Hours per Unsolved Crime

Without collator = 3.79 hours

With collator = 4.54 hours

An increase of 0.75 hours significant at the P = 0.059 level.

d) Percentage of man hours spent on criminal information leads increases from 5.1% in the 'without Collator' condition to 24.5% in the 'with collator' condition.

e) Number of Suspects Generated per Crime

Without collator = 0.89

With collator = 1.18

An increase of 0.29 significant at the P = 0.004 level.

f) Percentage of Suspects Generated via Criminal Information Leads

Without collator	= 12.34%
With collator	= 61.32%

g) Subject Inistiated Message Ratio

Without collator	= 0.52
With collator	= 0.50

h) Percentage of collator daily record slips mentioned by the subject was 23.2% and the percentage of fruitful collator slips was 10.9%.

To summarise this data for all police subjects, after the introduction of the intelligence/ collator system, detection rate increased by 13.3%, man hours spent on solved crimes decreased by 1.5 hours, man hours spent on unsolved crimes increased by 0.75 hours. The average number of suspects generated increased from 0.89 to 1.18. The percentage of man hours spent on criminal information leads and the percentage of suspects generated through criminal information leads show a large increase. The subject initiated message ratio stayed approximately constant over the two conditions.

C Comparison of Classes 1 and 2

The trends for both classes after the introduction of the collator are an increase of just over

13% detection rate, a decrease in the amount of effort on unsolved crimes, and increase in the number of suspects generated per crime and a large increase in the use of criminal information leads. The major differences between the classes are:

1) On average, system difficulty was higher for police subjects indicated by the high man hours per crime measures (significant at P = 0.05).

2) Police subjects make more use of intelligence information as indicated by higher criminal information lead measures, fruitful collator slips, number of collator slips mentioned and collator assisted detection rates. The observed differences are significant at the P = 0.1, 0.001, 0.05 levels, respectively.

2 <u>Passive-Active Collator System Comparisons (Classes 5, 6, 7, 8)</u>

A <u>Passive Collator : Civilian Subjects (Class 6 - 6 Subjects)</u>

a) <u>Detection Rates</u>

Without collator	= 62.5%
With collator	= 77.8%

The increase of 15.3% is significant at the P = 0.016 level.

b) Man Hours per Solved Crime

Without collator	= 6.48 hours
With collator	= 5.70 hours

The decrease of 0.78 hours is significant at the P = 0.047 level.

c) Man Hours per Unsolved Crime

Without collator	= 3.58 hours
With collator	= 4.18 hours

An increase of 0.6 hours p = 0.1

d) Percentage of Man Hours Spent on Criminal Information Leads

Without collator	= 1.97%
With collator	= 12.18%

e) Number of Suspects Generated per Crime

Without collator	= 0.82
With collator	= 0.92

An increase of 0.16 P = 0.078.

f) Percentage of Suspects Generated via Criminal Information Leads

Without collator	= 1.32%
With collator	= 37.17%

B Active Collator : Civilian Subjects (Class 8-4 Subjects

a) Detection rates

Without collator	= 55.75%
With collator	= 66.25%

An increase of 10.5%. P = 0.062.

b) Man Hours per Solved Crime

Without collator	= 7.37 hours
With collator	= 5.57 hours

A decrease of 1.8 hours, P = 0.062.

c) Man Hours per Unsolved Crime

Without collator	= 3.02 hours
With collator	= 4.65 hours

An increase of 1.63 hours, P = 0.125.

d) Percentage of Man Hours Spent on Criminal Information Leads

Without collator	= 3.27%
With collator	= 17.92%

e) Number of Suspects Generated per Crime

Without collator	= 0.78
With collator	= 0.82

An increase of 0.04, not significant.

f) Percentage of Suspects Generated via Criminal Information Leads

Without collator	= 4.65%
With collator	= 46.20%

C 'Between Class' Comparisons - Classes 6 and 8

Comparing these measures for Class 6 (Passive Collator : Civilian Subject) and Class 8 (Active Collator ; Civilian Subject), we find:

1) Improvement in detection rate = 15.3% for passive collator and 10.5% for active collator (P = 0.086).

2) Man hours per solved or unsolved crime did not change significantly between passive and active groups.

3) Percentage of man hours spent on criminal information leads was 12.18% in the passive condition and 17.92% in the active.

4) Number of suspects generated per crime = 0.98 for passive and 0.82 for active collator.

5) Percentage of suspects generated via criminal information leads = 37.17% for passive and 46.2% for active collator.

6) Percentage of fruitful collator reports = 6.13% for passive and 8.42% for active collator.

D <u>Passive Collator : Police Subjects (Class 5-7 Subjects)</u>

a) <u>Detection rates</u>

Without collator	= 59.07%
With collator	= 67.79%

An increase of 8.72%, P = 0.023

b) <u>Man Hours per Solved Crime</u>

Without collator	= 7.41 hours
With collator	= 5.83 hours

A decrease of 1.58 hours, P = 0.008

c) Man Hours per Unsolved Crime

Without collator = 4.00 hours

With collator = 3.54 hours

A decrease of 0.44 hours, not significant

d) Percentage of Man Hours Spent on Criminal Information Leads

Without collator = 4.56%

With collator = 23.54%

e) Number of Suspects Generated per Crime

Without collator = 0.84

With collator = 1.03

An increase of 0.19, P = 0.055

f) Percentage of Suspects Generated via Criminal Information Leads

Without collator = 11.64%

With collator = 62.71%

E Active Collator : Police Subjects (Class 7 - 7 Subjects)

a) Detection rates

Without collator = 60.93%

With collator = 78.86%

An increase of 17.93%. P = 0.008

b) Man Hours per Solved Crime

Without collator = 7.42 hours

With collator = 5.96 hours

A decrease of 1.45 hours, P = 0.016

c) Man Hours per Unsolved Crime

Without collator = 3.59 hours

With collator = 5.54 hours

An increase of 1.95 hours, P = 0.016

d) Percentage of Man Hours Spent on Criminal Information Leads

Without collator = 5.59%

With collator = 25.54%

e) Number of Suspects Generated per Crime

Without collator = 0.94

With collator = 1.33

An increase of 0.39, P=0.016

f) Percentage of Suspects Generated via Criminal Information Leads

Without collator = 13.04%

With collator = 59.93%

F 'Between Class' Comparisons - Classes 5 and 7

Comparing measures for Class 5 (Passive Collator ; Police Subject) and Class 7 (Active Collator : Police Subject), we find:

1) Improvement in detection rate = 8.72 for passive collator and 17.93 for active collator (P = 0.036).

2) Decrease in man hours per solved crime = 2.42 for passive collator and 1.45 for active collator (P = 0.355)

3) Increase in man hours per unsolved crime = 0.44 for passive collator and 1.95 for active collator (P = 0.027)

4) Percentage of man hours spent on criminal information leads = 23.54 for passive collator and 25.56 for active collator.

5) Number of suspects generated per crime = 1.03 for passive collator and 1.33 for active collator (P = 0.049)

6) Percentage of suspects generated via criminal information leads = 62.71 for passive collator and 59.93 for active collator.

7) Percentage of fruitful collator reports = 9.99 for passive collator and 11.89 for active collator (P = 0.159)

G A Comparison of Civilian and Police Subjects with Respect to Passive-Active Collator Systems

The most significant difference between civilian and police subjects is the following:

Whereas, for police subjects, the detection rate with an active collator is higher than detection rate with a passive collator, as predicted in Hypothesis 1 of Section 52, this is not true for civilians. Detection rate for this class of subjects is higher with passive than with active collator systems. Generally, other trends are in the same direction for both classes and are more pronounced for police subjects than for civilians. For example, the measures which indicate the use made of the collator system (the percentage of suspects generated via criminal information leads and the percentage of fruitful collator slips), are higher for police subjects than civilian subjects.

5.6.6 Short Delay-Long Delay Collator System Comparisons

Because of the difference between police and civilian subject performance with active and passive collator, which was discussed above, police and civilian subjects will be treated separately for all further conditions. This means that cell membership in the experimental plan is virtually halved for all cells, resulting in low statistical significance of observed differences.

The classes for comparison are:

Class 11 - Short Delay, Passive Collator, Civilian Subjects 2, 5

Class 13 - Short Delay, Active Collator, Civilian Subject 7

Class 17 - Long Delay, Passive Collator, Civilian Subjects 1, 10

Class 19 - Long Delay, Active Collator, Civilian Subject 6

and,

Class 12 - Short Delay, Passive Collator, Police Subjects 3, 4

Class 14 - Short Delay, Active Collator, Police Subjects 11, 12

Class 18 - Long Delay, Passive Collator, Police Subject 9

Class 20 - Long Delay, Active Collator, Police Subject 8

Class averages of 'with collator' detection rates are shown in the tables 16 a and b:

Table 16 'With Collator' Detection Rates for a) Civilian Subjects b) Police Subjects

(a)	Short Delay	Long Delay
Active Collator	52%	84%
Passive Collator	80%	83%

(b)	Short Delay	Long Delay
Active Collator	92%	86.5%
Passive Collator	78%	65.5%

These tables show clearly a reversal of trends between civilian and police subjects. However, the average P for difference in these Tables ≐ 0.4, allowing little confidence in the trend.

Tabulating detection rate increments (that is, detection rate with collator - detection rate without collator), we get the results shown in Tables 17 a and b.

Table 17 Detection Rate Increment for a) Civilian Subjects b) Police Subjects

(a)	Short Delay	Long Delay
Active Collator	9%	4%
Passive Collator	17%	20%

(b)	Short Delay	Long Delay
Active Collator	17.5%	17%
Passive Collator	18.5%	2%

Again, a reversal trend between civilian and police subjects can be discerned, but at a very low confidence level (P = 0.4).

5.6.7 Small Quantity-Large Quantity Collator System Comparisons

The subject classes for comparison are:

Class 23 - Small Quantity, Passive Collator, Civilian Subject 14

Class 25 - Small Quantity, Active Collator, Civilian Subject 23

Class 29 - Large Quantity, Passive Collator, Civilian Subject 19

Class 31 - Large Quantity, Active Collator, Civilian Subject

and,

Class 24 - Small Quantity, Passive Collator, Police Subjects 17

Class 26 - Small Quantity, Active Collator, Police Subjects 13, 21

Class 30 - Large Quantity, Passive Collator, Police Subjects 22, 16

Class 32 - Large Quantity, Active Collator, Police Subjects 18, 20

Class averages of 'with collator' detection rates are shown in the tables 18 a and b.

Table 18 'With Collator' Detection Rates for

a) Civilian Subjects b) Police Subjects

(a)	Small Quantity	Large Quantity
Active Collator	63%	66%
Passive Collator	75%	65%

(b)	Small Quantity	Large Quantity
Active Collator	70.5%	70.25%
Passive Collator	59%	67.5%

Again, the reversal trend between police and civilian subjects is evident, but the average P = 0.4, so again, the sample sizes were not large enough to give any confidence in this observed trend.

Tabulating detection rate increments, after the introduction of the collator system, we get:

Table 19 Detection Rate Increment for a) Civilian Subjects b) Police Subjects

(a)	Small Quantity	Large Quantity
Active Collator	11%	18%
Passive Collator	11%	7%

(b)	Small Quantity	Large Quantity
Active Collator	27%	9.75%
Passive Collator	0.5%	10.5%

5.7 Findings

Hypothesis 1

Detection rate with collator system $>$ detection rate without collator system.

An increase of 13.3% significant at P=0.004 level was observed for police subjects.

An increase of 13.4%, significant at P=0.005 level was observed for civilian subjects.

This hypothesis is, therefore, confirmed for all subjects at this level.

Hypothesis 2

Detection rate with an active collator system $>$ detection rate with a passive collator system.

a) Police subjects

An increase in the predicted direction of 11% (P = .036) was observed.

Hypothesis 2, is, therefore, confirmed for police subjects at this level.

b) Civilian Subjects

An increase in the opposite direction to that predicted (i.e. passive detection rate was greater than active detection rate) of 11.6% was observed, significant at the P = 0.086 level.

Hypothesis 2, is, therefore, not confirmed for civilian subjects.

Hypothesis 3

Detection rate with short delay, active collator $>$ detection rate with long delay, active collator.

a) Police Subjects

An increase in the predicted direction of 5.5% ($P = 0.5$) was observed.

Hypothesis 3 is weakly confirmed for police subjects.

b) Civilian Subjects

An increase of 32% in the opposite direction to that predicted was observed, ($P = 0.5$)

Hypothesis 3 is, therefore, not confirmed for civilian subjects.

Hypothesis 4

Detection rate with short delay, active collator $>$ detection rate with short delay, passive collator.

a) Police Subjects

An increase in the predicted direction of 14% ($P = 0.167$) was observed.

Hypothesis 4, is, therefore, weakly confirmed for police subjects.

b) Civilian Subjects

An increase of 28% in the opposite direction to that predicted was observed.

Hypothesis 4, is, therefore, not confirmed for civilian subjects.

Hypothesis 5

Detection rate with short delay, passive collator $\rangle$ detection rate with long delay, passive collator.

a) Police Subjects

An increase of 12.5% in the predicted direction was observed, (P = 0.333)

Hypothesis 5 is, therefore, weakly confirmed for police subjects.

b) Civilian Subjects

An increase in the predicted direction of 3% was observed (P = 0.667).

Hypothesis 5 is, therefore, not confirmed for civilian subjects.

Hypothesis 6

Detection rate with long delay, active collator $\rangle$ detection rate with long delay, passive collator.

a) Police Subjects

An increase of 21% in the predicted direction was observed (P = 0.5).

Hypothesis 6 is, therefore, weakly confirmed for police subjects.

b) Civilian Subjects

An increase of 1% in the opposite direction to that predicted was observed (P = 0.667).

Hypothesis 6 is, therefore, not confirmed for civilian subjects.

Hypothesis 7

Detection rate with large quantity, active collator $>$ detection rate with small quantity, active collator.

a) Police Subjects
No change in detection rate was observed.

Hypothesis 7 is, therefore, not confirmed for police subjects.

b) Civilian Subjects
An increase in the predicted direction of 3% ($P = 0.5$) was observed.

Hypothesis 7 is, therefore, not confirmed for civilian subjects.

Hypothesis 8

Detection rate with small quantity, active collator $>$ detection rate with small quantity, passive collator.

a) Police Subjects
An increase of 11.5% in the predicted direction was observed (P 0.167)

Hypothesis 8 is, therefore, weakly confirmed for police subjects.

b) Civilian Subjects

An increase of 12% in the opposite direction to that predicted was observed ($P = 0.5$).

Hypothesis 8 is, therefore, not confirmed for civilian subjects.

Hypothesis 9

Detection rate with large quantity, active collator $>$ detection rate with large quantity, passive collator.

a) Police Subjects

An increase of 2.75% in the predicted direction was observed ($P = 0.667$)

Hypothesis 9 is, therefore, not confirmed for police subjects.

b) Civilian Subjects

An increase in the predicted direction of 1% was observed ($P = 0.5$).

Hypothesis 9 is, therefore, not confirmed for civilian subjects.

Hypothesis 10

Detection rate with large quantity, passive collator detection rate with small quantity, passive collator.

a) Police Subjects

An increase of 8,5% in the predicted direction ($P = 0.167$) was observed.

Hypothesis 10 is, therefore, weakly confirmed for police subjects.

b) <u>Civilian Subjects</u>

An increase in the direction opposite to that predicted of 10% was ovserved (P = 0.5).

Hypothesis 10 is, therefore, not confirmed for civilian subjects.

The above results are summarised in Table 20.

Table 20 Hypothesis Confirmation Summary Table

	Police Subjects	Civilian Subjects
Hypothesis 1	Confirmed	Confirmed
Hypothesis 2	Confirmed	Not Confirmed
Hypothesis 3	Weakly Confirmed	Not Confirmed
Hypothesis 4	Weakly Confirmed	Not Confirmed
Hypothesis 5	Weakly Confirmed	Not Confirmed
Hypothesis 6	Weakly Confirmed	Not Confirmed
Hypothesis 7	Not Confirmed	Not Confirmed
Hypothesis 8	Weakly Confirmed	Not Confirmed
Hypothesis 9	Not Confirmed	Not Confirmed
Hypothesis 10	Weakly Confirmed	Not Confirmed

Further findings are:-

1) The introduction of a collator system results in a decrease in the amount of effort (in terms of man hours) spent on solved crimes and an increase in the amount of effort spent on unsolved crimes, for both police and civilian subjects.

These results are significant at the $P < 0.005$ and $P < 0.05$ levels, respectively.

2) The overall average amount of effort spent per crime is greater for police subjects than civilian subjects (a result for which $P = 0.05$, therefore, it is only weakly significant). This result indicates that the control rule was adjusted to make the system more difficult for policemen.

3) In general, police subjects made more use of collator and criminal information, as indicated by higher collator assisted detection rate, higher collator assisted detection rate, higher percentage of fruitful collator slips and higher percentage of suspects generated from criminal information leads.

5.8 Discussion of Findings

To test that the increase in detection rate over the last three days compared to that of the first three days was not caused by end effects (e.g. detection rate might be low on the first three days due to unfamiliarity and high on the last day due to the subjects trying unnaturally hard to achieve a 100% detection rate when they discover that it is theoretically possible to solve all crimes), the result was checked by comparing averages over days 2 and 3 with averages over days 4 and 5. The figures were 57.7%, 70% for police subjects; 55.5%, 69.9% for civilians. The differences were not significant and it was, therefore, concluded that end effects were not significant.

The reduction in man hours associated with solved crimes after the introduction of the collator system is consistent with the following facts:

1) That more up-to-date information in the collator system should allow quicker access to suspects.

2) That suspect names very often turn up from collator reports before routine investigations have been completed.

The increase in man hours associated with unsolved crimes after the introduction of the collator system is consistent with the fact that collator information (e. g. sightings of known villains in the vicinity of crimes, suspicious vehicles, etc.) results in more leads to follow and, in general, crimes are unsolved because fruitless leads have been followed to exhaustion.

In these experiments, extra time spent on unsolved crimes was compensated for by the saving of time on solved crimes. Thus, there was no loss in terms of man hours per crime. However, the situation could arise in which the amount of effort required per crime does increase upon the introduction of a collator system, due to the increased proportion of promising leads. There is likely, therefore, to be a point of diminishing returns on the utility of large quantities of collator information. This contention is supported by the results from the large quantity-small quantity experiments, which show no significant differences.

Note that the introduction of a decision mechanism to curtail an investigation according to some function of effort expended, detection probability and crime seriousness, could lead to significantly better use of collator information be decreasing the amount of effort expended on unsuccessful investigations.

However, without such a mechanism, the conclusion from this set of experiments is that timeliness of collator information is more important than quantity.

The apparent reversal of trends between police and civilian subjects, though not statistically significant, could be another indication of the danger of swamping a system with information. The hypothesis is that civilian subjects, largely inexperienced in the given task, found it difficult to use information passed by the active collator but were able to use the extra enquiry facility afforded by the passive collator. This hypothesis could be checked by analysis of individual/ subject behaviour.

To conclude, our answers to the two questions posed in Section 5.1 are:

1) The Collator should seek the most up-to-date intelligence information rather than the largest quantity.

2) He should operate in what we have defined as the active mode.

5.9 Summary and Conclusions

The basic simulation described in the previous chapter was extended to include a local intelligence collator facility. A series of experiments was then carried out to evaluate the effects on system performance of alternative ways of using the facility. The subjects in the experiments were selected from two groups. The first group were professional policemen with CID experience and the second group were Home Office scientists with considerable knowledge of police operations. In all, 24 two-day experiments were run and data collected for testing ten hypotheses. Only one of these hypothese was confirmed with acceptable significance; the rest were either weakly confirmed (low statistical significance) or not confirmed. However, it was observed that, in general, the hypotheses significance levels were better for police subjects than for civilian subjects. This lends some substance to the belief that the simulator does indeed provide a realistic vehicle for policemen to manage. This follows from the observation that if the system does correspond to what policemen have experience of, they will perform more consistently than subjects who have less experience of the real thing.

However, the main conclusion was that the statistcial validity of the results was low yet considerable expenditure of time and effort by both policemen and researchers was involved. Thus the experimental method was felt to be inefficient as a system evaluation tool. This view is only relevant if other more efficient tools exist, otherwise even an inefficent tool is valuable. Since methods of measuring performance in the field are still the subject of ongoing research, the SIMPOL approach can provide useful information if used wisely.

However the question of the efficiency of the manual SIMPOL simulation system as a system evaluation tool led directly to question of how to increase its efficiency. One way clearly was to develop a computer model of the total SIMPOL system <u>including</u> the subject's role. The next phase in the development of the project was to examine the feasibility of this approach and to develop a computer model if it proved feasible.

Chapter 6

SIMPOL III - Further system evaluation experiments and feasibility study for the development of a computer model

6.1 Objectives and Strategy

At the end of the SIMPOL II series of experiments the simulator had evolved into a realistically complex model of a CID system. However the inefficiences of the manual simulation process cast doubts on its general utility as a system evaluation tool. The main criticism was the manpower commitment required to run an experiment. This was felt to be too great and meant that it was impossible to get enough data to validate the model in the statistical sense. Because of this two main objectives were set for the further development of the system. These were i) a further study of the effects of loading on system performance using the manual system and ii) using the procedures and models already built into the system and data acquired by running the manual system to design and programme a computer simulation model of the operation of a criminal investigation organisation. The loading studies were designed to investigate variations in both crime input rates and in manpower availability. It was also hoped to provide base data with which the results of a manpower study then being set up by the Police Scientific Development Branch could be compared and also to provide a standard for the development of the computer model.

6.2 Field Studies

The detective representations in the original SIMPOL systems were based on the following two observations:-

1) For any given enquiry a good detective gets more useful information than a poor detective.
2) For any given enquiry a good detective gets information sooner than a poor detective.

The information quantity characteristics for the simulated detectives were related to the structure of the crime information. Thus a good detective retrieved information from the general class, loser class, detailed scene information class and local enquiries class. The medium ability detectives were not allowed to retrieve local enquiries information and the poorest ability detectives were not allowed to retrieve local enquiries information or detailed scene information.

A time characteristic was fixed for each simulated detective which specified the time taken to get information. For example, it varied from half an hour for a good detective to get a loser statement to over 3 hours for a poor detective to report failure on local enquiries.

Thus detective abilities were rigidly specified and subjects were often frustrated to find they could never modify these preset characteristics. For example Detective Constables Keath and Terrell were classified as "poor" detectives, they were slow and did not get much useful information. However no amount of instruction, threat or entreaty could change their behaviour characteristics.

It was therefore decided to further increase the realism of modelled detectives a) by narrowing the range of detective ability modelled and b) by allowing subjects to get more information by demanding more effort from the detective team.

A series of field studies was organised in five different police forces in order to determine a more detaile detective model. Initially formal questionnaires were used to try to investigate the various categories of procedures and activities carried out by detectives at different stages in an investigation and to establish detectives' perceptions of the main characteristics of crimes, criminals and other detectives. It was very quickly found that detectives did not like being questioned in this way. As with most demanding jobs it was difficult for the respondent to detach himself and think about it at the necessary level of abstraction. For example respondents stated that there was no such thing as a "typical" crime or a "typical" detective. Each crime is different each detective is different - to average out in terms of what is "typical" or "generally true" was felt, by the respondents to be misleading. Further, the interview situation itself inescapably provoked a sharp observer-observed polarisation. Detectives did not like being "put on the spot" and examined formally about their operating methods. Of course this sort of behaviour is not peculiar to detectives. It is a common problem for behavioural scientists studying professional skills and measurement techniques for this type of study are an important research area (Klahr 1969, Bainbridge et al 1968, Gagne 1965).

In view of these factors the use of formal questionnaires was discontinued and a "crime maze" technique tried. This used a simple game like approach to get the detective to think aloud about his probable actions and expectations in an hypothesised but realistic crime situation. A simple branching structure for a crime was prepared consisting of "situations" and "actions". Any one situation could lead to any one of a set of possible subsequent situations depending on which action was selected. A typical situation scenario with associated action choices is shown in Fig 11. Typically one crime maze contained 20 - 30 situations each with 5 or 6 action choices. This complexity was necessary for the required degree of realism but it was difficult to handle manually and verbally. The maze was administered by allowing the detective to read the first situation and select and discuss an appropriate action. This determined the next situation where the process was repeated.

However the same basic difficulties were encountered using this technique as with the questionnaires, the most common criticism being "I wouldn't choose just one of these actions, I'd expect the lot to be done".

SITUATION

Man found at 2.30 pm badly beaten in alley-way near town centre. Panda car XYZ called to scene by 'visual contact' is hailed by pedestrian who found victim. An ambulance has been called. Victim is unknown.

You are in the CID Office clearing up some paper work. Communication Centre phones through to report the above situation.

Yours next action is:

1) Go immediately to the scene of the incident yourself (2)
2) Find some colleagues for assistance and go to the scene (3)
3) Report to DI or Superintendent and wait for his decision about who should go (4)
4) Alert hospital and traffic patrol (5)
5) If none of these, what would you do first?

Fig 11 Sample Crime Maze Scenario and Action Lists

So the use of the crime maze technique was not continued after the pilot experiments.

In retrospect it is clear that the failure of these attempts at formal "measurement" of detectives' attitudes and perceptions affecting their decision behaviour was due to three main causes i) the fact that the research team comprised inexperienced interviewers trying out new techniques in a hurry; ii) that for perfectly valid reasons detectives tended to be sceptical of attempts at overt scientific analysis of their activity and iii) that detectives had genuine difficulty in "standing back" from their work and giving opinions about what characteristics best typified crimes, criminals and detectives. The value of these attempts to the project team was in introducing the formidable problem of measurement in judgement situations and the associated branches of psychological measurement theory developed to tackle these. (Torgerson 1958, Coombs 1964, Greene & Carmone 1970).

This unsuccessful sally into the area of formal analysis of the detective's judgement situation forced the project back to the less formal approach adopted in the previous SIMPOL exercises. That is specific real crime reports were studied and the detectives who had been involved interviewed informally about how they had dealt with the crimes. However as well as asking detectives to go over past crimes in detail they were also asked about current crimes. It was found that informal conversations with detectives were much more informative and through these it was possible to build a fruitful relationship between the researcher and the detective. In some cases the researchers accompanied detectives on investigations and sat in on interrogations. The insights gained through this co-operation, though not quantifiable in any strict sense, led directly to a theory of detection which could form the basis of the computer model and provide a modified and more realistic structure for the detective models in the SIMPOL system. This will be presented in the next section.

6.3 The Development of the SIMPOL system

6.3.1 The Crime Library

In pursuit of the general aim of more realism the types of crime included in the system were extended from breaking offences to include frauds, crimes of violence and sex offences. Realistic proportions of breakings, frauds, crimes and sex crimes were obtained from the 1966 Home Office Statistics for crime in England and Wales. Table 21 below shows the details of this crime classification. Note that larcency from unattended vehicles has not been included in the breaking offences. The high frequency of this type of offence would have grossly unbalanced the distribution of crime types.

Table 21 CRIME CLASSIFICATIONS

(Derived from HO Stats. 1966)

Gen. Class	HO Class	No. Reported	No. Detected	% Clear-up	Prop. of Total	Crime
Sexual	17	3,137	878	28%	0.7%	Att. Buggery
	20	10,939	2,801	26%	2.4%	Ind. Ass.
	22	4,156	567	13.5%	0.9%	Unlawf. S.I.
	139	2,916	1,418	83%	0.6%	Ind. Exp.
Violence	8	22,204	13,880	62.5%	4.7%	Mal. wound
	5	2,257	540	24%	0.5%	Fel. wound
	104	7,385	4,149	56%	1.6%	Ass. on const.
	34	4,474	1,621	36%	1.0%	Robbery
Frauds	37	4,347	1,866	43%	1.0%	E. M. B.
	50	39,361	3,200	8.5%	8.4%	Ort. by false P.
	53	6,261	1,250	20%	1.2%	Other frauds
	58	10,698	1,400	13%	2.3%	Forgery & Uttering
Burglary	28	9,026	2,032	22%	2.0%	Burglary
	29	83,615	9,936	12%	18.4%	House-breaking
	30	119,146	24,579	21%	26.2%	Breaking in shops, offices etc.
	31	17,134	1,748	10%	3.76%	Att. Break in
	32	44,566	1,284	29%	9.8%	Ent. & att. felony
	33	1,691	958	57%	0.4%	Poss. of HB tools
	39	8,219	872	11%	1.8%	Lar. from person
	40	53,639	6,000	11%	11.8%	Larc. in house
	45	186,407	11,000	6%		Larc. unatt. vehicles

From this table the following proportions were derived:-

1) Break ins - 70% of crime library
2) Frauds - 15% of crime library
3) Crimes of violence - 10% of crime library
4) Sex crimes - 5% of crime library

A new crime library and associated criminal behaviour histories conforming to this pattern was written. General information summaries for crimes in each of these categories are shown in Table 22.

Table 22 Crime Summaries

Crime No.	Time Reported	Type	Complaint	Comments	Seriousness
4	08.15	Burglary	Mr Humphreys, manager of Duncan Electrics, 27 Fleming Road, reports that a quantity of electric cable has been stolen from a factory which his firm is rewiring at 180-186 Fleet Street (C. 6.).	20-100 yard drums of PVC coated 15 amp cable stolen. Entry through rear door not securely fastened. Nothing else missing.	
8	16.45	Burglary	Mr N Garrett, 20 Beagle Road (B. 4.) reports gas meter broken into.	Conservatory door forced open and meter broken into. About 25s. stolen.	
23	09.00	Burglary	Mr A Newton, proprietor of Newton Antiques, 17 Cheyne Way (E. 6.) reports a burglary at his shop.	Rear door of shop forced. About £200 worth of goods missing (mainly jewellery).	
25	13.00	Burglary	Mrs M Hedley, 96 Lyndhurst Avenue (D. 3.) reports house broken into whilst she was out this morning.	Loser left home at 8.45. Returned at 12.30 to find glass in kitchen door had been broken and about £35 missing. House was ransacked but nothing else was taken.	

Table 22 (Contd.)

Crime No.	Time Reported	Type	Complaint	Comments	Seriousness
9	12.00	Indecent exposure	Mrs Sarah Clifford, 25 Boyle Road (D.2.) says a man exposed himself to her in Hove Park (C.2.).	Mrs. Clifford was walking across the park; a man approached wearing an overcoat. He suddenly pulled open his coat and held open his trousers, exposing himself to her. Didn't say anything and she rushed straight home and phoned the police.	
8	02.00	Assault	Mr B Jakmon, 35 Wharton Drive (C.4.) says his daughter has been attacked by a man in Preston Park at about 12 midnight.	Girl says she was walking home from a club when a man grabbed her from behind. She fainted during the struggle and can't remember much about it. When she came round the man had gone.	

Table 22 (Contd.)

Crime No.	Time Reported	Type	Complaint	Comments	Seriousness
129		Fraud	Mr H. Wardle, 200 London Road (B. 3) reports that £5 was stolen from his wife on Friday evening.	Appears to be a confidence job. Man called on Friday evening and said his car had broken down, he had no money at all and he had to return to London that night as his wife had been taken to hospital with a suspected miscarriage. He asked loser if she could lend him some money which he would return to her the following Monday. Wrote an IOU and left address and phone number. Her husband later phoned the number but it was disconnected. Address fictitious.	
48		Fraud	Mr Coates, 38 Venus Road (F. 1) reports that his wife's Hoover washing machine and vacuum cleaner have been taken by a man posing as a Hoover rep.	Loser's wife says a man called at the house and asked if she owned a Hoover washing machine. She said 'Yes' and he asked if he could examine it, explaining that they were operating a promotional scheme, whereby Hoover customers were being offered free overhauls of their equipment. He then said that two bearings had gone in the machine and it would have to be repaired	

(Contd. next page)

Table 22 (Contd.)

Crime No.	Time Reported	Type	Complaint	Comments	Seriousness
48 contd.				(at no charge to her) and also that the motor on the cleaner needed overhauling. He took both machines away. Loser rang Hoover depot in North Street to check and was informed that they knew nothing about the matter. He then contacted the police. His wife did receive a receipt from the "rep." but it was plain and did not bear Hoover's name.	
86		Violence	Mr C Armstrong 29A Woodland Ave. (B. 5)	Loser was walking home alone down Faye Road. Someone jumped on his back and hit him on the back of the neck. Loser was then kicked in the crutch and fell to the ground. Wallett containing £20 was taken from his pocket. Local resident found him and called police.	
49		Violence	Mr H Baker a milkman reports finding a man unconscious with head injuries in a Morris 1100 parked outside Cottage Club (B. 5)	Mr Baker was delivering milk when he came across victim slumped across front seat of car. Thought he was asleep but then saw blood on the back of the man's head. Opened car door but didn't move man. Called police. No-one else around.	

The main experimental requirements for this series of experiments was a measure of the effect of increased crime load on system performance. Previous experience indicated that a level of 8 - 10 crimes per day was regarded as a normal or manageable load. Three crime rates were then specified for the experiments, 5 crimes per day representing underload, 10 crimes per day representing normal manageable load and 15 crimes per day representing overload.

Also the length of simulated period was increased from 6 to 8 days because, as was observed in the early experiments,the first session (simulated day) was a learning period and often also the last day was treated untypically by subjects rushing to get things cleared up before the end. By extending the simulated time period the effects of these "end effects" could be reduced.

The total maximum crime requirement was therefore 8x15 = 120 crimes for the programme.

6.3.2 Detective Characteristics

After critical discussion of the SIMPOL II system the following three areas for development of the detective models were distinguished:

1) The range of variation of detective characteristics was too large and

should be reduced. Mainly the lowest ability detectives were thought to be too low in ability.

2) Detective characteristics were too rigid, more flexibility in everyone to D.I. instructions was desirable. For example, it should be possible to get detectives to make a more thorough investigation by stronger instructions and it is realistic to get more useful information by doing so.

3) Detectives should be able to get information by what are called indirect activities, that is through contacts and informants, as well as from direct crime investigation activities.

To implement these required changes modifications were made to both the methods of storing and consequently retrieving crime information and the spectrum of detective characteristics.

Formally eight classes of crime information were distinguished. These were:-

Class 1 - General information

Class 2 - Detailed scene information

Class 3 - Loser and/or complainant information

Class 4 - Local enquiries and/or witness information

Class 5 - Contact information

Class 6 - Informant information

Class 7 - Uniformed Branch information

Class 8 - Fortuitous information

The first four classes are as defined for the previous systems. In these information was stored as a sequence of data items, most obvious and easily retrievable items are at the beginning of the sequence less obvious items at the end. Previously however detective characteristics were defined categorically that is a detective was allowed to get all the information from one class or more depending on a defined retrieval characteristic. In the modified system rules were prescribed determining how the amount of information retrieved by a detective could vary with 1) the number of enquiries he has on hand and 2) the instructions given to him by the D.I. Thus each detective would be in one of three states called "cursory", "normal" and "thorough". For each detective the "normal" state determined for each class in each crime the number of data items retrieved under normal conditions. These normal conditions were an invariant characteristic of each detective. For example, a detective with good local knowledge and a high number of contacts would get less information from local enquiries than from contacts and informants. In the "cursory" state a detective retrieves fewer items than in his "normal" state and in the "thorough" state he retrieves more.

The state of a detective at any time was determined by the nature of D.I. commands. For example an instruction of the form "Don't spend too much time on this one, just let me know what's happened," would put a detective into the cursory mode, whereas one of the form "I'm giving this crime top priority; it must be cleared up!" would put the detective into the "thorough" mode.

The time required to get each item was fixed and the same for all detectives. Items in Contact and Informant Classes (5 & 6) were tagged with the names of detectives who had access to them. That is, to allow for the fact that many contacts and informants are specific to individual detectives, the items within these classes were treated categorically.

An example of a new format crime is shown in Table 23.

6.3.3 Towards a Theory of the Detection Process

Clearly the development of a digital simulation model requires a precise specification of all aspects of the crime detection process. In its entirety such a specification will be a theory of the problem-solving and organisational behaviours implicit in the detection process. After the interaction between the field studies and the redesign of the detective models in the manual simulation system it was possible to postulate a structure for real detection processes based in the two sorts of activity, direct and indirect. The following sequence of events usually occurs in the detection of a crime through direct detective activity.

1. Receive complaint
2. Visit scene and get forensic evidence, if any

Table 23 A Typical Crime

B 3/1	(2)		**COMPLAINANT.** Mr Barker, Manager, Alderton Co-op, 20-24 Western Rd, E.4. **COMPLAINT.** Mr Barker reports that his shop has been burgled during the night.
		L+G (1) 1	ALL DETECTIVES. Co-op is quite a big shop - several depts. Entry was via skylight on flat roofed extension at rear of premises. The building is alarmed, but not this particular skylight. Access to skylight from adjacent building (No. 18) which is presently unoccupied. Mr Barker is not sure what is missing; apparently small items. Thinks transistor radios, electric shavers, hair dryers and watches, have gone. Departments are checking stock. Probably more than £500 worth missing. Have obtained list of current employees and Records are checking these out. Have examined No. 18, found definite signs of access. Rear of No. 18 has loading area. No. 18 used to be a 'Fancy Goods' shop.
		L+G (2) 1 to 3	ALL DETECTIVES. Results of Records check. Couple of blokes with 'previous'. Martin Fisher, 18, taking away motor vehicles, 18 mths ago, (known to Terrel and Pavey). Has worked in stock room for 5 mths, seems o.k. Arthur Wallis, 32, homosexual offences, last one three years ago, seems scared stiff. No. 18 has been shut up for the last 11 mths, end of lease, possibly under development. No signs of forced entry. Co-op. No staff sacked recently. All staff seem clear.
		L+G (3) 1/4	HAWKES only. Fellow by the name of Phillip Beasley, who I know a bit, is working at the Co-op, fills shelves in the supermarket section, he is 16 years old. Seen around with Frank Wood and Des Fuller, a right set of villains!. Beasley seen in Wood's Mini lately. Also in the Dragon pub, George St., E.4. Wood and Fuller may be in on this one, I'll check it out.

Table 23 Cont'd

B 3/1			LIKELY VILLAINS. John Selby, 31, 46a Harrow Road, shop and office breaking. Associates, Ros Stafford, 27 George Bean, 26 Harry Bellis, 22 Les Tepper, 24 Norman Marlow, 34, 14 Sydney Street, office and factories. Many others.
			S.O.C.O. Definite signs of entry via No. 18. Skylight jemmied. Poor prints on skylight and surrounds. Not much to go on. Will try to get a decent print processed.
		L+G	PROPERTY. Complete list of property. Total value is £788.17.6d. All small stuff.
		L.E. (1) 1	Local Enquiries No residential property. Nothing turned up.
		(2) 1	Nothing more turned up.
		 (1) (2)	CIRCULATION. No results from routine enquiries. Detectives to try 'leaning on' some of the more shady second hand dealers. B, S, H, K, C, J, E, Try following:- Roy Williamson, 43 Carson Rd, E.4. Sid Hough, 17 Lansdowne Rd, E.6. Ken Petty, 28 Bismark Rd, E.2. All dealers in kind of goods that are missing.

Table 23 Cont'd

B 3/1		CONTACTS. B, H, S, C, No luck from any contacts. Three days later, begin to get whisperings about Wood and Des Fuller.
	H.	INFORMANT. Peter Webster, 23, 87 Eden Way. Known to Hawkes. Meets Hawkes in Admiral Nelson gets chatting about Co-op job. Webster intimates that Wood and Fuller have done the job. They are going to flog the stuff in London. But they have another job set up for a shop in Palmerston Road and are intending to do it soon. The reason for grassing is that Frank Wood has put Webster's ex-girlfriend, Mary Burnn, in the club, and then left her. Webster and Wood used to be mates.
		CHECK ON WOOD AND FULLER Frank Wood, 25, works in a cut price tyre firm, Cole's Tyres Ltd., 283 Western Rd, D. 3. Lives at 93c Crabwell Gdns, E. 3. Convictions for shop breaking, factory breaking and stealing cars. Desmond Fuller, 21, works as a fitter at Harold Abbot Ltd., 46-50 Broom Rd, C. 4. Lives at Flat 4, 91 Lumiere Ave, E. 3. Convictions for shop and factory breaking. Both are married.
		PROPERTY. Found at Wood's flat up until Day 3, 2130 hrs. After this takes goods to London. Also takes goods from B 3/2, Fine Fayre Records in Palmerston Road, E. 3, which is done on Day 3, at 2030 hrs.
		INTERROGATION. Very difficult, unless most of goods recovered. Villians know most of the Detectives.

3. Interview complainant/loser, witnesses
4. Do local enquiries and circulate descriptions of stolen property
5. Supply information gleaned from the above procedures to the Police System information stores e.g. finger print records, collator files, records office, photograph albums. The output from this will be a list of suspects names - the possibles list.
6. Locate and interrogate or otherwise attempt to eliminate suspects from the possibles list.
7. Charge or release remaining suspects depending on availability of evidence.

Clearly there were three distinct phases in this sequence:

Phase 1: A complaint is received and a set of procedures is set in operation aimed at getting as much data as possible to input to Phase 2.

Phase 2: The police organisation is assumed to contain a set of information storage and retrieval systems e.g. fingerprint records, M.O. records, collator files etc. In principle these accept incomplete descriptions of suspects as input and aim to produce names of suspects as output.

Phase 3: The names of suspects generated during Phase 2 are tested. That is suspects are checked perhaps by direct interrogation, perhaps otherwise for suitability as culprits.

This structure is shown as a block diagram in Fig. 12 showing tests between the blocks so that an investigation may be terminated after any stage. The terminal box in this diagram introduces the second major feature of the overall model, that of the indirect detective activity sequence.

In essence direct activities are those aimed at finding from specific crime information the identity of the guilty party. Conversely indirect activities can be defined as those which aim to work from a knowledge of the behaviours and characteristics of known criminals to a knowledge of which suspects could have committed which reported crimes.

Thus indirect activities are those involved in the use of intelligence information, contacts, informants and collator files mainly. Detectives use this to build an overall picture of the properties and behaviours of the criminal population as well as to get specific items of information. Through this knowledge officers can detect changes in the behaviours of the criminal population and try to relate these to the reported crime pattern.

In most real situations direct and indirect activities are complementary and such a clear cut distinction as has been made is seldom apparent. Nevertheless the field work carried out both by this team and other Home Office scientists strongly supports the general view that a detective is a processor capable of working in either of these modes and switching from one to the other according to stage of investigation, number of cases in hand and D. I. instructions.

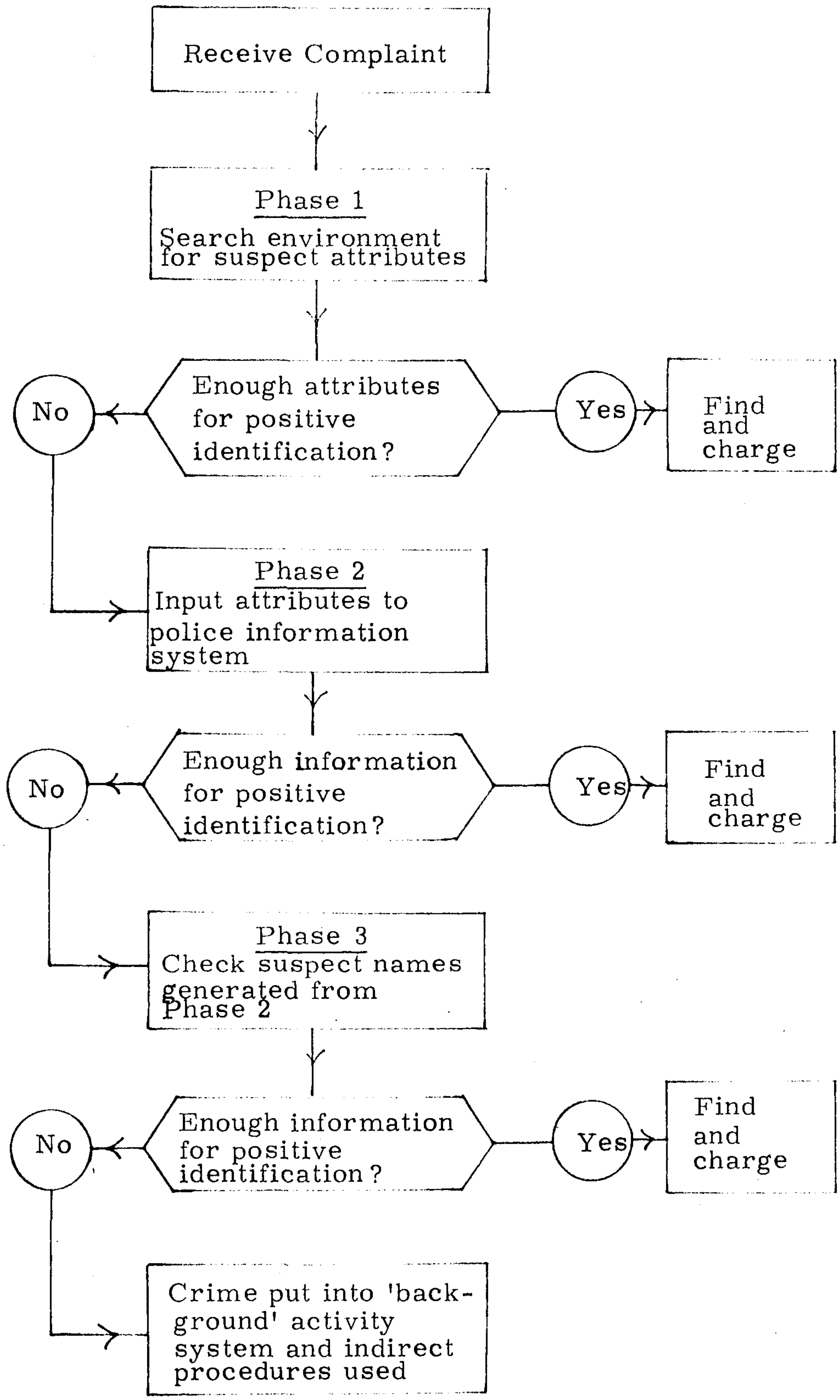


Fig. 12 Three Phase Model of the Detection Process

6.4 SIMPOL III Experiments

Four main objectives were set for this series of experiments 1) To measure the effects on system performance of varying crime input rate 2) to measure the effects on system performance of varying the number of detectives available for duty 3) to investigate relationships between direct and indirect detective activities and their respective effects on system performance and 4) to determine a resource allocation procedure which might form the basis of a computer model.

Fifteen subjects were available for the experiments and the experimental design below was adopted.(A detective team = 1 detective sergeant + 2 detective constables.)

Table 24 Experimental Design for SIMPOL III Experiments

No. of detective teams on duty	Crime Input Rate (Crimes/day)		
	5	10	15
1		Cell A Subjects 3, 4, 9	
2	Cell D Subjects 10, 14, 15	Cell C Subjects 1, 2, 7	Cell E Subjects 11, 12, 13
3		Cell B Subjects 5, 6, 8	

The distribution of subjects, all professional policemen, according to rank was as follows:

Detective Chief Superintendent	-	1
Detective Chief Inspector	-	1
Detective Inspector	-	5
Inspector (Uniformed)	-	2
Detective Sergeant	-	5
Detective Constable	-	1

Total length of service in the police force ranged between 13 and 23 years with an average of 17.7 years. Length of service in CID ranged from 5.5 years to 14 years, average 9.9 years. Eight of the subjects were from forces responsible for dense urban areas and seven from county or county town forces.

The experimental design had five cells and could be regarded as two separate series of experiments. One series was intended to measure the effects of changing crime rates (Cells C, D, E) for three values of input rates. The other series was intended to measure the effects of varying detective availability (Cells A, B, C) for three values of the number of detective teams available. Cell C was common to both experiments and provided a common reference point.

Each subject's experiment lasted two real days and covered a simulated working period of eight working days.

Each subject was given the standard briefing data several days before his experiment so some prior knowledge of the simulation system could be assumed. On arrival in the laboratory each subject was given a further verbal account of the objectives and any of his queries were answered. As expected from previous experience many of these queries expressed doubt or apprehension about the motives e.g. were the experiments tests of ability and if so, who were the results for? Doubts were allayed by 1) emphasising informality and no pre tests of ability were administered. 2) Stressing the exploratory nature of the project and the essential need for critical co-operation from highly experienced professional policemen. 3) By providing assurances of the anonymity of the results. All subjects accepted these assurances and gave full co-operation.

Half-way through each experiment, that is at the end of the first day, and at the end of the experiment each subject was asked to complete a simple questionnaire designed to elicit the subject's view of the realism of the exercise. A copy of the questionnaire is attached as Appendix 2.

At the beginning of each experiment subjects were told how many detectives would be on duty and that the others must be considered unavailable during the simulation. Subjects were not told what crime loading would be used.

Subjects were told that for every crime dealt with they were required to fill out a simplified Crime Report. Its main function was to establish the subject's estimates of crime seriousness as a guide to his resource allocation rule but also as a realistic "simulated office work" task. Each simulated day lasted just under two hours.

The experiments were run by two experienced operators. One, the main operator had the task of representing the police system - keeping and updating detective logs and generating replies from crime information. The second operator kept crime logs, recorded detections and delivered complaint sheets and the collator's daily reports. All discourse between the subject and the simulator was tape recorded.

In summary in each experiment the subject had to control a simulated CID force having the following facilities 1) a number of detective teams, ranging from 1 to 3 (a detective team consisting of 1 Detective Sergeant and 2 Detective Constables) 2) a finger prints department including two specialist Scenes of Crime Officers (SOCOs) 3) a records office containing local criminal records and Modus Operandi (MO) Files and 4) a local intelligence system run by a collator who circulates a daily record bulletin. A population of 88 active criminals was responsible for the 120 crimes in the crime library and crime information was created by first writing behaviour histories for each of the active criminals over the simulated period and then devising crime data from these.

6.5 Results

There were three categories of results from this set of experiments 1) an analysis of questionnaires given to subjects (a) half way through and (b) after each experiment 2) the comparison of system performance for the five cells of the experimental design and the derivation of data about the relative amounts of effort expended on direct and indirect detective activities and 3) the derivation of procedures and rules used by the subjects to allocate crimes to detectives.

6.5.1 Questionnaire Results

Results from the two questionnaires are given for each subject in Tables 25(a) and (b). A tick indicates agreement with the stated observation which is given in abbreviated form in the left hand column.

Three subjects 4, 8 and 14 completed only the first of the two questionnaires. For the others it can be seen that subjects tended not to change their responses from the first to the second presentation of the questionnaire. The average number of questions to which responses were changed was 3.2 ranging between 1 and 7. From this it can be concluded that the subjects attitude to the simulated situation does not seriously change between mid-way through an experiment

Table 25 Questionnaire Results a) First b) Second

(a)

Questions \ Subject		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Crimes Unrealistic	1													✓		
Detectives Low Quality	2			✓	✓	✓		✓	✓		✓	✓		✓		✓
Simulation Too Fast	3				✓		✓		✓			✓	✓	✓		✓
One Voice Bad	4				✓	✓										
Tiring	5			✓	✓	✓	✓					✓	✓	✓		
Too Many Crimes	6	✓	✓				✓					✓	✓	✓		
Too Easily Cleared	7												✓	✓	✓	
Too Many Contacts	8				✓					✓						
Expect SOCO More Success	9			✓	✓				✓			✓	✓			
Simulation Too Short	10	✓			✓	✓	✓			✓	✓	✓		✓		✓
Scene Info Too Good	11		✓		✓								✓	✓		
Expect More Recovered Property	12					✓	✓								✓	✓
Poor Local Knowledge	13				✓	✓					✓			✓		
Want to Leave Office	14	✓	✓	✓	✓	✓	✓		✓		✓	✓	✓	✓		✓
Hard to Keep Track Crimes	15	✓		✓					✓	✓	✓		✓	✓		✓
Crimes Too Trivial	16	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓		
Overloaded	17		✓	✓	✓					✓	✓	✓	✓	✓		
Simulation Unrealistic	18															
Inv of Crime Superficial	19	✓	✓	✓	✓		✓		✓	✓	✓	✓	✓	✓		✓
Lack of Crim Pop Inf	20				✓	✓	✓		✓	✓	✓	✓	✓	✓		✓

Table 25 Cont'd.

(b)

Questions \ Subject		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Crimes Unrealistic	1										√					
Detectives Low Quality	2					√		√			√	√		√		
Simulation Too Fast	3		√				√			√	√		√	√		√
One Voice Bad	4															
Tiring	5			√		√						√		√		√
Too Many Crimes	6	√	√	√			√					√	√	√		
Too Easily Cleared	7												√	√		
Too Many Contacts	8													√		
Expect SOCO More Success	9					√	√	√		√	√	√				
Simulation Too Short	10						√			√	√	√		√		√
Scene Info Too Good	11	√	√										√	√		
Expect More Recovered Property	12					√	√									
Poor Local Knowledge	13					√	√			√				√		
Want to Leave Office	14	√	√	√		√	√	√			√	√		√		√
Hard to Keep Track Crimes	15		√	√			√	√			√	√		√		
Crimes Too Trivial	16	√	√	√		√	√				√	√	√	√		
Overloaded	17	√	√	√			√					√	√	√		√
Simulation Unrealistic	18									√						
Inv of Crime Superficial	19	√	√	√			√			√	√		√	√		√
Lack of Crim Pop Inf	20					√	√			√	√	√	√	√		√

and the end of an experiment. This confirms that learning and familiarisation is completed during the first half of an experiment.

Other conclusions from the questionnaire are that, overall, the model is considered to be realistic, only one subject disagreeing with this at the end. The most frequently cited reasons for any lack of realism were 1) the inability of the D.I. to get out of the office and do his own investigations 2) many of the crimes were too trivial to warrant CID attention 3) some of the simulated detectives were not thought to be up to CID standards (some subjects, while commenting that some of the detectives were below standard, added that this was quite realistic 4) two thirds of the subjects felt they were hampered by not knowing more about "local villains" and felt a lack of personal contact.

With regard to the ergonomics of the simulated situation seven out of the twelve final respondents said that the pace was too fast. None felt confused by the fact that one operator represented all the detectives. Eight experienced some difficulty in keeping track of the different crimes and ten felt handicapped by their inability to get out of the "office" and do investigations themselves.

6.5.2 System Performance Results

Detection rate (defined at time t as the percentage ratio of the number of crimes cleared up to the number of crimes input up to time t) is shown plotted against simulated time for all the subjects and all the experimental conditions in Figs. 13a-e. From these it can be seen that two subjects, S2 in cell C and S15 in cell D, had consistent abnormally low performances. Examination of protocols showed that both these subjects followed highly inflexible, procedure dominated modes of operation. For example S2 concentrated on the collator facility attempting to relate all activity to this and S15 concentrated on getting his men out and about on indirect activities to the exclusion of direct crime investigation activities. Though this further demonstrated the SIMPOL system's potentialities as a testing device it was decided to leave these anomalous subjects from the performance measure analyses. The table below shows the final average detection rate for each cell in the experimental design.

Table 26 Detection Rates for SIMPOL III Experiments (excluding anomalous subjects)

No. of Det Teams	Crime Loading		
	5 per day	10 per day	15 per day
1		34%	
2	48%	30%	30%
3		42%	

Shown graphically in Figs. 14a and b the two curves, representing change of performance measure with increasing number of detective teams and increasing crime loading respectively, show considerable similarity. Transforming the abscissae into the composite load measure, crimes per day per

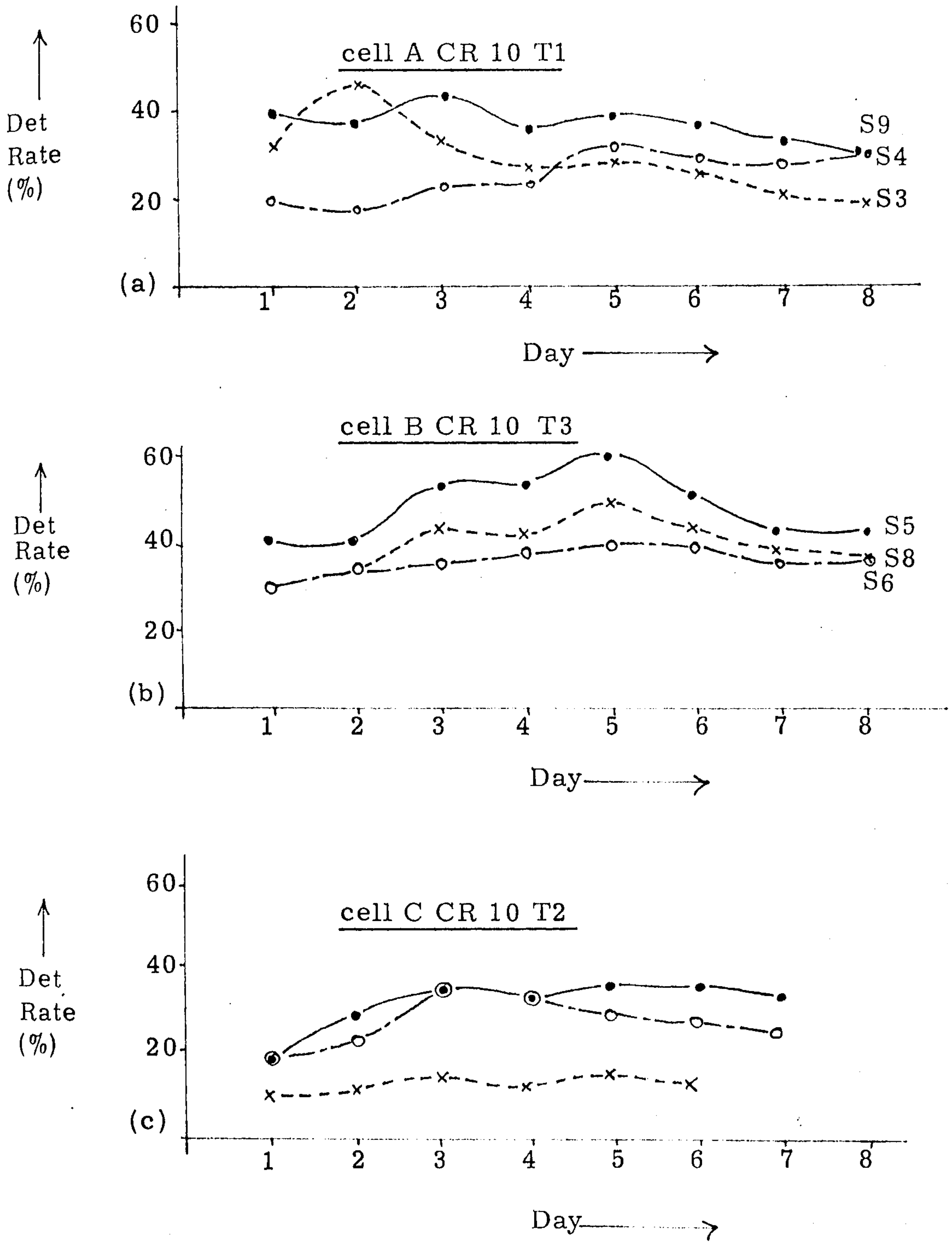


Fig. 13 Detection Rate v Time, for all Conditions and Subjects

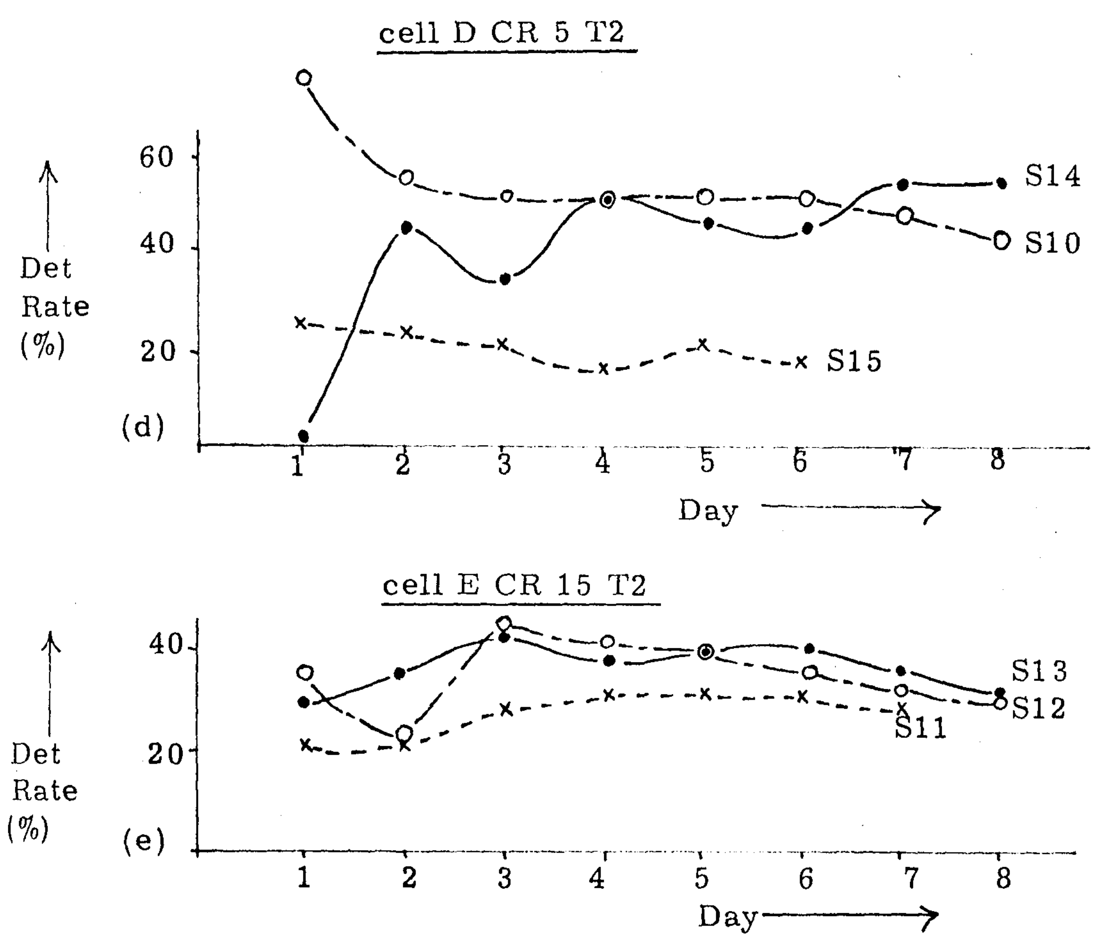

cell D CR 5 T2
60
40
20
Det
Rate
(%)
(d)
S14
S10
S15
1
2
3
4
5
6
7
8
Day
cell E CR 15 T2
40
20
Det
Rate
(%)
(e)
S13
S12
S11
1
2
3
4
5
6
7
8
Day

Fig. 13 Cont'd

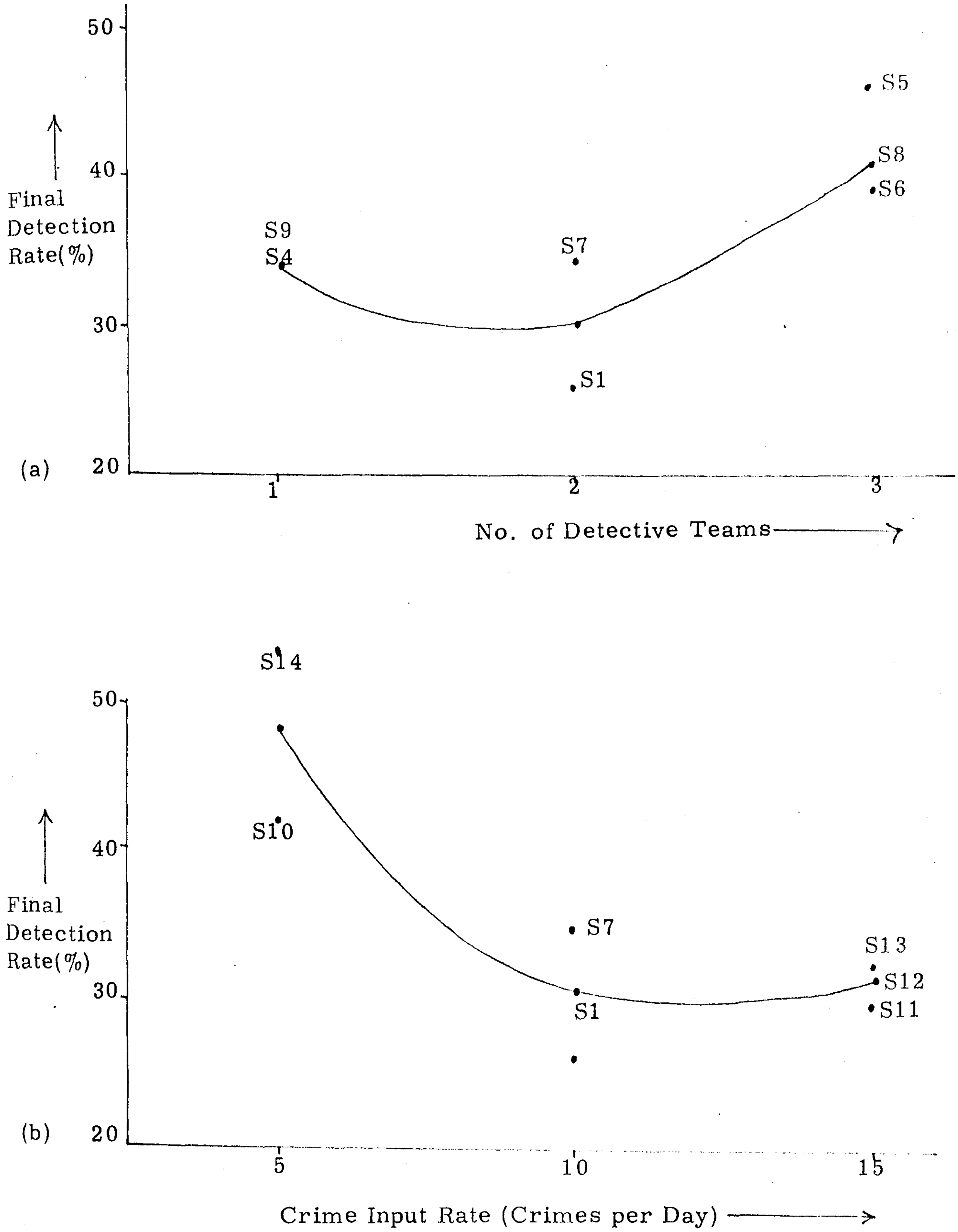


Fig. 14 Detection Rate versus a) Number of Detective Teams and b) Crime Input Rate

detective, results in the curves shown in Fig. 15. These show clearly the main characteristics of this part of the performance space of the system. That is, a relatively small increase in the composite load measure from 0.8 to 1.7 results in a significant drop in the performance measure which then stays approximately constant up to the maximum load point of 3.33 crimes per detective per day.

The key question arising from this result, and indeed one which lies at the heart of all simulation work, is whether this result is an artifact of the model itself or whether it does reflect some feature of the real system? There are two approaches to resolving this issue. One which we shall call the traditional seeks to show that the same phenomenon, or something very like it, has been observed in the real system. That is a body of data about the behaviour of the real system is required as a check on the model. But if similar behaviour has been observed in the real world we can only say that the model produces similar behaviour to the real world system and we are still left with the important question as to how well the mechanisms in the model explain the mechanisms which give rise to the behaviour of the real system. Behaviour correspondence tells us little about that problem.

The other approach begins with this latter problem of explanation. It starts with the observation of model behaviour, seeks to explain that in terms of model mechanisms and then postulates mechanisms within the real world system. The empirical task

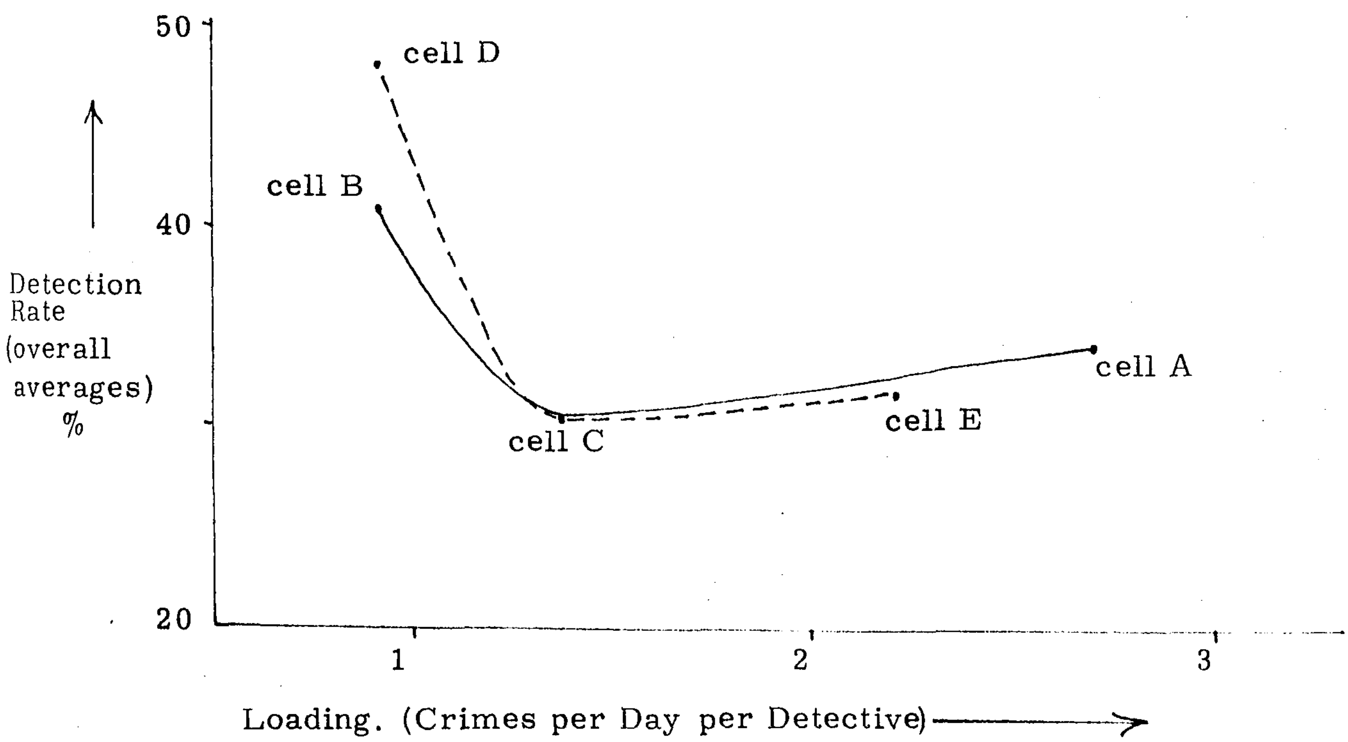


Fig. 15 Detection Rate v Composite Load Measure

of detecting these mechanisms is thus rather more precisely defined than the traditional question "has the real world system produced a similar behaviour?".

An explanation of the observed drop in performance over the range of increasing load is found in the allocation of detective manpower to the different phases of the investigation process. Figs. 16a, b, c, show the relationship between proportion of detective time spent in direct enquiries and the proportion spent in indirect activities. From this we see that the reduction in performance is associated with a reduction in the amount of time spent on indirect activities. Thus the hypothesis that this phenomenon of the model's behaviour suggests is that increasing the proportion of time on indirect activities at higher levels of loading would increase performance at these higher levels. Is there any justification for believing this might be the case in real CID units? Studies of detective activities and work loads were carried out by Home Office staff but, at the time of writing, results were not available. Therefore there is no hard evidence to support the hypothesis. On the other hand discussions with police officers about the plausibility of the hypothesis indicated some measure of support. For example it has been stated that often too much time is spent on routine visits - called "showing the flag" public relations exercises which provide little useful information. Thus the main point to be made is that, in spite of a lack

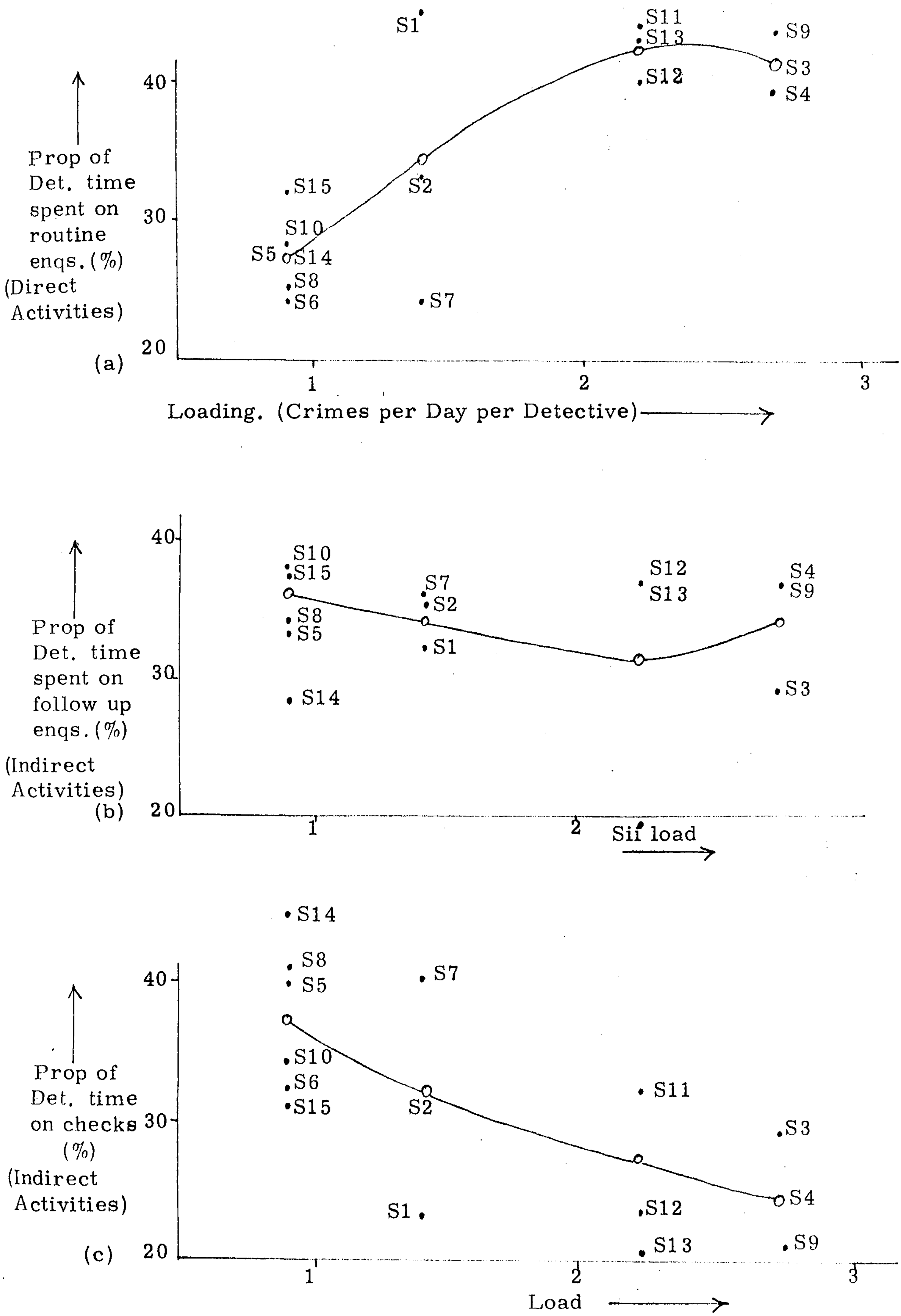


Fig. 16 Proportion of Time on a) Routine Enquiries v Load b) Follow Ups v Load c) Checks v Load

of empirical support for the general validity of the model, hypotheses can be generated to explain features of the model's behaviour which can act as input to police for considering alternative strategies. So the model has use as a means for suggesting alternative modes of operation.

6.5.3 The Derivation of Decision Rules

One of the requirements for the SIMPOL III set of experiments was the study of the resource allocation rules used by the subject in deciding which detectives to allocate to which crimes. The specification of such a rule is necessary for the design of a computer model of the simulation systems. However as far as the computer model is concerned there are three alternative approaches to the problem of programming decision rules. First a normative prescriptive rule might be used. That is a rule which specifies how resources ought to be allocated based on some, perhaps theoretical, principles giving a mathematically defined optimal procedure. Second a rule based on what an individual subject did over a period of time in the decision situation examined and third, an average rule based on what a group of subjects did. We might call these rules the ideal, actual and average respectively.

Strategically the interest at this stage of the project was in the possibility of modelling an individual's behaviour but to use that in a modelling system which would allow the eventual examination of both ideal and average decision rules. To this end the data from one subject in the SIMPOL III series was examined in detail. The allocations made during the experiment were listed and from this empirical data a decision rule was inferred. The algorithm obtained is shown in flow diagram form in Fig. 17. The seriousness figures were obtained from the crime reports which the subject had to complete for each crime tackled. From this we can see that this particular subject perceived detectives as being in five possible states:

1) Free - the detective isn't doing anything and is therefore available

2) Doing routine enquiries and therefore not available i.e. in this state the detective is non-interruptable.

3) Doing follow-up activities i.e. he has done routine enquiries and is following these up by, for example, finding car ownership or checking dealers for stolen property

4) Searching for suspects

5) Writing reports or consulting contacts and informants

These last three states are listed in the order in which this particular subject preferred to interrupt detectives with new tasks. Table 27 shows the allocation obtained by applying the algorithm together with the actual allocation made by the subject for a sample of 15 crimes.

Thus there is close but not perfect correspondence between the behaviour of the algorithm and the subject's behaviour. It would have been

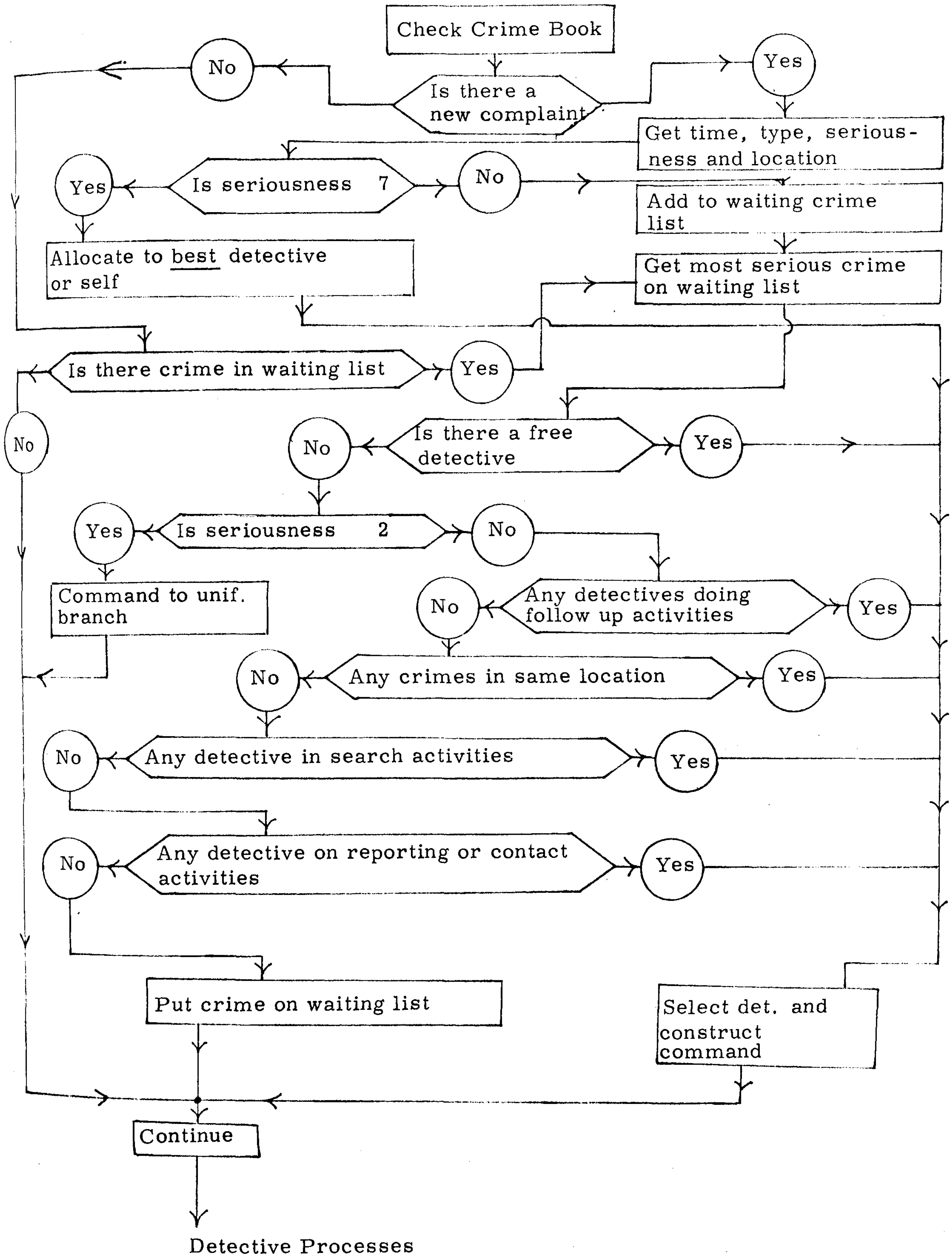


Fig. 17 D. I. Resource Allocation Algorithm

Table 27 Comparison of subjects' allocations during a manual SIMPOL experiment with allocations made by an inferred algorithm

Crime No.	Algorithm Allocation	Subject Allocation
61	D.S. Brown	D.S. Brown
67	D.C. Salmer	D.C. Salmer
65	D.C. Keath	D.C. Keath
63	D.C. Salmer	D.S. Brown
86	D.C. Hawkes	D.C. Hawkes
84	D.C. Salmer	D.C. Salmer & Unif.
83	D.C. Salmer	D.S. Brown & Unif.
82	D.S. Pavey	D.S. Pavey & Unif.
81	D.C. Keath	D.C. Keath & Unif.
103	D.S. Pavey	D.S. Pavey
102	D.C. Salmer	D.C. Salmer
101	D.C. Salmer	D.S. Brown
105	D.S. Pavey	D.C. Salmer & Unif.
106	D.S. Pavey	D.S. Pavey
107	D.S. Pavey	D.S. Pavey

surprising were such a simple algorithm able to reproduce perfectly the behaviour of the subject. However the fact that it was possible to get such a close correspondence supported the notion that a programmed model of a subject's resource allocation strategy was feasible and that this could form part of a computer model of the total SIMPOL system.

6.6 General conclusions from the SIMPOL III set of experiments

The SIMPOL III experiments were designed to fulfil several functions mainly however to explore the response of the system to changes in crime loading and detective strength and to study the possibility of making a computer model of the system.

The experiments on loading showed that the response of the system to increasing load was non-linear. Examination of this non-linearity suggested an hypothesis that decreases in performance as load increased was due to a shift from indirect to direct detective activities. Though it has not been possible to test this hypothesis in a real CID system the hypothesis appeared to have intuitive plausibility in the eyes of some CID officers.

A decision algorithm was inferred from the experimental data showing how one subject allocated detectives to crimes. On this basis plans for developing a computer model of the SIMPOL system were made and this development is described in the next chapter.

Chapter 7

The Structure of a Computer Model of the SIMPOL System

7.1 Introduction

This chapter outlines the structure and programming of a digital simulation of the SIMPOL system based on the manual SIMPOL simulation system described in the previous chapters. It was designed to run on the IBM 1130 single disc computer system in the Police Scientific Development Branch of the Home Office.

The remainder of the chapter falls into five parts. Section 7.2 outlines the main features of the digital simulation programme structure. Section 7.3 covers the structure and organisation of the data base. Section 7.4 describes the CID model including the resource allocation algorithm used by the model D.I. Section 7.5 describes the input requirements for a simulation experiment and the form of output results. In Section 7.6 output protocols from a run with the model are presented. Finally in Section 7.7 there is a brief discussion of the uses of this type of model.

7.2 The Program Structure

A digital simulation, like a mathematical model, is an abstract representation of a real entity. There are several types of digital simulation, the most fundamental distinction is between simulations which model flows through a system (e.g. flows of money, electric current, hydraulic fluid, personnel, raw materials etc.) and those which model sequences of distinct events, (e.g. valves closing, aeroplanes landing, traffic lights changing, decisions being made).

Our concern in studying police organisations has been to come to an understanding of the crime detection process through the information handling behaviour of detectives. This has meant that the type of model we have developed is event orientated. Detectives carry out discrete types of activity switching from one type to another as information is uncovered. Further we have sought to represent in detail the detective's decision making behaviour. Simulation models which reflect this level of detail are classified as micro-simulations as opposed to macro-simulations which model aggregated behaviours. (See Elton and Rosenhead; 1971).

A block diagram of the SIMPOL computer model is shown in Fig. 18. In principle the operation of the model is as follows. Complaints are generated from crime information stored in the data base. These are processed by the Force model to produce an output list of detected and undetected crimes. The system is dynamic, that is, the Force model has to deal with a sequence of complaints. It does this by means of a resource allocation algorithm which was derived from observations of D.I. behaviour in the manual SIMPOL system. Detailed flow diagrams and listings of the whole model are presented in Appendix 3.

The data base contains information about crimes and criminals. Its detailed structure is explained in Section 7.3.

The Force model contains models representing the operations of detectives and their supporting systems - the collator, records office, scenes of crime unit, the model of the resource allocation system used by the D.I. and a less detailed model of uniformed branch activity where it impinges on CID functions.

In general any one of the sub systems modelled in the Force model can be thought of as an agent which carries out certain

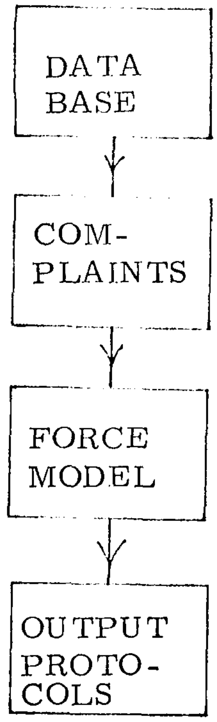


Fig. 18 Overall Block Diagram of SIMPOL Computer Simulation System

specified operations on data given as its input data. The results of these operations are either data which are parts of a suspect description or data which specify a type of activity required to get a suspect description. In summary agent activities either result in the retrieval of suspect descriptors or the specification of further activity types required to get a suspect descriptor. Fig. 19 shows the list of activities which are allowed for a model detective. A breakdown of the Force model into the component active agents is shown in Fig. 20.

The operation of the total simulation model is controlled by a sequence of events. Several types of events are defined. The two major types are

1. Complaint report and
2. The end of an activity

These are scheduled at irregular intervals during the course of a simulation run. The complaint schedule is defined prior to a run and constitutes the main input. The "Activity end" events are not scheduled prior to a run, they are scheduled by the model as the run proceeds. As well as scheduled discrete events there are events which occur as a direct consequence of a scheduled event and there are events which are designed to simulate continuous or continuing activities.

An example of the former is the "begin activity" event which follows an "end activity" event. The particular "begin activity" event for a detective which occurs at any instant is selected from a list called the "Noticing List" according to the detective's priorities at this instant. One example of the latter is the decision process which selects the next event. This is a model of the more or less continuous process of situation assessment

ACTIVITY TYPE No.	ACTIVITY
1	Attend scene and get general information
2	Interview loser/complainment
3	Do local enquiries
4	Check records/photo album
5	Check vehicle indices
6	Check collators files
7	Check contacts/Informants
8	Search for suspect
9	Interview suspect
10	Report preparation
11	Attend court

Fig 19 List of Programmed Detective Activities

FORCE MODEL

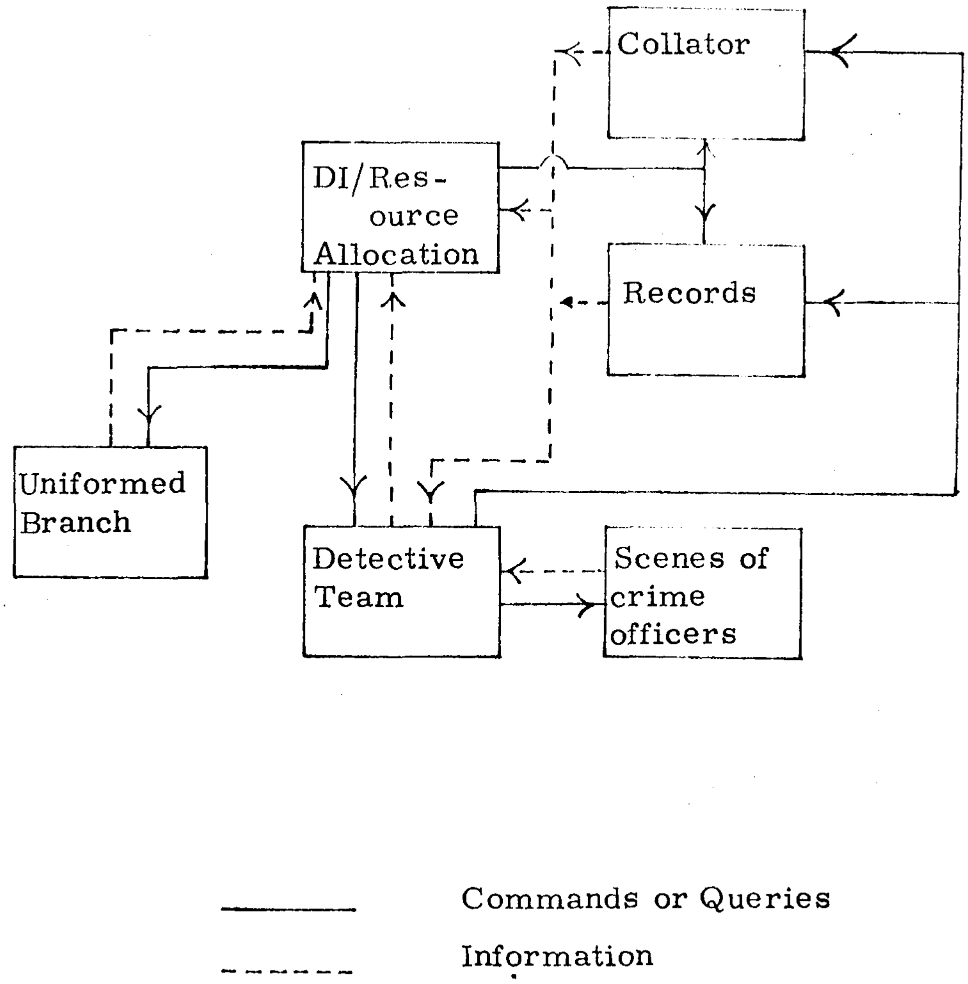


Fig 20 Force Model Block Structure

which a detective carries out as he is attending to routine activities. Thus "begin assessment" is an event which occurs at every time interval.

An outline flow diagram showing the timing relationships is shown in Fig 21.

Summaries of the procedures carried out within the model at the end of each activity type are given below.

Activity 1 - General Enquiries at Scene

Information about the address, value, type of property stolen, etc. is retrieved from the data base and transferred to a crime report data structure. If the data base contains a large amount of scenes of crime information a request is registered for a visit by a Scenes of Crime Officer. The recommended next activity is listed as type 2 - Interview Loser.

Activity 2 - Interview Loser

Information is retrieved from the data base and, depending on its type, is copied to the crime report data structure or to a suspect or vehicle description list. The recommended next activity is type 3 - local enquiries, if no significant suspect information is found or is Type 8 - Search for suspect if significant information is found.

Activity 3 - Local Enquiries

Similar to type 2 except that the next activity will be type 7 - Check contacts and informants if no significant suspect information is found.

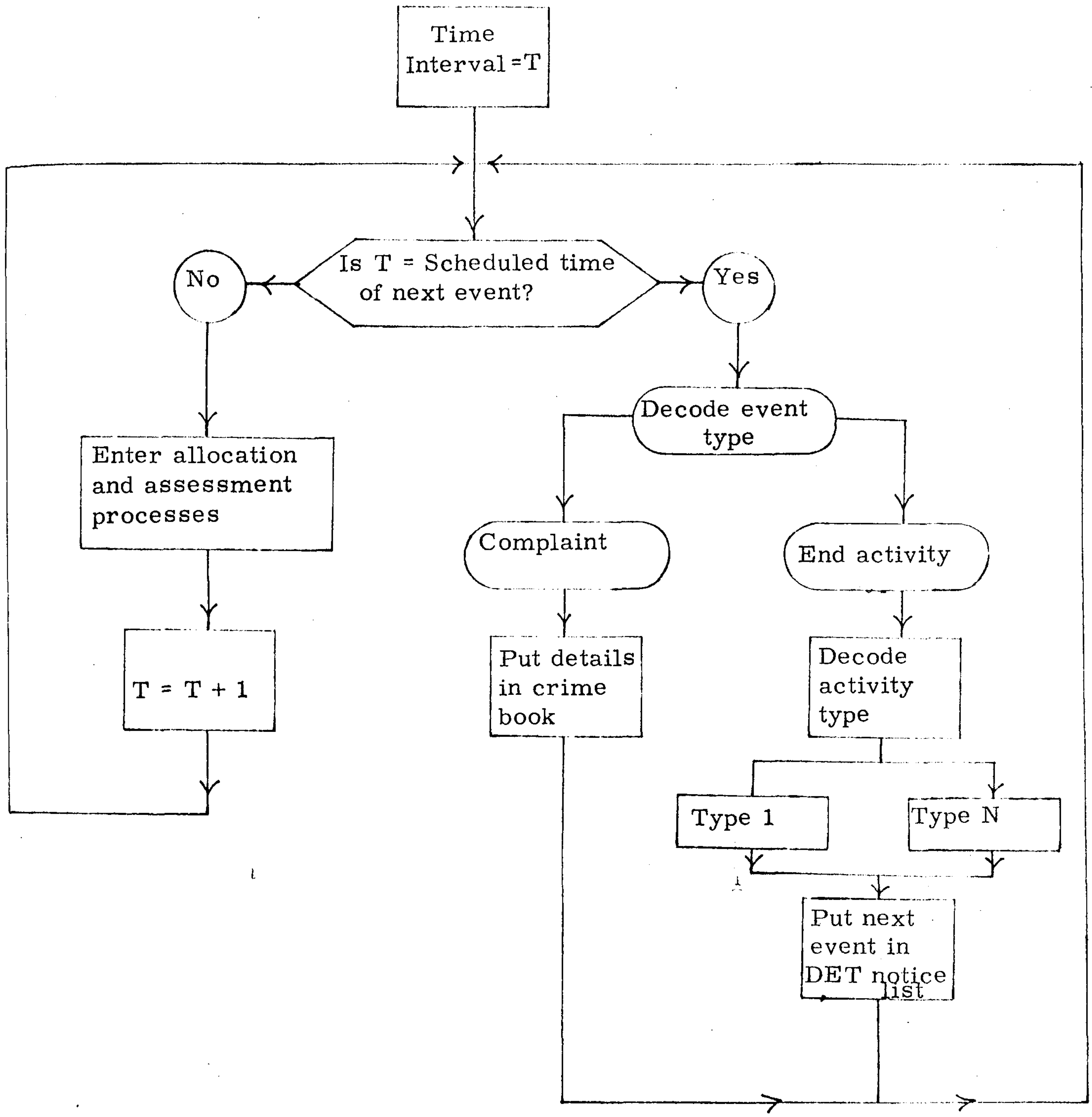


Fig 21 Outline Programme Organisation

Activity types 4, 5 and 6 consist of searches for suspect names via records, vehicle or collator report. If a suspect name is found, Activity type 8 (Search for suspect) is recommended, otherwise no next activity is specified.

Activity 8 (Search for suspect) is basically a test to see if a suspect is at the address the detective chooses to search (usually the last known address for the suspect).

If the suspect is found the next recommended activity is Type 9 (Interview) otherwise another search is recommended.

Note that when one activity is stated as the logical next step of a terminated activity it is put into the detective's noticing register where it becomes eligible amongst others, for selection as the next activity to be carried out.

In summary the crime investigation process is modelled as a sequence of prescribed routine activities (Types 1, 2 and 3) followed, if these don't produce suspect identifying information, by a set of follow up activities (Types 4, 5, 6 and 7) and in turn either of these groups of activity can be followed by searching for and interviewing suspects.

7.3 Data Base

The data base has two major components, "Criminal" data and "Crime" data. Very broadly the CID model tries to retrieve data from the crime data base using the modelled activities to build a description of a suspect which can then be matched aginst the descriptions stored in the "Criminal" data base.

Each criminal is specified by the set of 17 descriptors shown in Figure 22. The values of the descriptors are either numerical values e.g. Age or Height, or are codes representing a classification e.g. Crime Class, Modus Operandi, Job or Vehicle Type. The classifications used for some of the descriptors are shown in Table 28. 95 criminal descriptions were stored in this way. Data for the first 34 are shown in Table 29.

The "Crime" data base is slightly more complex. Each crime has four categories of information class and each class has several types of associated information. This associated information is either a specific value e.g. the time at which the crime occurred. or a code e.g. specifying the type of premises broken into, or a pointer to another list containing "description fragments". Minimally a "description fragment" is a pair of numbers, the first specifying an attribute e.g. 9 - Hillman Avenger (see Table 28). This basic crime information structure is shown in Figure 23 and its form of representation in the computer in Figures 24 (a) and (b). 95 crimes are stored in the data base in this way, two of which are listed in Tables 30 (a) and (b).

The basic input to the simulation model is a crime programme generated from the crime data base by a program CPROG which sequences the crimes in order of their reporting times.

Another data file CRCR is a crime-criminal map specifying for each crime the criminals actually responsible and is designed to help validate the results of the detection model.

This basic data base structure has been used for initial testing of the SIMPOL computer model. Extensions which have been designed but not implemented yet include:

Physical Description				Crime Style				Social Description				Vehicle Description					Vacant (at present)		
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Sex	Age	Ht	Col-our	Crime Class	Av. Ser.	M.O.	Lon-er	Add-ress	Job	Mar-ried	Close Assoc.	Make	No.	Year Model	clr.	Cro-ok No.			
																1			
																2			
																3			

Fig 22 A list of attributes comprising a criminal description

Table 28 Criminal Information Classification

Code No.	Crime Class	Modus Operandi	Job	Vehicle Type	Vehicle Colour
1	Breakings	Petty theft, vandalism	Retired	Truck	White
2	Violence	Low value breakings	Unemployed	Ford van	Red
3	Fraud	High value breakings	Labourer	Bedford van	Black
4	Sex	Shop/Office breakings	Salesman	BMC van	Blue
5		Safes & very high class breakings	Delivery man	Vauxhall Cresta	Grey
6		Robbery with violence	Office Worker	Mini	Brown
7		Bodily harm	Factory Worker	Sports Car	Cream
8		Fraud against businesses	School-child	Ford Anglia	Beige
9		Fraud against individuals	Student	Hillman Avenger	Maroon
10		Fights, public nuisance	Shop Worker	Cycle	Yellow
11		Sex offences	Club Worker	Mini Van	
12		Theft from person or shop	Hippy	Austin 1100	
13		Hi-Jacks	Odd job Man	Zephyr	
14			Director	Removal Van	
15			Apprentice	Rented Van	
16			Plumber/ Electrician	Motor Cycle	
17			Seaman/ armed forces	Cortina	
18			Gypsy	Lorry	
19			Domestic Worker	Laundry Van	

Table 29 Listing of First 34 Entries in Criminal Data Base (VINF)

SEX	AGE	HGT	COL	CR.CL	AV.SE	MO	LON	ADD	JOB	MAR	ASS	MAKE	NO	YEAR	COL	V.NO
1	25	71	1	1	6	3	2	56	5	2	0	2	943	70	2	1
1	11	60	1	1	4	1	2	51	8	2	3	0	0	0	0	2
1	12	62	1	1	5	1	2	42	8	2	2	0	0	0	0	3
1	20	72	1	1	4	2	2	87	12	2	7	0	0	0	0	4
1	16	66	1	1	5	2	1	44	2	2	0	0	0	0	0	5
1	28	73	1	1	4	1	1	26	13	1	0	1	283	58	4	6
1	19	70	1	1	5	2	2	87	12	2	4	0	0	0	0	7
1	23	71	1	2	5	10	2	67	3	2	0	5	171	64	7	8
1	22	69	1	1	6	4	2	53	3	2	10	6	234	68	2	9
1	24	68	1	1	6	4	2	53	7	2	9	4	886	69	7	10
1	10	67	1	1	4	1	2	72	10	1	0	0	0	0	0	11
1	48	69	1	4	4	11	1	73	10	1	0	0	0	0	0	12
1	29	72	1	1	5	2	1	54	11	1	0	0	0	0	0	13
1	13	66	1	1	4	1	2	42	8	2	15	10	0	0	2	14
1	13	64	1	1	4	1	2	52	8	2	14	10	0	0	10	15
1	12	64	1	1	3	1	2	45	8	2	18	0	0	0	0	16
1	15	70	1	1	4	2	2	45	15	2	19	0	0	0	0	17
1	11	60	1	1	2	1	2	45	8	2	16	0	0	0	0	18
1	14	67	1	1	2	1	2	45	8	2	20	0	0	0	0	19
1	14	63	1	1	2	1	1	45	8	2	19	0	0	0	0	20
1	35	73	1	1	4	2	1	56	3	1	0	0	0	0	0	21
1	44	70	1	3	6	9	1	90	4	2	0	7	890	66	1	22
1	36	74	1	2	7	7	1	57	11	1	0	8	76	88	9	23
1	28	70	1	3	6	8	2	76	4	1	0	9	113	70	6	24
2	25	64	1	3	4	9	2	46	6	1	0	0	0	0	0	25
1	52	68	1	1	3	1	1	55	2	1	0	0	0	0	0	26
1	27	67	1	1	4	2	1	57	2	2	0	11	901	64	5	27
1	14	68	2	1	3	1	2	45	8	1	29	0	0	0	0	28
1	13	66	2	1	3	1	2	45	8	1	28	0	0	0	0	29
1	50	67	1	1	4	2	1	46	11	1	0	12	311	69	7	30
1	15	69	1	1	4	2	2	45	8	1	0	0	0	0	4	31
1	21	73	1	1	4	1	1	58	6	1	0	6	885	66	3	32
1	30	74	1	2	7	6	1	67	17	1	0	0	0	0	0	33
1	26	69	1	1	5	4	2	45	7	1	35	2	283	68	2	34

CLASS	TYPE	VALUE
GENERAL INFORMATION = 1	CRIME TYPE = 1	BREAK IN = 1 VIOLENCE = 2 FALSE PRETENCES = 3
	SERIOUSNESS = 2	(Value)
	PREMISES = 3	HOUSE = 1, 2 or 3 FACTORY = 4 SHOP = 5 OFFICE = 6 WAREHOUSE = 7
	ADDRESS = 4	(area code)
	REPORTING TIME = 5	(value)
	M.O. = 6	(type code)
S.O.C.O. = 2	FINGERPRINTS = 1	(Identifying Code)
	FOOTPRINTS = 2	(" ")
	CLOTHING = 3	(" ")
	TYRE MARKS = 4	(" ")
LOSER = 3 INFORMATION	PROP. DESCR. = 1	CASH = 1 JEWELLER. = 2 GOODS = 3
	ESTIMATE OF TIME COMMITTED = 2	(Value)
	SUSPECT NEM = 3	(Name Code)
	DESCRIPTION = 4	POINTER
	PHOTO IDENT = 5	(Name Code)
LOCAL ENQUIRIES = 4	SUSPECT NAME = 1	(Name Code)
	PHOTO IDENT. = 2	(Name Code)
	DESCRIPTION= 3	POINTER

Fig 23 Basic Crime Information Structure

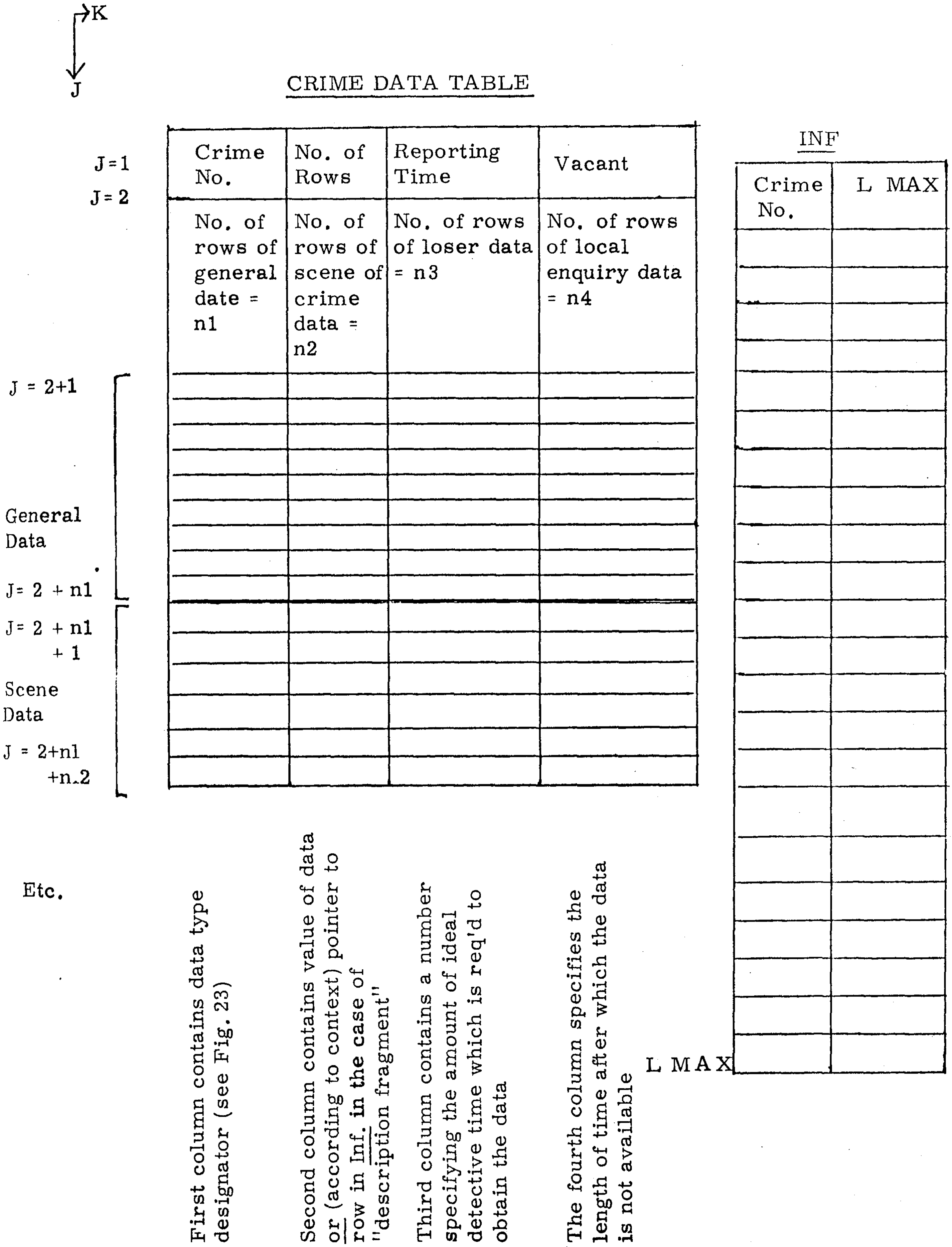


Fig. 24a) Crime Data Table Layout

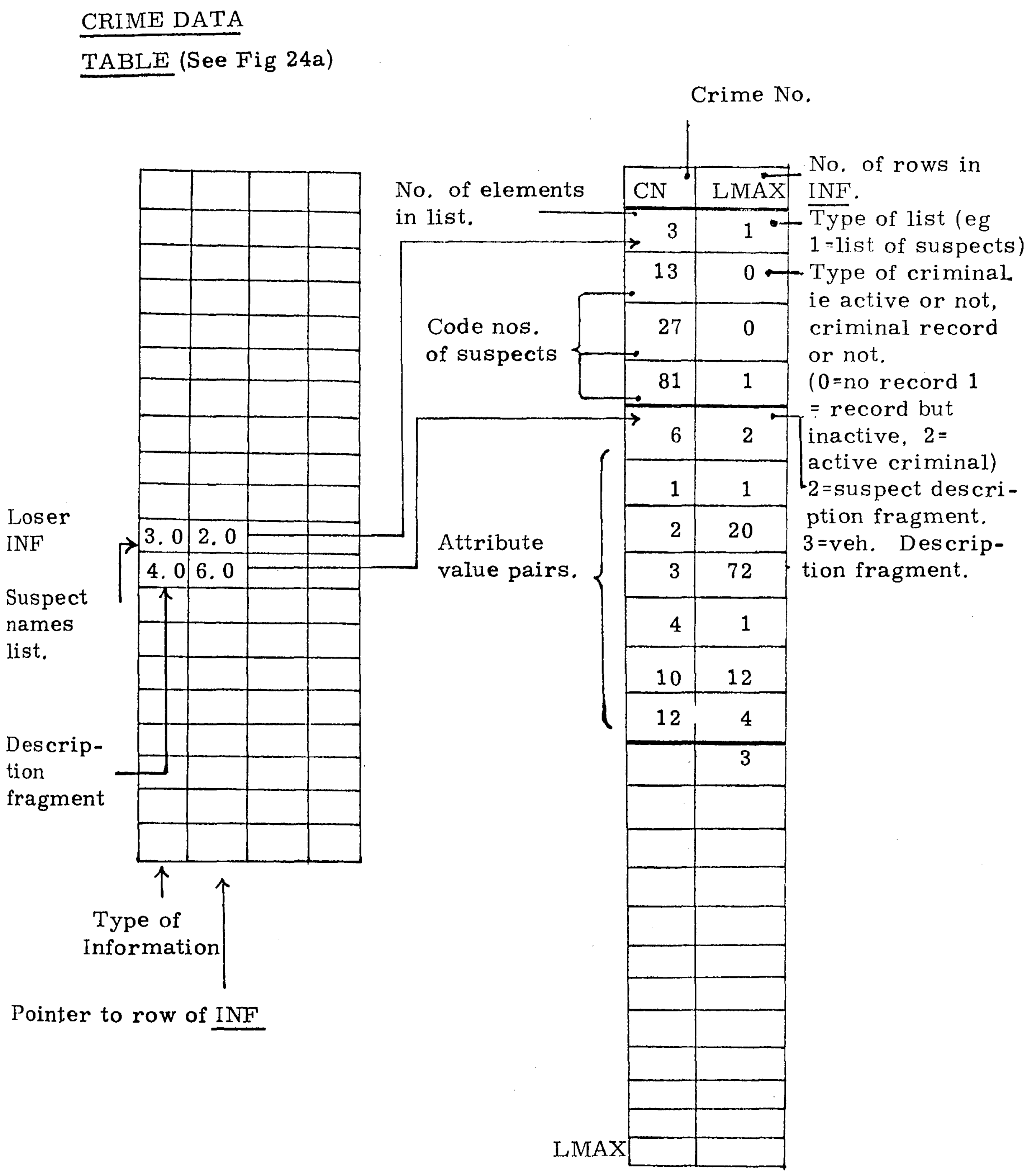


Figure 24 b Example of pointer mechanism linking description fragment list (INF) to main crime data structure

CRIME NUMBER 2

CRIME SOURCE DATA - CR

2.0000	11.0000	2.4000	0.0000
6.0000	2.0000	2.0000	1.0000
1.0000	1.0000	1.0000	1.0000
2.0000	6.0000	1.0000	1.0000
3.0000	8.0000	1.0000	1.0000
4.0000	51.0000	1.0000	1.0000
5.0000	2.4000	1.0000	1.0000
6.0000	100.0000	3.0000	2.0000
1.0000	100.3000	2.0000	2.0000
5.0000	100.4000	2.0000	2.0000
1.0000	9.0000	1.0000	1.0000
2.0000	1.8000	3.0000	2.0000
1.0000	1.0000	3.0000	2.0000

DETAILED CRIME DATA - INF

2	11
6	0
1	1
2	10
3	60
4	1
9	51
10	8
2	5
10	2
0	0

Table 30 (a) Typical Crime Data

CRIME NUMBER 3

CRIME SOURCE DATA - CP

3.0000	18.0000	2.2400	0.0000
0.0000	0.0000	4.0000	1.0000
1.0000	1.0000	1.0000	1.0000
2.0000	3.0000	1.0000	1.0000
3.0000	5.0000	1.0000	1.0000
4.0000	67.0000	0.0000	1.0000
5.0000	2.3400	1.0000	1.0000
6.0000	1.0000	1.0000	2.0000
1.0000	16.0000	3.0000	1.0000
2.0000	2.2800	2.0000	2.0000
3.0000	2.0000	1.0000	3.0000
5.0000	6.0000	2.0000	2.0000
1.0000	13.0000	4.0000	2.0000

DETAILED CRIME DATA - IDF

2	18
3	1
113	0
114	0
5	1
6	2
1	1
2	20
3	72
4	1
10	12
12	4
2	1
2	2
3	2
2	5
11	1
0	0

Table 30 (b) Typical Crime Date

1. A sequence of criminal "sittings" corresponding to primitive local intelligence collator reports.

2. Files representing the characteristics of fingerprints and marks retrieved from the scene of a crime which are then operated on by procedures representing the fingerprint and forensic processes.

3. A file representing described characteristics to be operated on by procedures representing the photo album check and identikit processes.

An overall block diagram of the model is shown in Fig 20. A flow diagram of a DI resource allocation algorithm is shown in Fig 17. This is a realistic algorithm derived from manual SIMPOL data. Table 27 shows, for a sample of crimes during a SIMPOL experiment the allocation suggested by the algorithm compared with the actual allocation selected by the subject of the SIMPOL experiment. This shows good agreement. (Only three of the actual allocations are not contained in the predictions. Two of these involve uniformed branch allocations indicating that the way the uniformed branch decision was made by the algorithm was not adequate. The algorithm shown in Fig 17 includes a modified uniformed branch decision). Note the option whereby the DI can decide to investigate a crime himself if the seriousness is high enough. This option was not allowed in the manual system.

After any activity a detective must decide what his next acitivity is going to be. Each model detective has a "Plan" and a "Notice List" on which to base this decision. A "Plan" is a list of activities in order of expected occurrence. So if nothing more important intervenes the detective selects the item at the head of the "Plan" as the next activity. However, items in the "Notice List" are items which have cropped up since the last decision was made and have to be assessed. Each item in the "Notice List" is tagged with a weight which is a measure of its importance. Thus a command from the DI creates an entry in the Notice List with a very high priority whereas a follow up activity to circulate a property description from a crime of low seriousness creates a low priority entry in the "Notice List". During a decision interval the detective takes the items in the "Notice List" and sorts them into his "Plan" in order of priority. After this process has been completed the "Notice List" is empty and the item at the head of the "Plan" is the next activity for that detective. An outline flow diagram of these detective processes is shown in Fig 25.

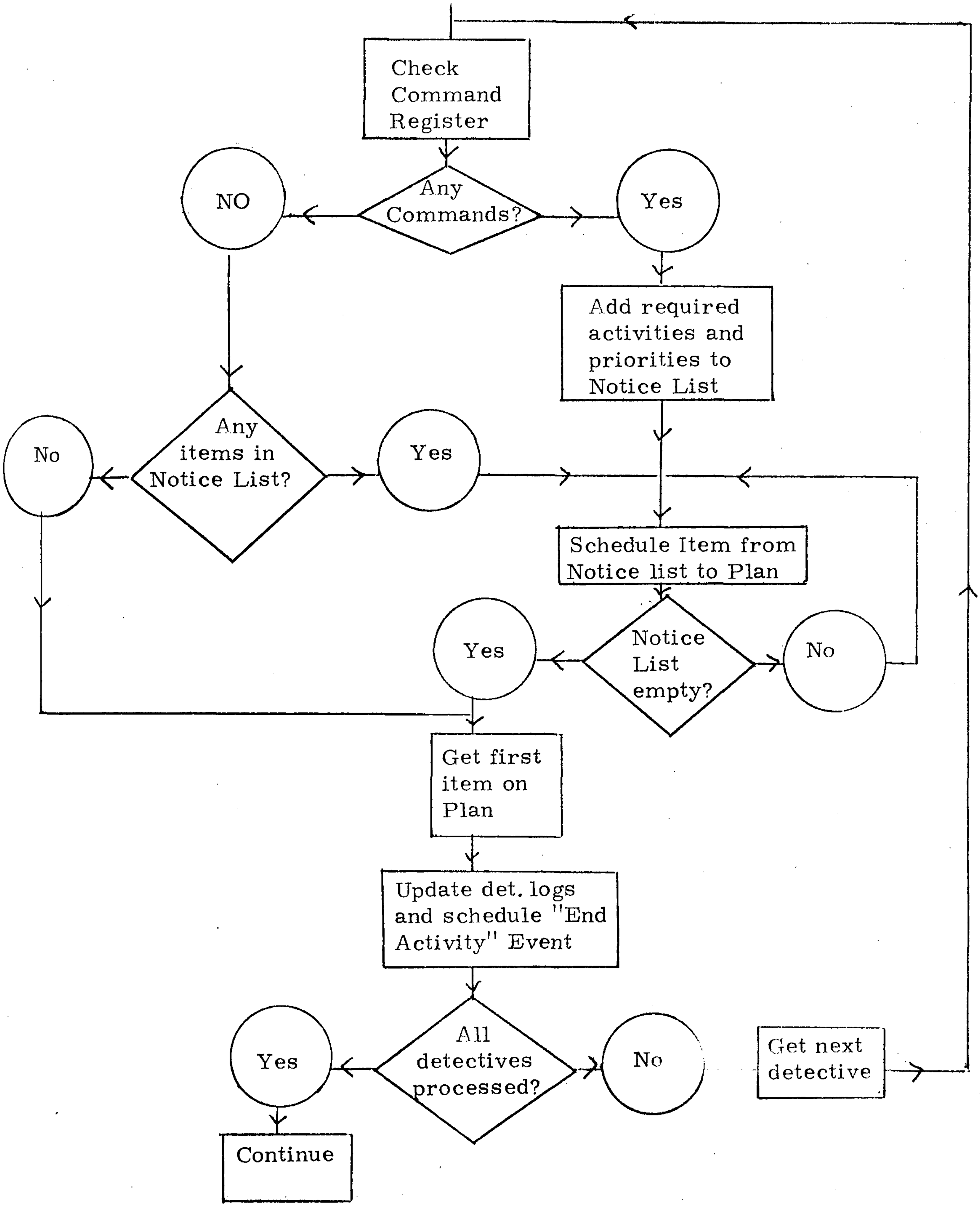


Fig 25 Outline of Detective Activity Selection Processes

The detection process itself is modelled by the retrieval of information from the crime data base and matching/decoding processes. The matching processes occur when only suspect descriptions and not names are retrieved. In this case the detective will build up a suspect description table similar in structure to that shown in Fig 24. However, only some of the attribute values may be filled in. The model attempts to match this partial description against the complete descriptions contained in the criminal data base. Identification, then, will be based solely on the number of matching attribute-value pairs.

The information retrieved from the crime data base is first entered into a "Crime report" (see the DCRI structure in Appendix 3) which then contains pointers to "Suspect" and "Description fragment" lists.

7.5 Input to the Model

The prototype form of the computer model was designed to follow the types of experiment carried out with the manual SIMPOL. This will allow rough validations of the total system. Therefore the basic requirements are that the number and types of detective available in the model should be variable and that the number and types of crime in the crime programme should be variable.

The number of detectives is a simple parameter of the system. The type of a detective is specified by a list containing his rank, years of CID experience and performance rating. The performance rating is a factor which relates a modelled detective to an ideal. It is a weight which is used to determine the amount of time taken by an activity. Thus for each piece of information in the data base a number specifies the amount of time required by the ideal detective to get this piece of information. So a detective with a low rating may take longer than a detective with high rating to retrieve the same item of information. A second time parameter attached to the information acts as a "threshold of availability". This specifies an interval after which the information is not available. This simulates the time dependence of certain types of information.

The number and type of crime in a crime programme is specified simply by listing the crime numbers of the crimes required for the particular programme. This list of numbers, which may be in any order is then fed in as data and the system automatically sequences a schedule of crime complaints to act as input to the SIMPOL model.

7.6 Output Protocols

The prototype version of the model was tested with a team of six simulated detectives operating on the crime programme shown in Table 31. Reporting time is given in the time units of the model which is equivalent to 15 minutes real time.

The model was programmed to output the following information for each time interval:

1. Time interval.
2. Any crimes reported during the interval with their class and seriousness.
3. Output any detective activities beginning during this interval.
4. Any activities which end during the interval and the results of these activities.

   e.g. E ACT 1CR 62 D6
   FIREP
   G. INF
   L INT TO D NOT

   means that D6 has completed Activity 1 on Crime 62. He has filed some general information in his report and decided that the next activity for this crime will be to interview the loser. Reports on whether or not the activity has solved the crime may also be output at this point.

Table 31 Crime Programme

Crime No	Reporting Time
62	128
3	129
1	135
2	135
61	135
60	137
10	147
58	155
59	155
4	160
5	161
6	162
67	225
70	225
7	226
8	227
63	227
66	227
65	229
69	229
9	230
64	231
11	243
68	251
13	271
12	273
18	316
16	325
72	325
17	327
73	331
15	338
71	341
74	341
14	351
19	353
75	359
22	382
79	417
77	419
26	420
24	421
25	421
23	427
20	431
76	443
21	449
78	450
32	477
81	477
82	477
30	523
29	524
33	525
28	530
31	530
80	530
27	535
83	537
85	569
84	571
34	605
35	609
87	609
36	611
88	612
86	626
37	626
41	633
38	635
39	639
40	641
92	703
48	706
47	707
49	715
91	718
46	719
45	722
44	729
90	729
42	731
43	731
89	738
94	763
50	797
51	800
52	801
53	802
95	803
56	804
93	804
57	807
54	815
55	818

5. Ouput "RES ALL" if the programme enters the "Resource Allocation" part during this interval.

6. Ouput the result of the resource allocation i. e. which detectives ordered to which crimes.

7. Ouput "ENTER DET. PROCESSES" if detective decision processes are entered during the interval.

8. Ouput names of subroutines entered for each detective and any new activities due to start e. g. COMPR
   PLPR
   TEST
   D1 ACT 1 CR 2 T 143

   means that for Detective 1 the "Command" processor, the "Plan" processor and the result was the decision to do Activity 1 on Crime 2 estimated completion time 143.

A sample section of protocol is shown in Fig 26 and a bar chart derived from the protocol, showing the detectives' activity schedule over a period of the simulation is shown in Fig 27.

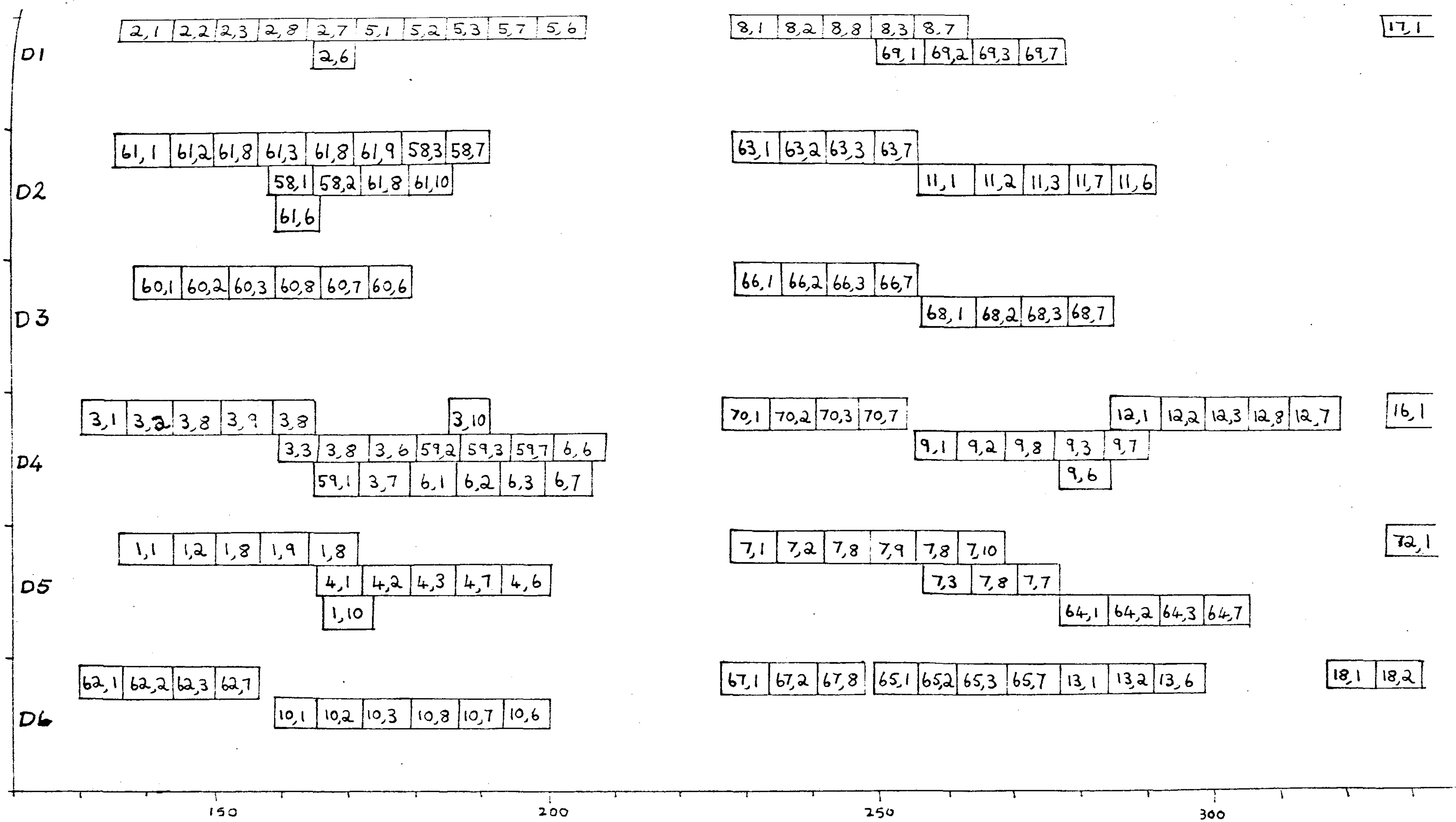
For the purposes of this prototype test the crime-criminal file (CRCR) was used to make detections and the process of estimating the duration of an activity was made identical for each detective and each activity. This results in the constant activity duration shown in the Fig 27. Apart from that the bar chart shows that the main logical structures of the model function correctly. Detectives are allocated to crimes and activities are carried out in their logical order. Some crimes are detected, most are not. One result of the logic of the detectives "Command registers" and "Noticing registers" is that occasionally detectives paralled up certain activities. Sometimes late activities for one investigation e. g. searching for suspects or writing reports tend to be carried out simultaneously with early activities of the same or other crimes. Though strictly speaking this was not purposely designed into the system it is realistic and will be retained.

```
D  6ACT  1CR 10 T 165
 INTERVAL  159
D  4 TO CR  59.
E ACT  3 CR 60D 3
LOCAL ENOS.
ADSUS
RES ALL
ENTER DET. PROCESSES.
TEST
D  2ACT  6CR 61 T 166
NOTPR




PLPR
NOTPR
PLPR
TEST
D  3ACT  8CR 60 T 166
COMPR
PLPR
TEST
D  4ACT  3CR  3 T 166
 INTERVAL  160
CRIME  4 REPORTED.TYPE 1 SER  4
RES ALL
ENTER DET. PROCESSES.
 INTERVAL  161
CRIME  5 REPORTED.TYPE 1 SER  4
RES ALL
ENTER DET. PROCESSES.
 INTERVAL  162
CRIME  6 REPORTED.TYPE 1 SER  4
RES ALL
ENTER DET. PROCESSES.
 INTERVAL  164
E ACT  8 CR  2D 1
SRCH
E ACT  3 CR 61D 2
LOCAL ENQS.
ADSUS
E ACT  9 CR  1D 5
INTERR
CRIME  1 SUSPECT  1
FIREP
 CRIME  1DETECTED BY DET 5
RES ALL
ORDER DET  5 TO CRIME  4
ORDER DET  1 TO CRIME  5
ENTER DET. PROCESSES.
TEST
D  1ACT  7CR  2 T 171
NOTPR
PLPR
NOTPR
PLPR
TEST
D  2ACT  8CR 61 T 171
NOTPR
PLPR
TEST
D  5ACT  8CR  1 T 171
 INTERVAL  165
D  1 TO CR  5
```

Figure 26 Section of Output Protocol



Legend x,y ≡ Crime x, Activity y TIME (1 unit = 15 mins.) ⟶

Figure 27 Bar Chart of Computer Simulated Detective Activities

7.7 Summary and Conclusions

A prototype computer simulation model of the SIMPOL system was programmed and tested to the point where the detailed logic of the model was working. Though exhaustive performance analysis of the model has not yet been carried out what has been achieved indicates the following:

1. The overall logic of the event based organisational model works.

2. The decision rules based on the concepts of a "Command register", a "Noticing register" and a "Plan" for synthesising these provide applausible model for the way detectives switch from activity to activity.

3. The concept of separate activities, each of which may be represented at different levels of detail, ranging from very gross to very detailed, provides a convenient, modular framework for the future development of the model.

4. The resource allocation process, also treated as a separate module, can similarly represent different rules or different levels of detail, or both, without affecting the overall model structure.

5. The data base organisation, in terms of two basic sets of information, "Crime" information and "Criminal" information, is effective and provides a convenient basis for extensions which might be required to model detective support activities (e. g. fingerprints, forensic and photographic identification) in more detail.

The possibility of extension and modification afforded by the modular structure of the model leads to a number of potential application areas. These fall into three categories:

1. Organisational design and evaluation
2. Management and planning
3. Education and training

Design and evaluation methods will make use of the possibilities for changing processes and logic in the model to test the effects of, for example, introducing new sorts of computerised intelligence aids, fingerprint or photographic identification aids and so on. This is not to say that a model will predict what will happen in a given situation but only that the organisation designers might gain valuable insights into organisational behaviour not otherwise attainable.

Similarly in management and planning the ability to look ahead into complex situations, particularly in real time command and control situations must be a valuable asset. Again not because a model can tell the manager what is going to happen (it can't) but because it could indicate the logical consequences of many interrelated assumptions and give some guidance as to future possibilities.

In education and training the need is more to explicate and demonstrate the structure of the model in order to give insight and understanding of how the real system works.

Each of these potential uses of a SIMPOL based model would require its own particular structures, inputs, outputs and support documentation. Future development should explore and define requirements in each of these areas.

Chapter 8

A Review of Some Other Approaches to Organisational Simulation

8.1 Introduction

Before going on to consider the main conclusions from the SIMPOL study and their relevance to organisation simulation it is important to relate the work to other approaches to organisational simulation.

Various classifications of types of simulation exercise exist. One widely used is that proposed by Shubik (1960). He distinguishes three classes of technique.

a) Gaming - in which players or decision makers act within a simulated environment.

b) Simulation - which does not include any human decision makers but does include decision rules for their behaviour.

c) Artificial Intelligence (or Heuristic Programming) - which seeks to simulate the cognitive processes of human decision makers.

However none of these classes is mutually exclusive. The SIMPOL system indeed has features of all three classes in it. A subject acted the role of a decision maker within the simulated CID environment, therefore it is partly a "game". But this simulated environment included simple models of other decision makers (i.e. detectives) in the organisation, therefore it is part "simulation". Also these models when formalised as computer program are simple artificial intelligence type models. Thus Shubik's classification though certainly reflecting the overall flavour of this field of study cannot be applied too rigorously.

More recently other writers have proposed other classification schemes: Moore (1968) for example draws a major distinction between gaming simulation and the heuristic programming (HP) methodology.

"In HP, it is the decision maker's internal cognitive mechanism that is being simulated and the environment operates as an uncontrolled exogenous variable. In game situations, it is the relevant environment that has been simulated and then operated in a controlled function on a variable, undefined decision maker."
(Moore 1968)

Bowen (1971) proposes a classification of game situations in terms of whether or not the players are automaton-like or person-like, whether or not the game controller can modify the system as it is running and the extent to which one player has knowledge of the other.

Another way in which the field of organisational simulation might be structured is in terms of the objectives or motives of the model builders. Broadly as we saw in the previous chapter three major motivations can be found for making organisational models:

1) For education and training.

2) For design (i.e. for assessing th performance of possible organisational structures).

3) For management and planning.

and to these we can add a fourth -

4) For scientific enquiry.

Game simulations are extensively used for training in military, business, international affairs and education generally. (Shepherd (1965), Coplin (1968), Boocock & Schild (1968), Armstrong and Taylor (1970), Mallen (1973), Gibbs (1974)). The reasons for the popularity of gaming-simulation as a training or educational device are complex and not yet clearly understood. But amongst the most important is the fact that interaction with a simulated environment allows the trainee to build up his own model or conceptualisation of how the system might actually work through direct "hands-on" experience with the simulated environment.

The use of organisational models as aids to the design or organisational structures is not nearly so common but is increasing. The work of the Romes (Rome 1964, 1965) and the work of Siegel and Wolf (1969) discussed in the next section come into this category.

Similarly the use of organisational models as part of the management science tool kit is still comparatively rare. Amstutz's (1967) computer models were aimed at this sort of use.

The use of simulation models of organisations as tools of scientific enquiry into the basic nature of such structures is still uncommon. The dominant mode of enquiry into organisational behaviour is empirical, seeking correlations amongst observed variables as a basis for theoretical constructs and classifications. For example the British sociologist Joan Woodward (Woodward 1965) has attempted to characterise industrial firms in terms of their observable behaviour and properties. She measured such things as span of control, the clarity of definition of duties, the amount and types of written communication and related these to the technologies, production systems, size and historical background of the firms.

Elliot Jaques (1956, 61) used the method of "action research" i.e. collaboration with members of industrial firms, to find out more about the psychological forces and stresses affecting group behaviour. One important finding was that there are definable leadership roles in groups and that if the leadership role is not filled the groups will not function well.

The work of Argyris (1960, 1962, a, b) and Likert (1961) concentrates more on the psychology of individuals in organisational roles. For example Argyris (1962 b) calls the process whereby an individual attempt to gain his own goals but has to adpt within the forces of the organisation "self actualisation" and relates the concept of a "good" organisation to conditions necessary for the mental health of the individuals in it. Likert (1961) concentrates on the characteristics of a good supervisor. He found that supervisors with the best record of performance in his study were those who focussed on the human aspects of their subordinates' problems. That is they tended to be "employee-centred" rather than "job centered".

Miller and Rice (1967) building on such observations see the major problem in organisations to be matching "task-centred" and "person centred" views and activities. With the former they identify "formal" organisational structures and with the latter "informal" structures. They then propose a theory in terms of three sub units of any enterprise.

1) A task control system

2) Methods of ensuring the commitment of its members to the enterprise's objectives through the creation of so called "sentient" systems (these denote the groups with which human beings identify as distinct from task groups with which they may or may not identify).

3) A mechanism to regulate relations between "task" and "sentient" systems.

The effect of simulation methods on the development of organisation theories could be profound. Laboratory models and computer models provide a way of testing and elaborating theories which could dramatically speed up the development of our understanding of organisations. By analogy to the field of psychology we can see that the use of the computer as a modelling medium in that area has rapidly increased our understanding of cognitive processes (Feigenbaum and Feldman 1963, Reitman 1965, Minsky 1968, Newell and Simon 1972, Norman and Rumelhart 1975). A similar effect is to be expected in organisation theory.

8.2 Some Approaches to Organisational Simulation

Guetzkow and Bowes (1957) set up an experimental organisation consisting of a group of six persons representing a "company". Within the "company" there were two sub groups of three "producers" and three "salesmen". The salesmen received "orders" from the experimenter who represented the "market" for the company. The salesmen then decided which orders to relay to which producers and when, and subsequently they had to sell finished products to the market. The function of the producers was to receive orders for products from salesmen to make decisions as to what, when and where to produce, to receive the finished products from the "factory" (represented by the experimenter) and to relay the finished products to the salesmen. All communication was written but no other communication restrictions were imposed. A simulation "run" comprised 60 trials, four trials constituted a segment and three segments made up an approximately two hour session. One session was scheduled each week for five weeks and during sessions participants completed open ended questionnaires. Trials corresponded to operating days for the simulated company so each simulation run simulated 12 weeks of the company's operations. The intention was to create a situation rich enough to permit a study of the development of differentiation within sub groups and interaction between sub groups. Altogether 7 "runs" each with different participants were carried out.

The volume of messages sent between sub groups and participants was measured and this measure was used to characterise structural differences amongst the groups. However, bearing in mind the small sample (7 runs), no relation was found between these observed types of organisation structures (characterised by communication patterns) and "company" performance, measured by profit. Nonetheless the authors concluded that a laboratory organisational simulation had advantages on three main counts:

1) that the simplified laboratory organisation is easier to manipulate and control than real world structures.

2) cause and effect chains can be directly tested whereas in the real world the analyst has to be "content with mere correlational associations between variables," and

3) the range of certain variables can be extended beyond that which occurs in the real world. That is, laboratory organisations can be created to study situations which would rarely, if ever, occur in reality.

As we have seen Guetzkow and Bowes study was primarily concerned with face to face communication and structures in small groups. Drabek's study (Drabek 1965), on the other hand, was concerned with the behaviour of a more realistic organisational structure representing the command and control room of a police system during a crisis. In particular he tried to duplicate as accurately as possible an existing organisation structure, man it with participants from the real organisation and measure its performance under simulated stress conditions. He duplicated the layout and equipment of the Police Communications Center in Columbus, Ohio and manned it with staff from the Communications Center. All communication was tape recorded and all action in the control room and round the maps was video recorded. Thirty two people, including the four police officer participants were involved in each run. The input to the simulator was a sequence of calls of different types ranging from crime complaints from the general public via telephone calls to patrol car reports via simulated radio links. The distribution of different types of call and the contents of the calls were based on observed sequences of calls in the real system. On top of this background of standard or "normal" activity was added the stress situation and calls associated with it. Drabek's simulated crisis was the crash of a jet transport aircraft with 151 passengers and 6 crew into a large apartment house complex. The experiment was organised in four sessions the first three using only normal input calls, the fourth being the crisis session involving both normal and crisis calls. Sessions lasted normally 1 to $1\frac{1}{2}$ hours and were run at normal rate i.e. the simulator clock ran at real time. Three groups of participants performed the simulation.

Performance variables were defined as numbers of messages between participants, delays in answering incoming calls, number of outgoing calls placed and analyses carried out on these in order to define stress. Drabek's conclusions about the effectiveness of realistic laboratory organisational simulation as a methodology were as follows:

> "1. The study clearly demonstrated that realistic simulation not only can be done, but that the technique possesses much practicality. Such simulation can be sufficiently realistic so as to make possible generalisation beyond the confines of the laboratory.
>
> 2. Utilisation of subjects from existing organisations to enact their organisationally defined positions, is an effective research method which reduces necessary laboratory time to a minimum.

3. When the above techniques are used, researchers must be mindful of their ethical responsibilities. Relationships between subjects may be permanently altered as a direct result of laboratory manipulation and investigators must not shirk their ethical responsibilities behind the "cloud" of "scientific objectivity".

4. A major limitation of the method of realistic simulation is the lack of flexibility in experimental manipulation Selection of any unit to be simulated must therefore be guided by theoretical considerations.

5. Once the simulate is constructed it may change in various ways which at times may be at variance with the research design. Only limited control is possible. Control limits depend upon constraints built into the system by investigators.

6. Extended field observation must be conducted before the simulate is constructed. Intimate knowledge of the system to be simulated is necessary whether the simulate is to replicate an actual existing system or a theoretically contrived system.

7. Researchers who endeavour to construct any simulate as complicated as the one described here will do well to remember the following: a) a clear division of labour must exist among the research staff b) simulation is an art and c) researchers must view the simulate through the "eyes" of participants and seek to become aware of the value, criteria for decision making and so on, used by the subjects."

(Drabek 1965, p206)

Another major laboratory simulation of an organisational structure is that reported by B & S Rome (1964 a, b, 1965). This was a simulation of a large information gathering and transmission organisation, very probably the CIA though this is not explicity stated. The method, called Leviathan, is computer based and complex.

"The Leviathan method, first of all, utilises a large computer based laboratory. An essential feature of this laboratory is its 24 separate stations at which individual subjects communicate independently

> and directly with the set of push buttons and a display scope (VDU) ... By means of these push button units and displays, subjects communicate with each other through the computer. An example of a complete message is: "Request approval to increase production rate to 999 at station A-1. Need maximum rate." (Rome 1964 (a)).

Four different organisational structures were examined during two main series of experiments carried out in 1963 and 1964. The main characteristics of these organisation structures are shown in Fig 28. Each series of experiments comprised 5 successive runs and a run was made up of a sequence of epochs equivalent to a simulated day. During each epoch the participants had the task of managing the throughput and dissemination of information by field agents, called robots in Leviathan vernacular. Runs were of variable length ranging from 15 epochs to 46 epochs. The flavour of the experiments and their aims is given in the following quote:

> "The 1963 subjects were essentially a close tracking control group : they were content to manage their robots exclusively by using corrective measures or negative control. The 1964 groups on the other hand, throughout its history operated as a far-sighted long range policy planning group that subordinated control to positive, innovative command objectives. As the 1964 series of experiments ran its course, this group's performance continued steadily to rise, and it was still rising when we terminated. Eventually, the group's performance rose to levels twice those of any previous performance, although its economic resources were not increased." (Rome 1965 p 21)

Performance was measured overall by rate of processing of "communiques" and the backlog of unprocessed "communiques".

Finally the Romes concluded that their initial results, area of investigation and research method could be applied to objectives of the greatest social importance - policy and strategy on the highest command levels, values and objectives at different levels

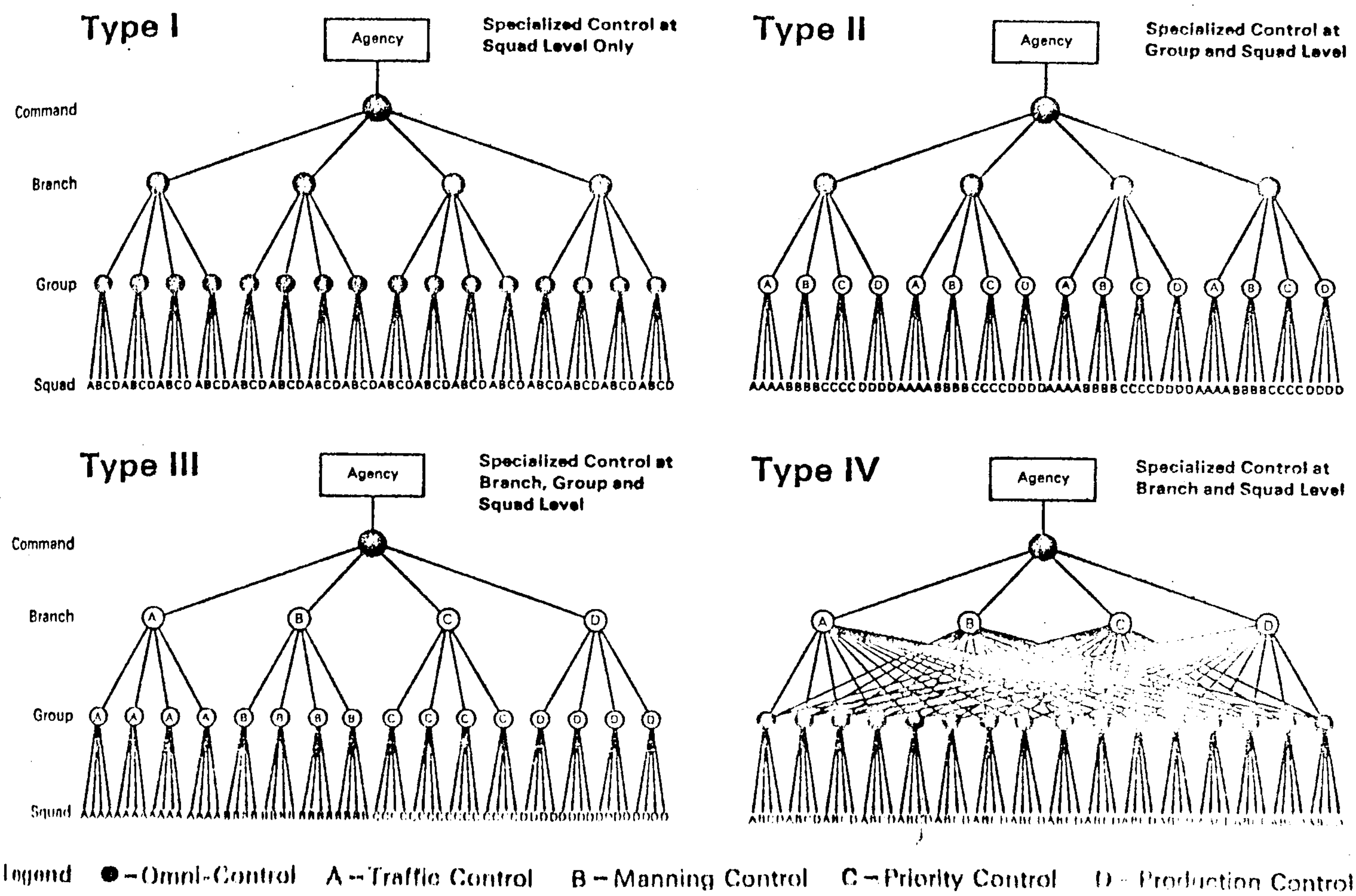


Fig 28 Varieties of Organisational Structure used in Leviathan Simulation

(From Rome ( ))

of hierarchies, and the social processes by which real men make their formal organisations actually operate.

In summary Guetzkow, Drabek and the Romes have succeeded in creating model organisations in laboratory situations. However each marks different points of the complexity continuum - Guetzkow and Bowes used a simple paper and pencil structure communication exercise, Drabek used a sophisticated simulator built after detailed studies of the real thing to study the behaviour of the simulate in crisis conditions in its environment. The Romes built their computer based simulator to examine the effects of different organisational structures based on the real structure and to examine hypotheses about different forms of performance regulation and evaluation.

Moving on now to consider computer simulation of organisational behaviour the literature shows that the bulk of effort in this growing area has been done in the United States. Shubik (1960), discussing the application of simulation methods to the economic aspects of industry, pointed out:

> "The high speed digital computer promises to provide the economist with means for constructing both the instruments for observation and the equipment for experimentation that have been the earmarks of the traditional sciences. Used in one way the computer supplies a viewing equipment to the economist in a manner analogous to the microscope for biologists (however a great amount of work goes into setting up the specimens to be observed)."

In a similar vein Dutton & Starbuck in "The History of Simulation Models" (1971) claim that:

> "Computer simulation is a technological invention in much the same sense that the electric toothbrush, the Bessemer furnace the deepwater well are technological inventions; but simulation is a more ambiguous concept existing in a more abstract and intellectual world."

Some of the earliest work on computer models of organisation, referred to in Rockelheim's (1967) bibliography, is that of Kibbee (1959) and Kagdis and Lackner (1963) carried out at System Development Corporation, Santa Monica. Both of these projects advocated computer simulation as one approach for research and design of business management control systems. Since then however there has been a rapid growth, as measured by the number of articles publishes in work on simulation of human behaviour.

Cyert et al (1959) and Cyert and March (1963) concentrated on the decision making process of the firm and used the computer to simulate a nine-step model of the process whereby a firm arrived at decisions about price and volume of production in a duopoly situation. They did not set out to represent the structure of the firm in their model but only to represent the decision making behaviour of the firm. This is an important distinction. Their approach is analogous to the behaviourist approach to psychology. This seeks to describe human (or lower animal) behaviour by observing behaviour and noting how it changes under the influence of well specified stimuli and without hypothesising structures to explain responses.

In applying their model to an actual example of a duopoly process they found surprisingly good fit on two measure, output and profit, but pointed out that they did not regard this as validation of their model. The model has so many parameters that

> "there are ample degrees of freedom in the specification of parameters to enable a number of time series to be approximated...... The general methodology for testing models that take the form of computer programs remains to be developed." (Cyert et al (1959))

Amstutz (1967), in contrast to Cyert and March (1963), presents an approach to organisational behaviour in the business environment based on the use of computer simulations of interactions within the marketing environment. Amstutz distinguishes two main levels of model, macro-models and micro-models. Macro-models are refinements of qualitative descriptions of the main processes of the marketing situation. Those are 1) the manufacture, distribution and consumption of the physical product 2) information generation and communication and associated responses and 3) capital transformation and value flow. These macro-models, based on qualitative analysis are presented in flow diagram form as "process flow" models; an example of a macro-model of the total market situation is shown in Fig 29.

In the framework defined by these macro-models Amstutz proceeds to analyse and quantify the particular processes involved and so to develop micro simulation models. Fig 30 shows the pricing decision logic in the retailer model. The variables, like PRICE, are calculated from sets of equations whose parameters are determined from empirical studies. However, as has recently been pointed out (Bryant 1975), Amstutz's approach demands a very large amount of input data and therefore, though the approach was a significant step foward in modelling technology, the problems of analysis and data collection have militated against widespread use.

Siegel and Wolf (1969) modelled task performance details of a submarine crew.

> "It is the purpose of this model to give the equipment designers quantitative answers to questions such as the following while the equipment is in the early design stages:
>
> 1) For a given operator procedure and a given machine design, can an operator be expected to complete successfully all actions required in the performance of the task within a given time limit?

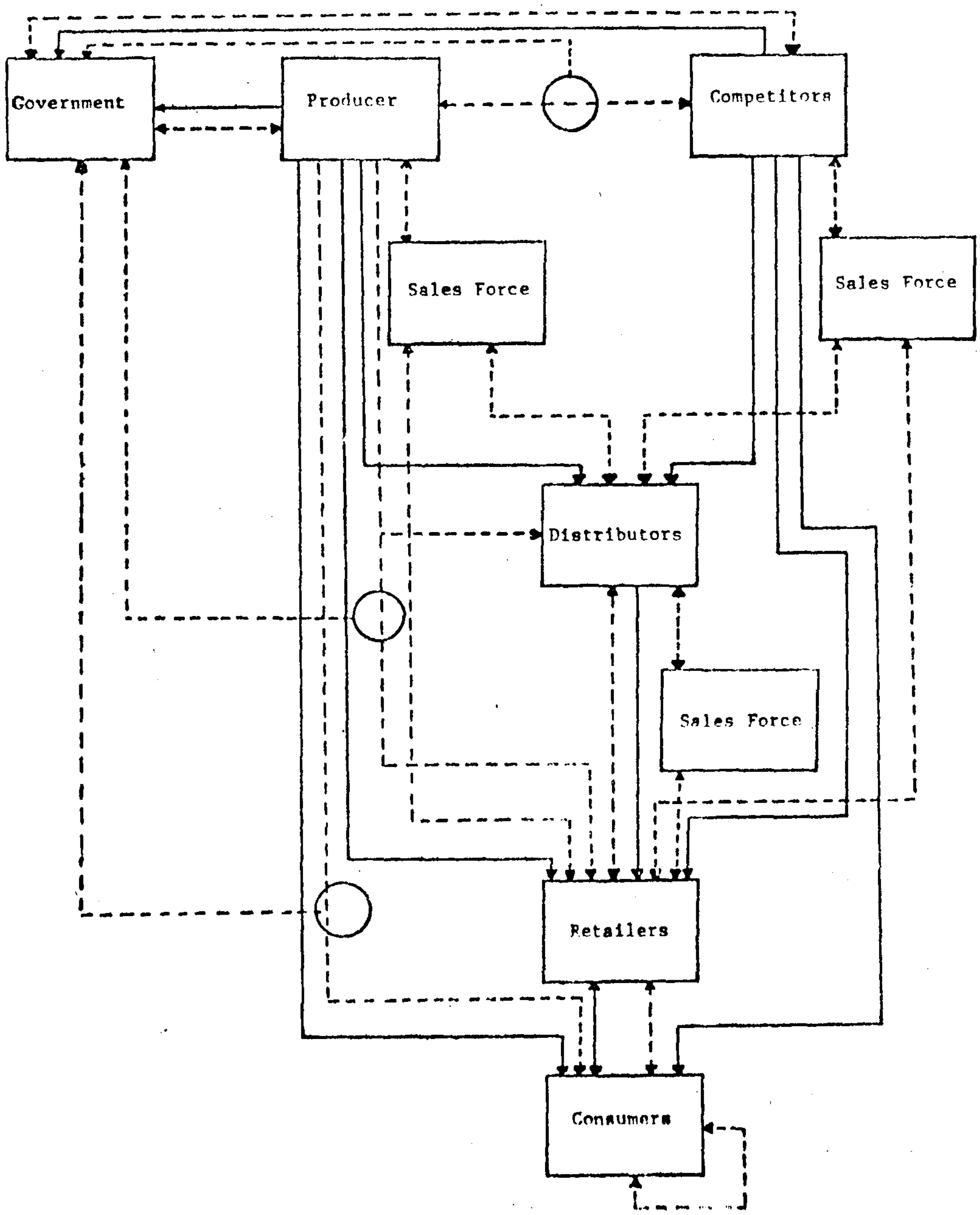


Fig 29 Macro-Model of Total Market Situation (from Amstutz (1967))

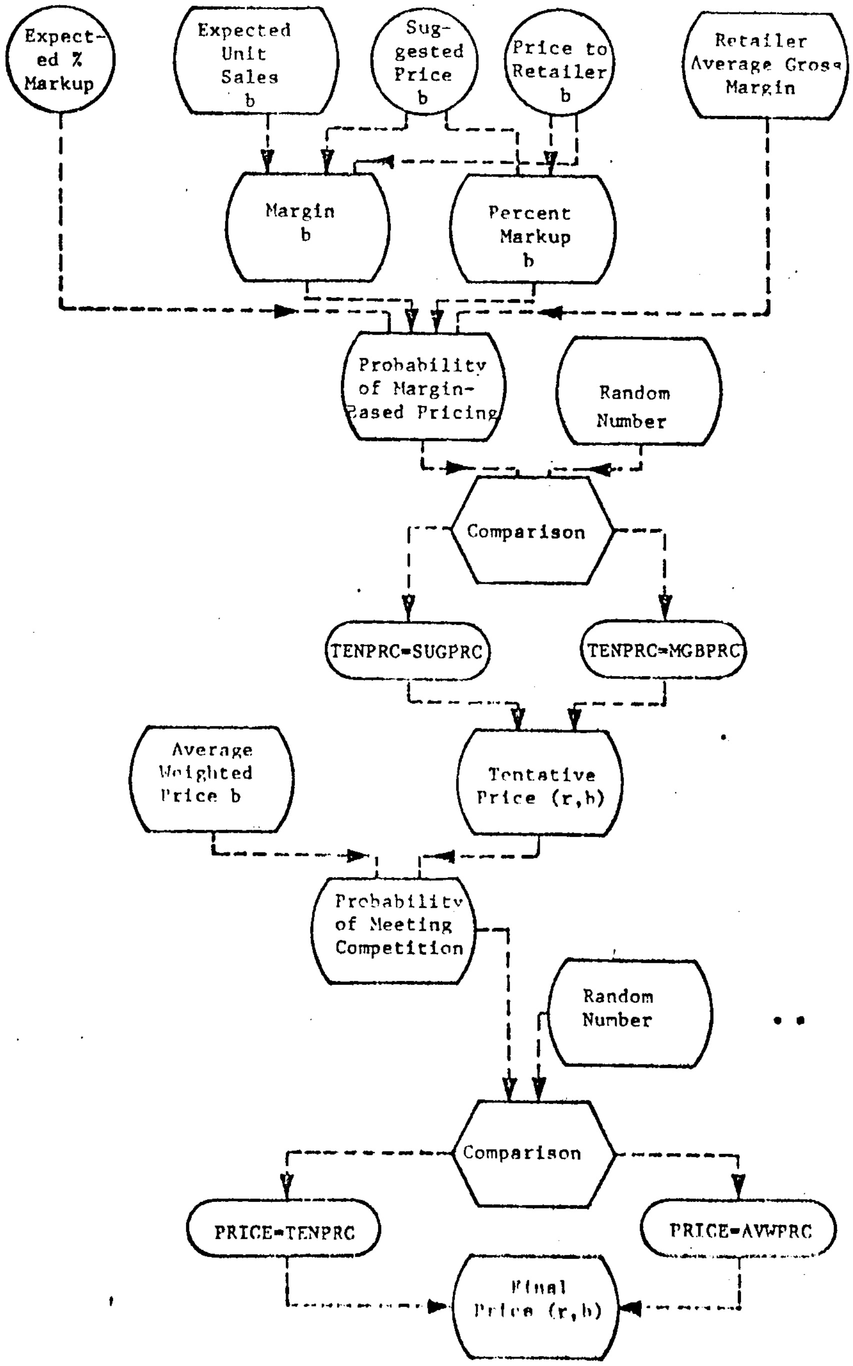


Fig 30 Retailer's Pricing Decision Logic (From Amstutz (1967))

2) How does success probability change for slower or faster operators and longer or shorter periods of allotted time?

3) How great a stress is placed on each operator during his performance and in which portions of the task is he overloaded or underloaded?

4) What is the distribution of operator failures as a function of operator stress tolerance and operator speeds? " (Siegel and Wolf (1969) p 11).

Initially Siegel and Wolf developed a two operator model and then expanded this to simulate the behaviour of larger groups. They wanted to predict certain qualities of the large man-machine system: for examples, system efficiency as a function of crew size, mission time, crew morale, equipment repair times, manpower loadings and others. In summary, in their own words, the new model was conceived as

> "a group of supervisors (naval officers) and workers (enlisted men) who form a "crew" and who run a system for a given period of time. The crew, characterised by numerical values selected by the computer, "performs" certain assigned work (for example, system operation and maintenance jobs) which is broken down into subtasks called "action units". (Siegel and Wolf, 1969 p 52)

In this situation the operators are integral parts of a complex man-machine system and their behaviours are reduced to the set of well specified procedures required to execute a subtask. Task performance is defined as being dependent on "operator stress" which is, in turn, dependent on such things as his own speed capability (stress rises if he falls behind) his colleagues (stress rises if they are not performing adquately), failure to complete a task successfully and delays in equipment response.

The model, programmed in Fortran for an IBM 7094, was tested by simulating a sample mission of a nuclear submarine on

> "long term isolated alert at alternating stationary submerged points. The system's only function is retaliatory delivery of nuclear missiles on receipt of proper instruction." (Siegel and Wolf 1969, p 109).

Crew efficiency, task performance, task failures, crew morale, working hours were among the measures obtained from four series of runs. Subsequently the results were validated against data obtained from a realistic 21-day training mission of a real nuclear submarine. Results comparing simulated and real data for manning and crew efficiency are shown in Figs 31 a, b. From results like these the authors concluded that their model was a valid representation of the real system which could be used as

> "a measure of the degree to which a man-machine system will meet its objectives before the system is actualised." (Siegel and Wolf 1969, p 140).

8.3 Comparisons with the SIMPOL Project

The basic strategies of the above simulation methodologies may be summarised as follows:

Strategy 1: The researcher tries to recreate the communication patterns of a real organisational structure by asking participants to act out the roles of different members of the organisation. This is the strategy adopted by Guetzkow and Bowes and also by other workers interested in the behaviour social, commercial, or political systems (Coplin, 1968, Boocock and Schild, 1968). The difficulty of quantitative analysis of the behaviour of such simulation systems has meant that they have their main value as

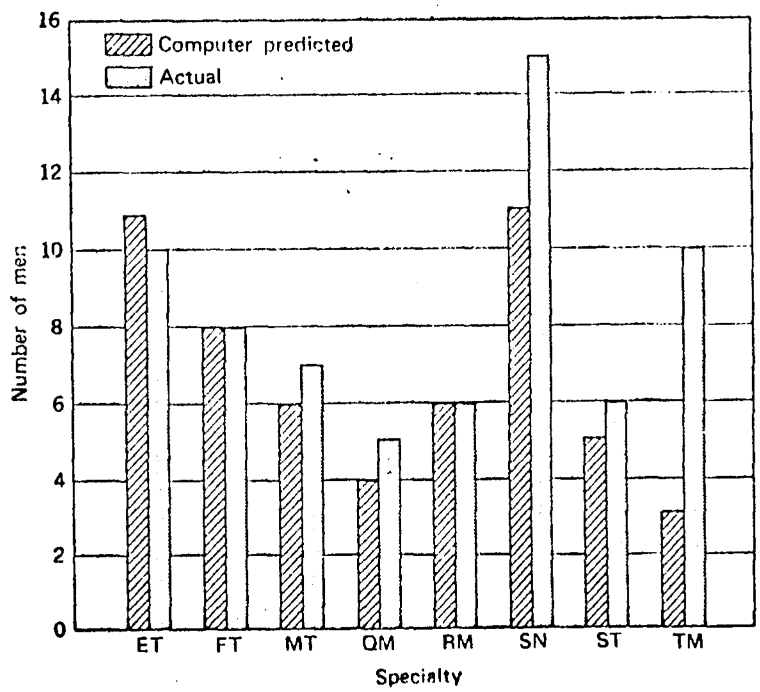


Fig 31a Computer Predicted and Actual Manning (From Siegel & Wolf (1969))

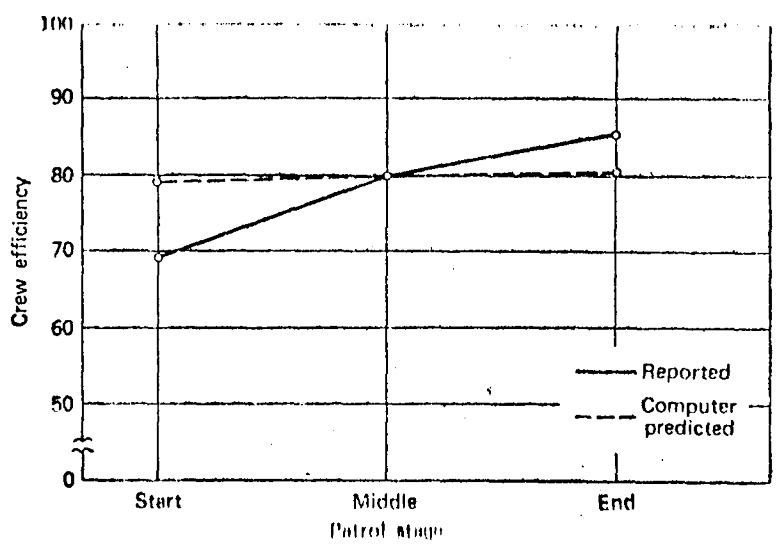


Fig 31b Computer Predicted and Reported Crew Efficiency
(From Siegel & Wolf (1969))

educational devices. In these situations causal explanations of observed behaviours can be analysed and discussed in debriefing sessions and students understanding of these behaviours built up.

<u>Strategy 2</u>: This is an extension of Strategy 1 which seeks to model more accurately the operation of large scale organisations and makes use of some degree of technological support to help the human participants. This may be in the form of sophisticated computer aids, as in the Rome's work, or as assistants to help work out the logistic implications of certain decisions in a war game (Shepherd, 1965).

<u>Strategy 3</u>: The researcher tries to recreate exactly the structure of the simulated organisation. Drabek's simulation comes into this category, as do such better known examples of simulation as air traffic control simulations and flight simulators.

<u>Strategy 4</u>: The researcher sets out to make a wholly abstract model of the organisation and its operating environment. Examples of this strategy are in the work of Cyert and March (1963), Amstutz (1967), Siegel and Wolf (1969).

Obviously the strategy adopted by any researcher will be determined by his objectives. Thus Drabek sought to examine the behaviour of a particular organisation under operating conditions which would very, very rarely occur in the real world. He therefore adopted Strategy 3 and replicated the organisation as exactly as he could and then proceeded to modify its operating conditions. On the other hand the Romes were concerned with the effects of structural changes on an organisation's performance and so their requirement was for a structure which could be easily modified. Similarly with Guetzkow and Bowes so that Strategies 1 and 2 were more appropriate. Siegel and Wolf enquired into the behaviour of a proposed man-machine system at the design stage. The flexibility of an abstract representation of the organisation was required to allow for assessment of the many changes required during the design process.

Elements of all four types of strategy may be seen in the development of the SIMPOL project. The original model SIMPOL I was basically exploratory in nature and fits Strategy 1 or 2. The next development, SIMPOL II, was a response to a need for more precise information about real CID system performance in certain defined operating conditions. This resulted in a more realistic model along the lines of Strategy 3. Finally as a result of limitations of the manual or game model in this evaluative role a computer model was made. (Strategy 4).

Thus the SIMPOL project seen in the context of organisational simulation generally is unique in developing a simulation methodology through several stages and types of model based on one organisation. The different stages in the development of organisational simulation are represented in the project as follows:-

1) Set up a simple "game" type of model for initial explorations.

2) Develop more realistic and elaborate models and use for evaluative studies.

3) Fully specify the model and develop computer models.

In terms of the work I have reviewed here these stages are typified by the work of Guetzkow and Bowes (1957) the Romes (1964) and Drabek (1965) and the final stage by the work of Amstutz and Siegel and Wolf.

The evolutionary development of the SIMPOL project and simulation methodology generally has been predominantly concerned with the <u>making</u> of models. This has shown that interesting and realistic models can be made.

The next stage in the development of the methodology will be concerned with the <u>use</u> of such models. Main areas of use have already been listed (p 199) but there are many problems to be overcome before such models gain wide acceptance. Perhaps the major problem is concerned with the concept of "validity". Since no model, by definition, can be wholly realistic how far can one go in believing a model and using such belief as a basis for decision? This question leads directly to very basic considerations on the nature of knowledge and understanding and how it is represented and used in the mind of the decision maker. Because of this the future of these simulation techniques in use will be dependent on the growth of our scientific understanding of human decision processes both at the individual and organisation levels. The next chapter presents one approach to understanding such processes.

Chapter 9

Theoretical Aspects of Modelling

9.1 Introduction

The aim of this chapter is to present a basis for an approach to an understanding of what organisational models are and how they may be used.

In the previous chapter we saw that initial developments in the field of organisational simulation had resulted in growing understanding and mastery of methods of making organisational models and suggested that the next stages of development would be concerned with ways of using these models.

For example Guetzkow and Bowes (1957) work led to rather little in the way of quantitative scientific conclusions. They did not for instance find any relation between communication structure and company performance. Also Bowen (1971) commenting on some American work in the field says:

> "Thomas and McNicholl's paper...enquires into the value of games that have been played in the United States and comes to the conclusion that remarkably little scientific value has resulted from a very considerable effort, except in so far as those who play games are also in an unstructured way, learning quite a lot."

Cyert and March (1963) in considering the value of their decision making model concluded that a methodology for testing such models had yet to be developed. Another commentator on Amstutz's (1967) work concluded that

> "its requirement for extensive market information created implementation problems." (Bryant 1975, p 134)

It is clear therefore that there are problems concerning the use of this modelling technology. One way to reach an understanding of these problems is through a fundamental appraisal of what models are in a general sense.

9.2 A Theoretical View of Models and Modelling Processes

A 'model' can be defined quite generally as any form of representation, abstract description or real object, which "stands for" something else. According to this definition any transduction process is a "modelling" process. For example our sense organs transform energy into nerve impulses. The nerve impulses then "stand for" the energy and we extract "meaning" from the impulses. Error signals in a control system "stand for" the cause of the displacement from equilibrium and allow corrective action to be taken. Scientific laws and theories stand for the underlying reality of ourselves and our environment and so science itself is a model which allows us to plan, decide and, hopefully, survive.

The physicist Erwin Schrodinger (Schrodinger 1944) has pointed out, in relating physics to the chemical processes of life, that

> "...the device by which an organism maintains itself stationary at a fairly high level or orderliness (= fairly low level of entropy) really consists in continually sucking orderliness from its environment .... Indeed in the case of higher animals we know the kind of orderliness they feed upon well enough viz. the extremely well-ordered state of matter in more or less complicated organic compounds, which serve them as foodstuffs."

So also at the cognitive level the central nervous system "sucks orderliness from its environment". That orderliness corresponds to what is meaningful for the organisms survival and its extraction is what I call "modelling" activity. In "What the frog's eye tells the frog's brain" (Lettvin, Maturana et al 1959) the authors showed that the frog's retina does not produce simple sensations according to light intensity falling on it. Rather they showed that the output from the retina is a set of four operations on the visual image. These operations abstract from the immense complexity of the patterns falling on the frog's retina four properties: 1) local sharp edges and contrast; 2) the curvature of edge of a dark object; 3) the movement of edges and 4) the local dimmings produced by movement, or rapid general darkening. It is these properites which are relevant to the frog's survival. Thus operation 4 would alert the frog to a large moving object, a predator say, and operation 2 is most sensitive to small objects (3^{o} or less) passing through its field of view - what the authors called the "bug detector".

The eye-brain system of the frog, therefore, has developed complex methods of abstraction and representation which give it a very particular model of its world and allow it a fair chance of existing and avoiding predators.

In relation to the human eye, the mathematician John Von Neumann has pointed out (von Neumann 1958):

> "...the retina of the human eye performs a considerable reorganisation of the visual image as perceived by the eye. Now this reorganisation is effected on the retina, or to be more precise, at the point of entry of the optic nerve by means of three successive synapses only, i.e. in terms of three consecutive logical steps."

Thus the human eye, also be virtue of its structure, "sucks order" from the immense varity of signals impinging on it. It too models its environment.

At a higher level work in developmental psychology has suggested that the growing human mind goes through several identifiable stages before it can finally handle the power for symbolic abstraction and manipulation required for mature adult behaviour. Jerome Bruner and his co workers, first through studies of concept formation and categorisation, (Bruner, Goodnow & Austin 1956) and then through studies of learning (Bruner, Olver & Greenfield 1966, Bruner 1966) have arrived at a definition of three phases in the development of the child's modes of representation. First the child interacts with its environment by pushing, pulling and prodding, kicking, sucking, that is by direct physical interaction. Bruner has characterised this stage as one in which the child has an "enactive" representation of its environment. Later the child begins to recognise pictures of things and to predict likely courses of events, as for example when a toy is pulled slowly across the filed of vision and then behind an obscuring obstacle the child expects the toy to reappear on the other side of the obstacle. At this stage Bruner says the child has an "iconic" form of representation. Still later, with the ability to deal with abstract symbols for things, the child acquires a "symbolic" form of representation.

These differenct stages are <u>not</u> sequential in the sense that one gives way or is replaced by the next. Rather they are additive. Indeed in adult life enactive, iconic and symbolic modes coexist and interact. For example the skill of riding a bicycle or type-writing would be mediated by an enactive representation, whereas driving a car requires the simultaneous operation of enactive motor skills, iconic recognition, visual prediction and symbolic interpretation of signs and signals.

Overall then the child, as it develops, acquires and uses increasingly sophisticated modelling capabilities.

9.3 Relevance to Organisational Processes

The concept of "model" being advanced is based on observed features of the interactions and responses of complex organisms to their complex environments. Models are complexity reducing devices which allow the organism to extract relevance and importance from its environment so that action aimed at survival may be carrie out. Though the approach was based on analyses of human responses at both neurophysiological and psychological levels it seems to be equally applicable at organisational and indeed societal levels. Both Beer (1966, 1972) and Ackoff (1974) develop and expand this argument.

If we do regard organisations as organisms with their own ways of representing their environments and themselves then it follows that modelling technologies are crucial for the survival of organisations. The growth of operational research methods and models in most large organisations testifies to this (Tobin 1976) such models tend to be models of the <u>external</u> operations of the organisations.

Organisational models however are models of the <u>internal</u> operations of an organisations. As such they could have a profound effect on organisational structures. Just as the realisation of self awareness is a critical step in the development of a child so the development of models which make explicit the internal decision processes of the organisation will be critical for most organisations. It is likely that the balances which exist between formal and informal power structures will be affected by the development of organisational models and it may well be that it is the natural opposition of these existing power structures which accounts for some of the failure of such new techniques to gain ready acceptance. Organisational modelling may, itself, however, help to shed some light on these processes.

Another important aspect of model use is the form of relationship between the userand the model. In most cases the user will not know precisely what he may ask of the model and get understandable replies. To put it another way unless the user has some other criteria for judging the relevance of the behaviour of the model how can he know that it is relevant? So the user must have some expectation of the model's behaviour before he can make sense of it. This means that the usermust himself have some model in his mind which he uses to judge the relevance or trustworthiness of the external model. Clearly the external model should not be the same as the user's internal model. If that were the case he would have no need of it for research use though he might indeed use such an external model to help communicate to other how he thinks. The nature of relationships between users internal representations and external models has not yet attracted much research attention. Though cognitive psychologists with the help of computer modelling methods, are building up an understanding of how human beings represent things (Norman & Rumelhart 1975) and computer scientists are developing sophisticated ways of representing knowledge structures in computers, links between the two are not yet clearly understood.

This argument imples that fruitful man-computer interaction must be based on sound understanding both of the principles of human cognition and principles of how human beings build "understanding" of processes and systems.

However to summarise I have argued that building and using models is fundamental to the interactions between complex systems and their environments. This is as true of organisations as it is of organisms. Models and modelling technologies are therefore crucial to most forms of human organisation. Organisational models will be of particular importance because they represent the internal functioning of organisations and as such may be used to help design structures for given objectives. Nevertheless before such uses can be widespread there are several important problems to be overcome. One of these concerns the effect the introduction of decision making processes based on explicit modelling techniques will have on the balance which existsbetween formal and informal structures in organisations. Another concerns the nature of man-computer interaction when the computer contains a model which is designed to increase the user's understanding of a system or process.

Chapter 10

Conclusions and Directions for Further Work

10.1 Conclusions from the SIMPOL project relating to crime detection

Returning now to conclusions from the SIMPOL project, there were three separate series of experiments each with its own objectives and experimental design. These experiments were followed by the development of a computer simulation model of the CID organisation. The main conclusions from the experiments with the CID system models are summarised below

1. For relatively little expenditure of effort it was possible to make a basic simulated CID organisation which demonstrated potential both as a training device and as a system evaluation tool. The training potential was not developed.

2. Pilot experiments with the basic model indicated that the form of "management style" adopted by the subject in the simulation affected the overall performance. In particular it was found that a rigid procedure oriented centralised command structure was less effective than a decentralised, delegation conscious command structure.

3. Extending the basic model to include local intelligence information gathering and collating system resulted in a more complex but realistic simulation.

4. A detailed quantitative analysis of that system performance showed

   a) that the local intelligence gathering system should seek the most up to date intelligence information rather than the largest quantity.

b) the collator should take an "active" interest in current investigations and sift his input for information relevant to these.

c) the significance level of these findings was greater when professional policemen ran the simulation than when untrained "civilian" subjects ran it.

d) the introduction of a collator system resulted in a decrease in the amount of effort spent on solved crimes and an increase in the amount of effort spent on unsolved crimes.

e) there was a tendency for civilian subjects to require more help (in the form of easier crimes) to achieve a specified performance than professional police subjects.

f) police subjects made more use of collator and criminal information, indicated by higher collator assisted detection rates, higher percentage of fruitful collator slips and higher percentage of suspects generated from criminal information leads.

5. Experiments to test the response of the simulation to changes in number of available detectives and to changes in crime input rate showed that the response of the system was non linear. A sharp drop in performance at a certain load figure was hypothesised to be due to a shift of emphasis from indirect to direct detection activities.

Overall these conclusions show that the organisational simulation methodology can provide detailed insights into system performance. However this conclusion must be qualified on two counts. First setting up and running such a series of experiments using experienced subjects was a cumbersome, time-consuming process. It took, for example, six months to set up and run the twenty four experiments in the SIMPOL II series. Also the two days required from each of the subjects was a significant and expensive portion of a busy senior detective's time. Only a comparatively small number of runs could therefore be carried out implying a low statistical validity of the above conclusions.

The second qualification concerns the validity of the models as representations of real CID systems. That is, even if the results presented above were highly significant statistically how much confidence could one have in transferring these results to real systems?

It was not possible during the SIMPOL project to carry out detailed studies of the response of real CID systems to varying levels of input load and manpower availability or to experiment with different styles of collator operation. Therefore we cannot claim that the behaviour of the models was valid in the sense of corresponding to observed behaviours of real systems. However, as we saw in connection with Cyert and March's (1963) company models, there are so many interacting parameters in the models that a very large number of different behaviour patterns might be produced. Simple behaviour correspondence between the model and the real system is therefore a necessary but not a sufficient condition to determine the validity of the models.

Validity is in fact a relative concept. A model, by definition, cannot be true or real in any absolute sense and the validity of a model is determined by a combination of several properties and attributes. This combination will be largely determined by the purposes for which the model was designed. For example a wind tunnel test aircraft model is unlikely to have a detailed cockpit layout. On the other hand an ergonomic cockpit model probably won't have wings. Yet each may be a valid model. Thus the concept of validity is inevitably bound to the concept of purpose or utility and a model valid for one purpose may not be valid for another.

If we accept that validity is relative to purpose, and behaviour correspondence between the model and the real system is not a sufficient condition for validity, then the issue of the confidence we can place in the model's response is difficult to decide. It will be based on an understanding of why the model has produced the behaviour it did produce. So if we can trace causal connections through the model and interpret these in terms of mechanisms in the real system we will have more confidence in the model than if we can't.

The validity of the SIMPOL models rests largely on this latter process. For example the non-linearity of response to increasing load in the SIMPOL III experiments were explained in terms of a switch from indirect to direct detective activities. Professional detectives were then able to interpret this explanation as something which could and did happen in the real system.

This then constitutes another necessary condition for validity to the behaviour correspondence condition discussed above. It is that causal explanations of model behaviour should be interpretable in terms of known mechanisms in the real system.

Note that though we can say that these are necessary conditions we cannot say that they are sufficient conditions. Because validity is relative to purpose there may be purposes for which one or other of these conditions is both necessary and sufficient.

In spite of these difficulties, however, the SIMPOL models demonstrated that organisational modelling can provide useful information for the analysis, design and evaluation of crime detection systems.

10.2 Conclusions relating to organisational simulation methodology

In retrospect the development of the SIMPOL project has recapitulated a sequence of stages apparent in the general development of organisational simulation. This sequence, as we saw in Chapter 8, begins with the creation of rather simple game-like models proceeding through more complex forms with more sophisticated technological back-up to a final stage of completely abstract computer models. The SIMPOL system appears to be unique in that this evolutionary development took place round one basic model, namely that of a crime investigation organisation. The main conclusions on the methodology of organisational simulation are:

1) Laboratory organisational models can be made which have definite utility as means of investigating organisational behaviours

2) The evolutionary methodology of starting with a simple model and progressively developing this is effective

3) Including persons experienced in the operation of the real system both as participants in the experiments and as critics of the model is an important part of the methodology. However it is important to obtain the right mental attitude by such participants. We found that prospective participants on first coming to the laboratory to participate in experiments were invariably apprehensive about the motives for carrying out such experiments. Their main worry appeared to be that the simulator might be used as an assessment or testing tool. We allayed such apprehension by emphasising the very experimental nature of the set-up and its role as a design tool to help design future systems rather than assess current ones. This appeared to have the desired effect in ensuring cooperation. Nevertheless it is important to note that the experimenter in adopting a methodology such as this does have ethical responsibilities with regard to his "professional" subjects. He must remember that if the simulator is at all realistic the subject may undergo some learning experience which may be transferred back to his professional situation after the exercise. The nature and amount of such transfer are, at the present time, largely unknown factors so the experimenter should try to minimise these by emphasising

the experimental, exploratory (and hence unreliable, to the mind of the subject) nature of the simulation exercise. This is a key area for investigation in any development of those methods for training purposes

4) Quantitative scientific results can be obtained from such models. However great care is required in experimental design in order to get reliable results and in interpreting these results.

5) Simple behaviour correspondence between model behaviour and real system behaviour is not a sufficient condition for the model to be valid i.e. to transfer results from the model to the real system. The links between cause and effect in the model's behaviour should also be interpretable in terms of mechanisms in the real system.

6) Laboratory models can be cumbersome and expensive to run. Developing computer models based on the laboratory models provides one answer to that problem. However even with a computer model a laboratory model has two important functions 1) it provides a useful intermediate step between the real system and the abstraction of a computer program. At this step model structures can be tested by "professionals" before being programmed 2) the computer model may be tested against the laboratory model before being tested against the real system. Such intermediate verification has the advantage that more detailed behaviour analyses and cause effect chainings may be examined than would be possible with a real system.

7) A "null" experimental control method (in which an environmental variable of the model is controlled by the

experimenter to obtain a stable, predetermined, value of a performance measure) may have value as training strategy. However the technique involves basic changes to the information structure of the model when the control rule is applied. Such changes were considered to be unrealistic and so the use of the null method is not recommended for system evaluation analyses.

10.3 Directions for further work

Main areas of use for organisational modelling methods have already been presented. They were

1) Education and training

2) Management and planning

3) Organisational design

These plus its use as a research tool form four areas or directions in which further developments should be carried out.

There are so many questions to be asked about organisational processes that the list of possible research topics for organisational modelling is very large. However strategic guidelines can be suggested. Broadly there are two issues, one concerned with the internal structure of the models and the other concerned with generating and interpreting their behaviours.

A major internal component of an organisational model is the model structure which represents the human "agent" in the organisation. The detective in the SIMPOL computer model is represented crudely by a set of "command" and "noticing" registers from which a "plan" for future action is synthesised. C M Elstob has now considerably elaborated this basic model in his SIMDET representation of detective decision processes (Elstob 1974). The use of such complex models of human decision processes within organisational contexts has not been widely explored and constitutes one future research area.

A major problem in the use of organisational models lies in making the behaviour of the model clear. Thus the scientist may be interested at one time in collecting detailed quantitative data on the behaviour of a large number of different predefined performance variables. In this case detailed statistical reports may be obtained by running the model according to the conditions of an appropriate experimental design. However at another time for another purpose the scientist may wish to have a broad overview of certain aspects of the model behaviour and to be able to modify the model quickly to explore possible new configurations. The development of experimental design systems and interactive modelling systems with associated experimenter interfaces is a further research area.

The education and training aspects of the SIMPOL system were not investigated in the project but most of the professional detectives who took part in the experiments thought that the model situation could be a valuable training aid for showing trainee detectives the problems of resource allocation and information flow in the CID. A training version of the system should be set up to test these ideas more fully. The issue of whether or not the use of "null" experimental control methods is justified in a training environment would be of interest to the field of organisational simulation generally and not just to CID systems.

However it seems likely that the major use of computer models of organisational structures will be in management and planning. The ability to simulate the behaviour of an organisation as it processes a number of projects or cases, several with conflicting demands, will allow managers a valuable tool for examining alternative methods of scheduling these projects. At the present time the main project management tool is the critical path network method. A major problem with CPT is that of working out interactions amongst projects represented by networks. Organisational simulation offers one way of evaluating such interactions. More generally questions like "What happens if this parameter has this value?" or "What is the effect of this parameter on that parameter?" are basic to planning and decision making activities. If computer models are to help managers answer such questions then much development is required into modes of interaction between the user and model. This is not a simple ergonomic question of workstation design. Rather it is a matter of the relationship which should exist between the model structure and the subjective expectations which the user will have of these structures. It is a question of the relationship between a cognitive model in the mind of the user and an external computational model in the computer. This must be an important research problem, not just for the development of organisational simulation methods, but for other users in which the computer is aiding the more contemplative, creative human decision processes.

Finally the work described in this thesis and other work on organisational simulation are very tentative explorations at the beginning of what will eventually be an important addition to the design disciplines which lie at the roots of our technological culture. This is the area of organisational design, the process of creating effective man-machine organisations. In the words of Jay W Forrester

"Our social systems are far more complex and harder to understand than our technological systems. Why then, do we not use the same approach of making models of social systems and conducting laboratory experiments on these models before we try new laws and government programmes in real life? The answer is often stated that our knowledge of social systems is insufficient for constructing useful models. But what justification can there be for the apparent assumption that we do not know enough to construct models but believe we do know enough to directly design new social systems by passing laws and starting new social programmes? I am suggesting that we never do know enough to make useful models of social systems. Conversely, we do not know enough to design the most effective social systems directly without first going through a model-building experimental phase. But I am confident, and substantial supporting evidence is beginning to accumulate, that the proper use of models of social systems can lead to far better systems, laws and programmes". (Forrester, 1971).

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APPENDIX 1

SIMPOL - Laboratory System Description

and Operating Manual

CONTENTS

1 Introduction

The police detective force simulation has grown out of a study of the manner in which information is processed small, but nevertheless very complex and probabilistic systems. The original experiments were designed to produce answers to questions like "How does detection rate vary with input load?" and at a more complex level "What sort of organisation is best able to cope with high input loads?"

Apart from the purely scientific applications, the simulator has potential as a training, teaching or testing device. We emphasise that this potential has not been developed at all, and therefore we expect that the programme which has been developed and used in this laboratory for the scientific experiments may have certain failings when asked to do a teaching job. For example, the restrictions on type of crime in our programme may lead to unrealistic situations in a training situation. However, these comments will apply only to the software, (that is the programme and the methods of storing and accessing information), which is fairly easily modified.

The simulator requires four operators and a subject. These will be referred to as OP1, OP2, OP3, OP4 and S respectively. In the first experiments only S was a professional policeman, but in a training situation, up to four policemen can be used, three as operators and one as the subject. The fourth operator OP4, has overall control of the simulation and must be completely familiar with the programme and the operation of the device and hence requires considerably more experience of the running of the simulator than the other operators.

Operators 1 and 2 each must carry out the programmed functions of a set of three detectives, one Detective Sergeant and two Detective

Constables. OP3 carries out the programmed functions of a set of three Scenes of Crimes Officers, two of whom are Detective Constables and can visit scenes of crimes in a small radio equipped van, and one who is a Sergeant and is the expert and who stays in the Scenes of Crime Office all the time. OP3 also operates the telephone switching system for the CID office and acts as the Operations Room. OP4 controls the simulation. His functions include the running of the Waiting Reply File, the control of difficulty levels, monitoring the input crimes and setting the alarm. On top of these supervisory functions, he also carries out the procedural, programmed duties of the Registry and the Switchboard. The subject S, has duties broadly equivalent to those of a Detective Inspector, that is he is expected to give his team of detectives instructions, (more or less detailed depending on how he judges their capabilities), to receive information from them and to decide on further action.

A detailed account of operator functions is presented below in Section 4. Subject briefing data is presented in Appendix 1.1

2 The Model

The model consists of two major components, a simulated community and a simulated police force. The community is based on a hypothetical South-coast town called Alderton, and the simulated CID unit comprises 6 detectives, 7 if the subject is included, plus services like finger prints, and a records office.

2.1 Geography of Alderton and Surrounding District

A map of the locality is shown in Fig 1.

The County Borough of Alderton is a seaside town in the county of Sussex, with a population of some 100,000. It is set on the the

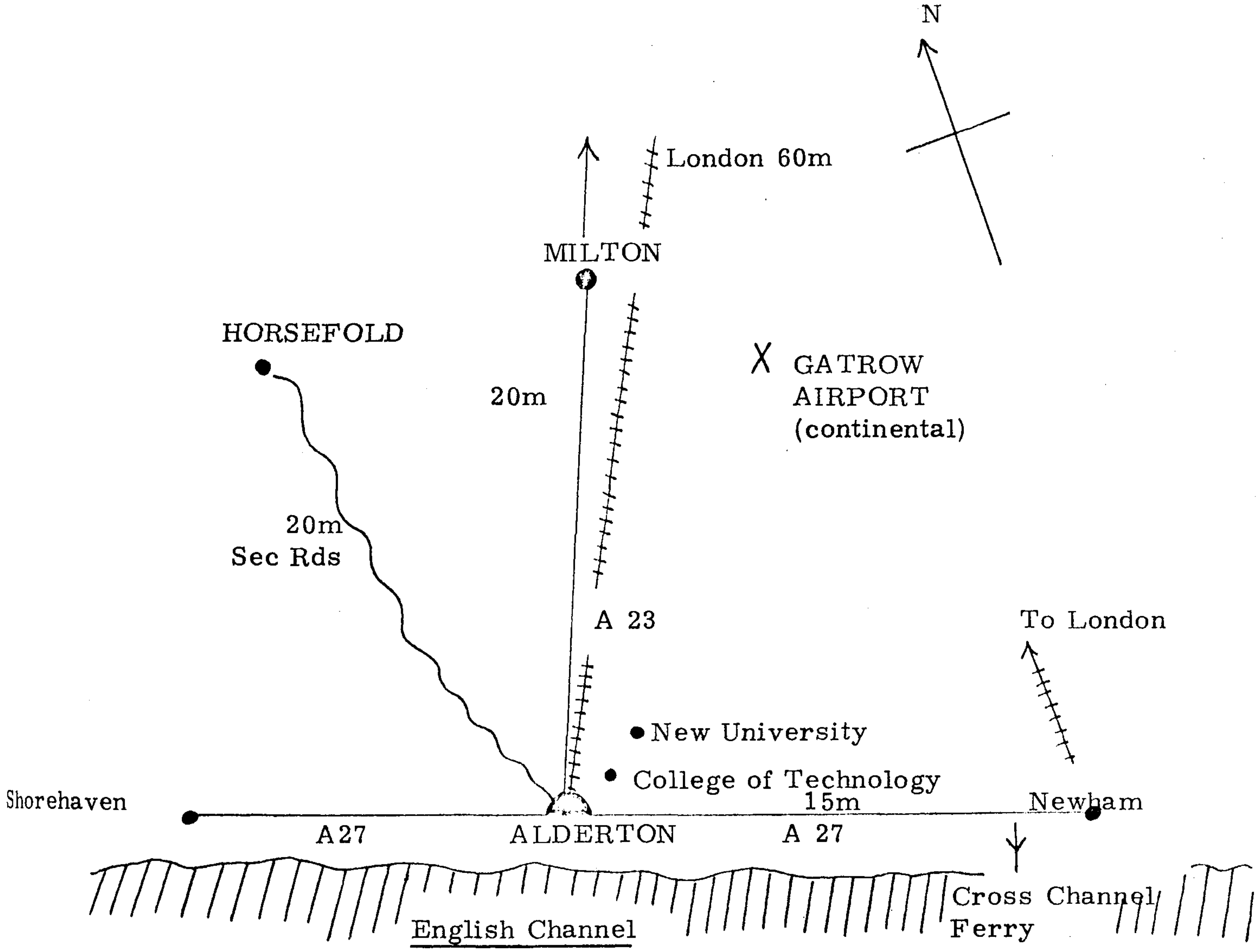

Fig 1 Map of Locality Showing Relationship of Alderton to it's Neighbours

South Coast and surrounded on its landward boundaries by the South Downs. Access is gained from the north via a main dual carriageway, the A23, and via a frequent train service from London 60 miles to the north. Road and rail services also run East West along the coast. There is a small airport some ten miles to the west, used mainly for private flying and charter services using small aircraft.

Nearest neighbours to Alderton are, Shorehaven ten miles to the west connected by the railway and the A27, Horsefold twenty miles north west, connected by second class roads, Milton twenty miles north up the A23, near which is a single runway airport, Gatrow, serving some of London's continental and Channel Island air traffic. To the east, connected by rail and the A27 coast road, is Newham, fifteen miles distant. This is a Channel port serving Dieppe with a passenger and car ferry.

The county of Sussex is divided into two parts for administration purposes, East Sussex and West Sussex. The dividing boundary runs round the western perimeter of Alderton.

The town of Alderton itself is mainly residential with a large number of hotels and boarding houses to cope with summer holiday traffic. In recent years, there has been a gradual influx of light industry, mainly manufacture of electronic components and electrical control gear. The main shopping or business area forms the nucleus of the town. There are the usual large department stores and high quality businesses, but also there is a large number of 'antique' and second-hand dealers which operate in a section of the town known as 'the Lanes'. These form the oldest part of the town in the centre of the business area and are a maze of narrow alleyways inaccessible to motor transport. They are lined with second-hand book shops, junk shops and a small number of genuine antique dealers.

Outside the town, three miles north east, is situated one of the new universities. The establishment is not yet completed and the student halls of residence are not built so that students tend to live in flats and lodgings in Alderton. On the north east limits of the town is a new College of Technology. So that of the young people in Alderton, a large percentage are students.

Alderton has its own concert hall, two theatres, six cinemas and large indoor sports arena for skating, swimming, wrestling and pantomime, etc. There are also some twelve registered night clubs and a casino in one of the larger hotels.

The wealthier residential districts of Hove to the west and Withdean to the north, are occupied in the main by retired business and professional people, though an increasing number of proprieters of the more lucrative type of business, such as estate agents and bookmakers are making their homes in these areas. In the surrounding countryside are situated a number of large country houses occupied by people of wealth.

Street maps and indices are provided for the subject and the operators.

2.2 Alderton CID

The simulated police force consists of the following:-

1 A team of six detecting officers made up of two Detective Sergeants and four Detective Constables. These are named Sergeants Brown and Pavey and Constables Salmer, Terrel, Hawkes and Keath. These men have varying abilities as detectives as indicated in Tables 1a and 1b below.

Officer	Service (Years)	General Assessment	Methodical	Imaginative
D S Pavey	15	Sticks to rules - not keen on responsibility	Yes	No
D S Brown	10	Enquiring and logical mind	Yes	Yes
D C Keath	7	Rather dull	Yes	No
D C Salmer	5	Has initiative -	Yes	Yes
D C Hawkes	4	Cannot be relied on to stick to rules - misses 'obvious' looking for 'obscure'	No	Yes
D C Terrell	2	Sticks to rules - not willing to make decisions	Yes	No

Table 1a Detective Characteristics

Officer	Local Knowledge	Interrogation Ability	Memory
D S Pavey	Average	Patient but unskilled	Fair
D S Brown	Excellent - wide contacts	Excellent	Very good
D C Keath	Good - knows local villains	Unskilled	Good
D C Salmer	Average	Efficient	Excellent
D C Hawkes	Good	Good	Fair
D C Terrell	Unsound	Unskilled	Fair

Table 1b Detective Characteristics

Insofar as the subject, S, is in command of this team of detectives, his status corresponds roughly with that of a Detective Inspector.

The six detecting officers operate from a CID Office with which the subject has direct telephone communication. OP3 normally will answer the CID room telephone and switch the subject through to the detective he requires.

2 A Scenes of Crime and Fingerprints Section in charge of an experienced fingerprints specialist, Sgt Elden. He has under him two Scenes of Crime Officers, SOCO's whose job it is to visit specified crime scenes to obtain photographs, fingerprints and other items of potential value as clues or evidence. The SOCO's have a radio-equipped Mini-van for transporting them and their equipment from scene to scene. The Finger Prints Bureau holds fingerprint records of all known local criminals and is in direct telephone contact with the subject.

3 A Registry (or Records Office) containing all records of local criminals, photographs, modus operandi, distinguishing marks, etc. (See Appendix 1.2 for Criminal Records). This department is run by a Sgt Whitton who has a direct telephone link to the subject. Registry has a teleprinter link with New Scotland Yard for receiving information about fingerprint searches, stolen vehicles, criminal movements and so on. The characteristics of Sgt Whitton and the fingerprints officers are presented in Table 2 below.

Officer	Service (Years)	General Assessment	Methodical	Imaginative	Memory
Sgt Elden	15 (Gen) 10 (Fingerprints	Very experienced no interest outside his field	Yes	No	Good
D C Davies (SOCO)	3	Keen - likes responsibility	Yes	Yes	Good
D C Jenkins (SOCO)	2	Competent	Yes	No	Fair
Sgt Whitton (Registry)	15	Very dull, does not like responsibility Due to retire soon	Yes	No	Fair

Table 2 Officer Characteristics

4 An Operations Room which for the purposes of the simulation receives all crime complaints, records them and then passes them onto the subject. The Ops Room maintains radio contact with all patrol cars, uniformed and CID, and with the SOCOs' van. There are two general purpose CID cars both equipped with radios. Messages to and from the uniformed branch will normally be transmitted via the Ops Room or via the detectives.

5 A Switchboard which enables calls to be made to outside the station, for example, to a complainant or to a neighbouring force.

Using this CID force, the subject is required to solve as many of the crimes passed in to him as possible. A crime is considered solved when and only when a suspect admits to having committed the offence.

As has already been stated, the subject's role corresponds roughly with that of a Detective Inspector. The other aspect of a DI's work, that is the routine office work, is represented in the simulation by an Auxiliary Paper Work Task. This entails crossing out selected letters from a random sequence of letters on a foolscap sheet. Part of a sample sheet is reproduced in Fig 2.

3 The Simulator

3.1 Hardware

Full technical specifications for all the equipment are contained in the Technical Manual. The functions of the various components are outlined here.

CANCEL - G A R TOTAL CANCELLED -

Z Q X R R D T K J S E E L Z N F Y W B M C I P I V V G O A O

T T J W B C Y O G I J S F M D K K G P X X D V V T S E B N O

Z H W W Z M C K U U U R R E Q G N Y X L L M R P A P A A D G

J T J I J I Z Y O I H X L A B B C V F V S F F D Q S Z Y L Y

P C E E X W W Z N H J U T T G G O Q E O M M C A F I X L J Z

C L D D Q H U K K T G P P Y M W B B O F S S V I R R E N A O

T K G G V Y Y Y C S O H H W P Z W D D E M D Z Z R I J B T N

N K T U G P P N S R A Z J I C F F E L D L U V C S Q A Q Q B

R G Z O Z E U D T K B A Y K H H F N L M N B C Z I I W W Z K

P Y R R J Z J J F G G C A Q U V T T B L O O E K I S S V M D

Y J V V H T S D L I V X T K B G C E Z X Q O J A F W X Q R S

T H D H V U U L P P K J J N Y T Y S Y W Z Z B V E I D G F A

L G C C I N R U P R O O N S W M V Q N F K K L H E I G A B C

Z F K N L M O Y T T S X X R V P Q U W J D D H B A G G I E E

F U O H I D E F G Z X U O L L N M U T G C J R S T Y S K K K

P B A Y Y A X U Q N F D J P U U M A H C E T Z X Z Z T U O K

S S V G G M H V P V K D J W P W Q W O N F L L R R C I I A Q

X Z Z O P D R B M C N E N T T K W W X S A A Q P L L J G D G

T U U U S V O H B K Y Y B B X Q J J K L Z W V A H O D S R R

I I P I C C C G F F H J I X Q T T M E E U S J F L Z Y W O P

M M N I R D D C A A H B B T V J C G L P W Y Z X O S U F E G

Q Q I Y V V X U N G O A H C J K K S N E F T Z R L D W P I B

M N H E D Q G Z X I B C O V J J H Y E D F X P P R J B J K L

U V G E A C I Z X W O O G Q I B S S K L M M V R Z Y A C H F

D T P Q J B E G O V T Y R D F H A A I K L N N N U U S C W W

P X Q Y E D Z T N G H S J B V K U O F I R L C G G P O X T B

S O K K K V U L L A D C C J I H P R Q S Z Z Y N B L M D E F

G H H O D A C V X Q D E G J S Z T T I Q U A K B C X W W W N

R Q I S T J N L V V A K U L M D N X Y Y O E F P P Z R H S A

U X F F R J T I O O C C L W N N E G G P Y K B V M D Z Q H C

A T R Q M K H H Y F W D Z T U S V O F N Y P G G J E L J B B

Fig 2. Part of Sample Auxiliary Paper-Work Task Sheet.

A photograph of the assembled equipment is shown in Fig 3 and photographs of the individual operatore's panels are shown in Figs 4, 5, 6, 7 and 8.

Op 1 sits at Box A and represents the three detectives, D Sgt Brown, D Constable Hawkes and D Constable Salmer.

Op 2 sits at Box B and represents the three detectives, D Sgt Pavey, D Constable Terrell and D Constable Keath.

Op 3 sits at Box C and represents the Finger Prints Department, Sgt Elden, D Constable Davies and D Constable Jenkins. He also operates the CID room telephone, the switchboard and the Operations Room channel.

Op 4 sits at Box D within reach of the remaining components. As well as his control functions, Op 4 represents the Registry (Sgt Whitton) and the External Switchboard.

The Subject S sits at the console shown in Fig 8 which must be situated in another room so that the subject is effectively insulated from the conversations of the operators.

The Information Store is sited between Op 3 and 4 and is accessible to either of them. The Waiting Reply File is organised by Op 4 and will be in front of him on his desk.

Each crime input to the subject is in the form of a complaint sheet, tagged with the case number, the loser's name, the address of the attacked premises. Instructions as to when a complaint is delivered to the subject are given by Op 4 but the complaint sheet will normally be delivered by Op 1 acting as messenger.

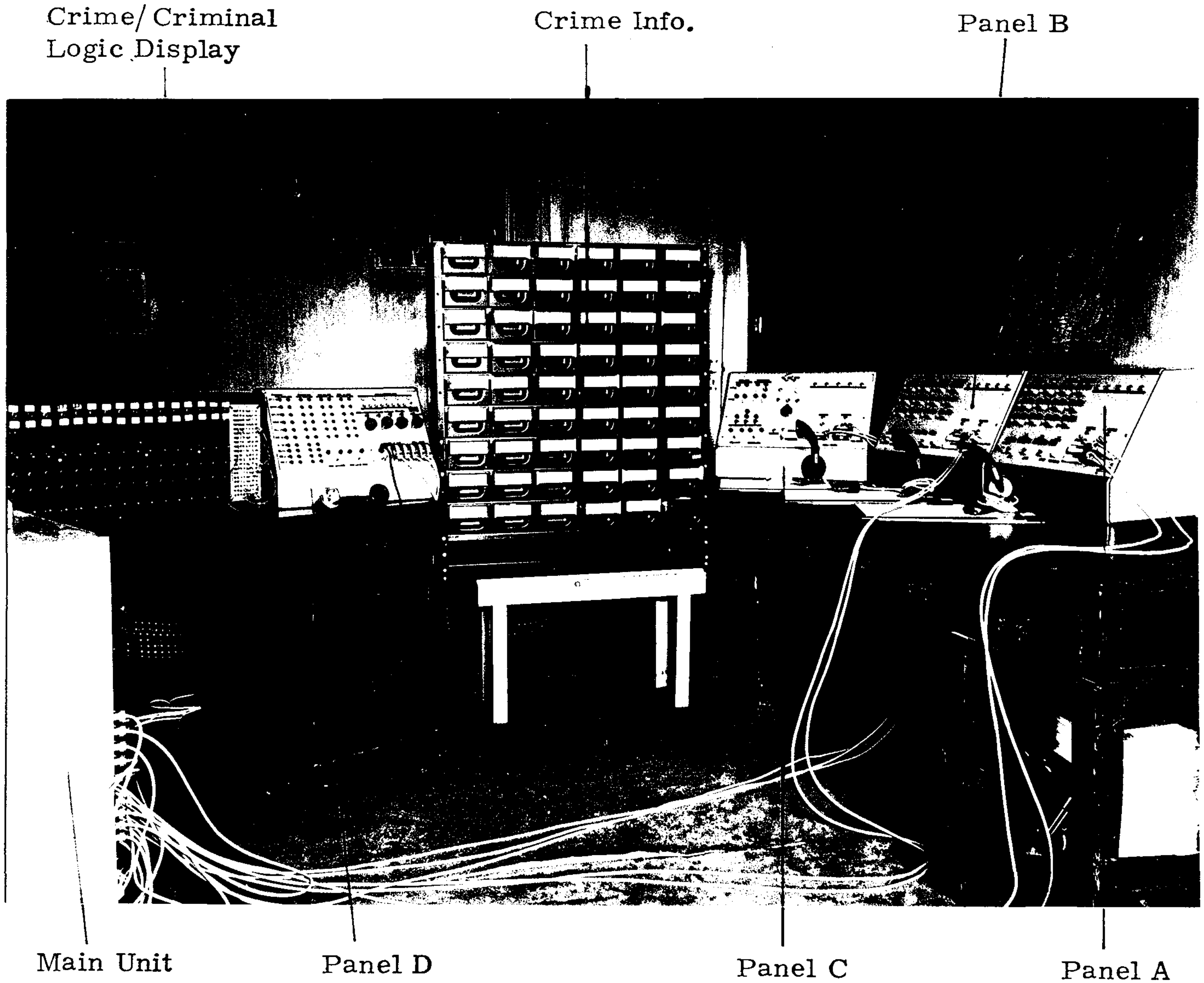

Fig 3 Assembled Simulator

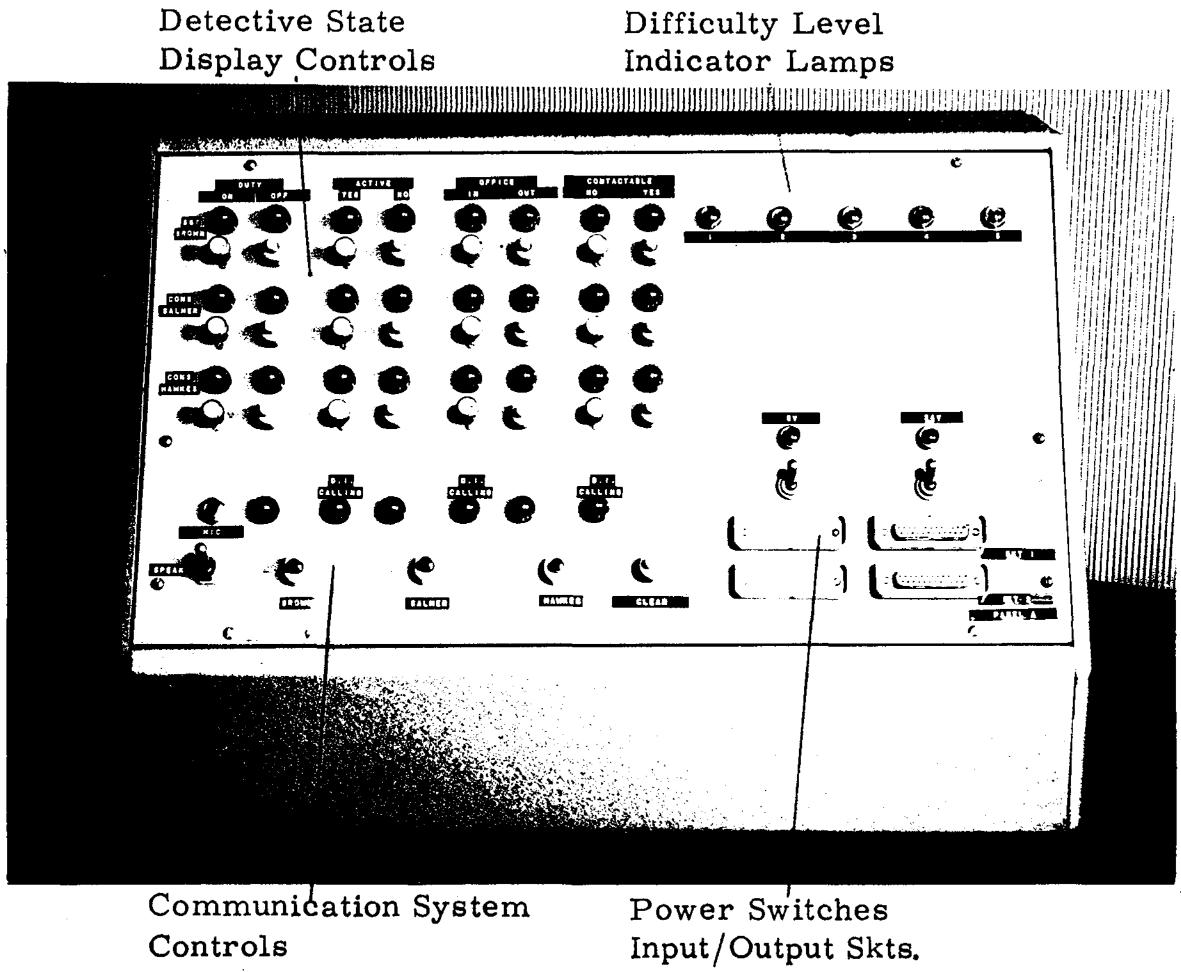

Fig. 4 Panel A Layout (Panel B is identical)

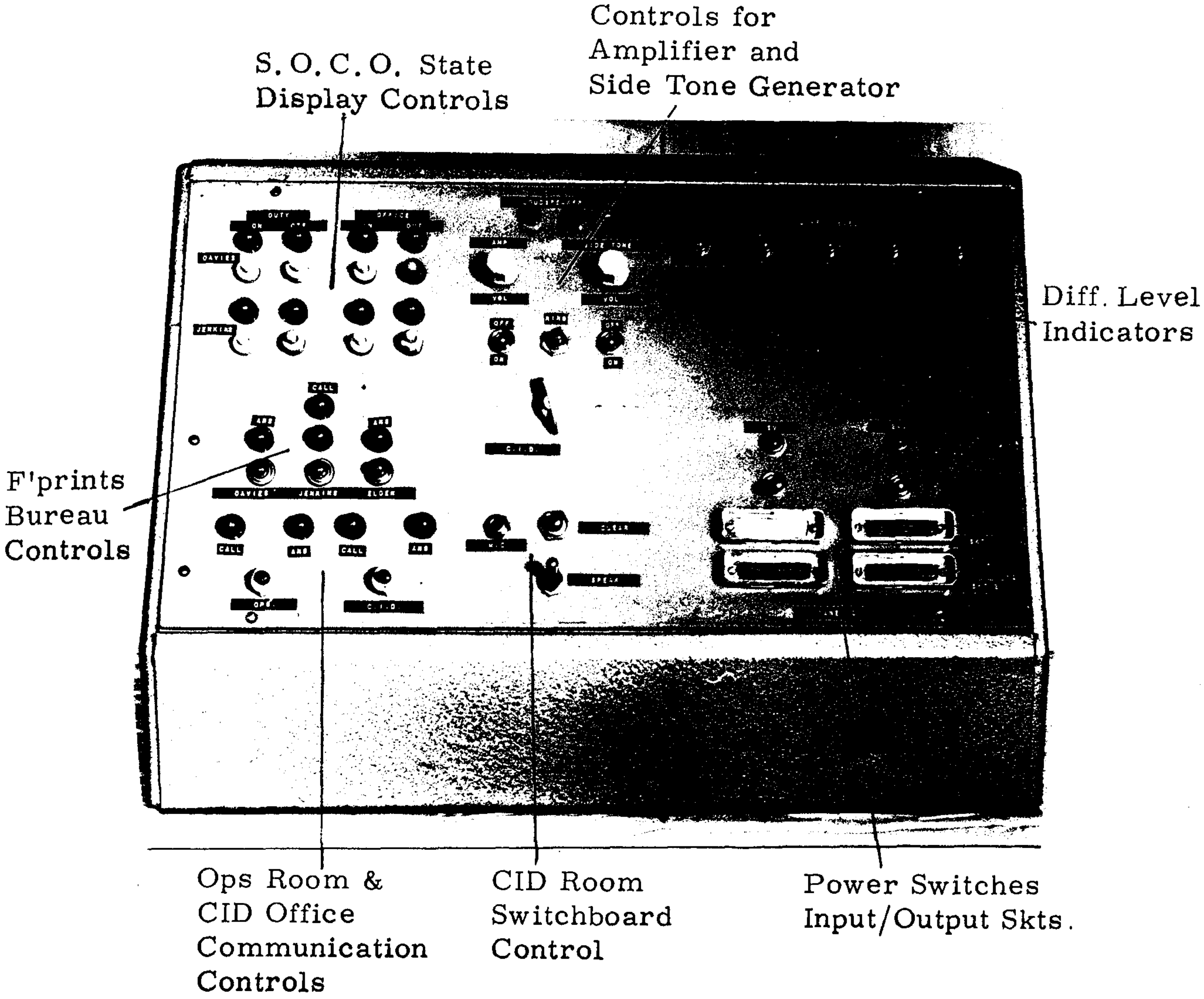

Fig. 5 Panel C Layout

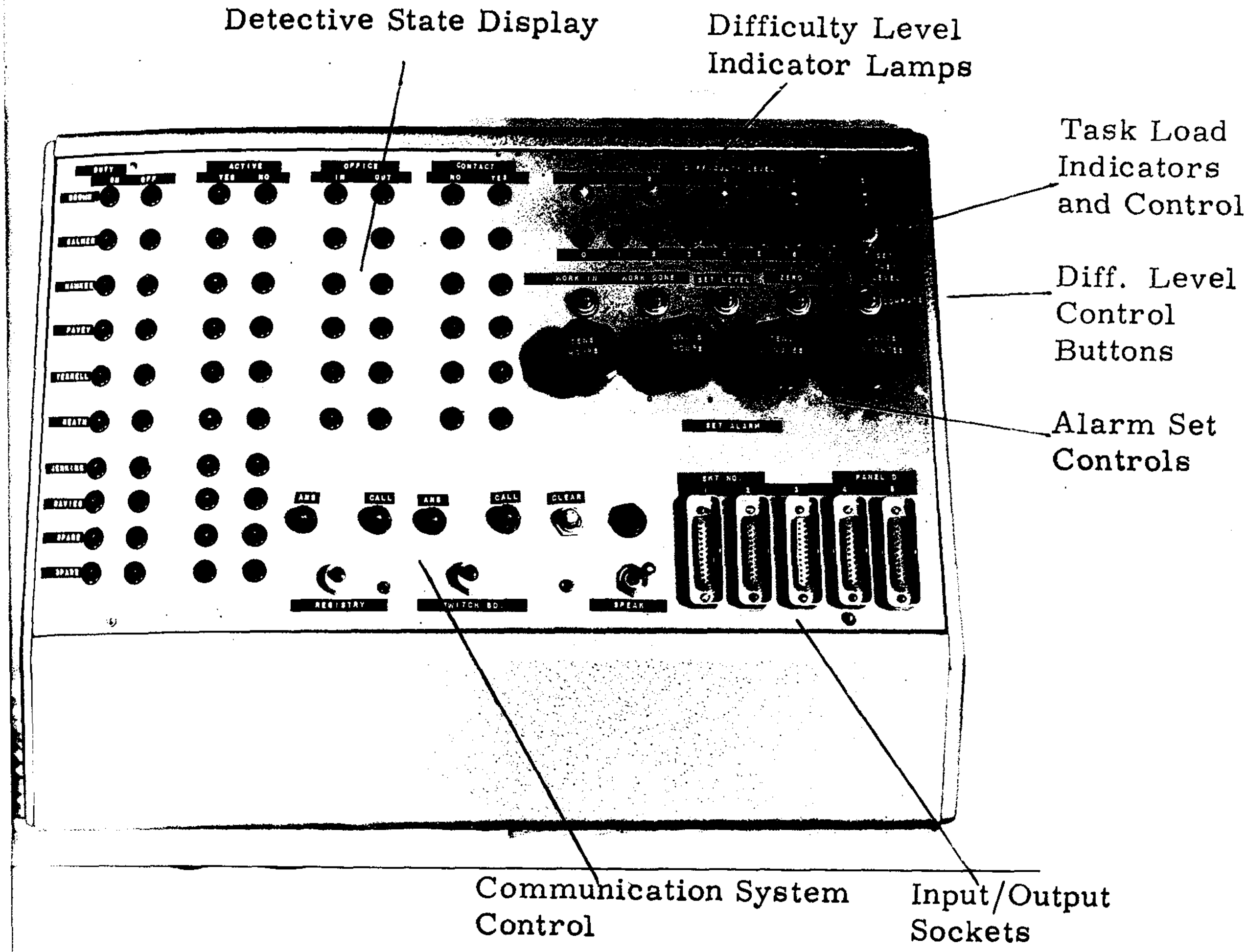

Fig. 6 Panel D Layout

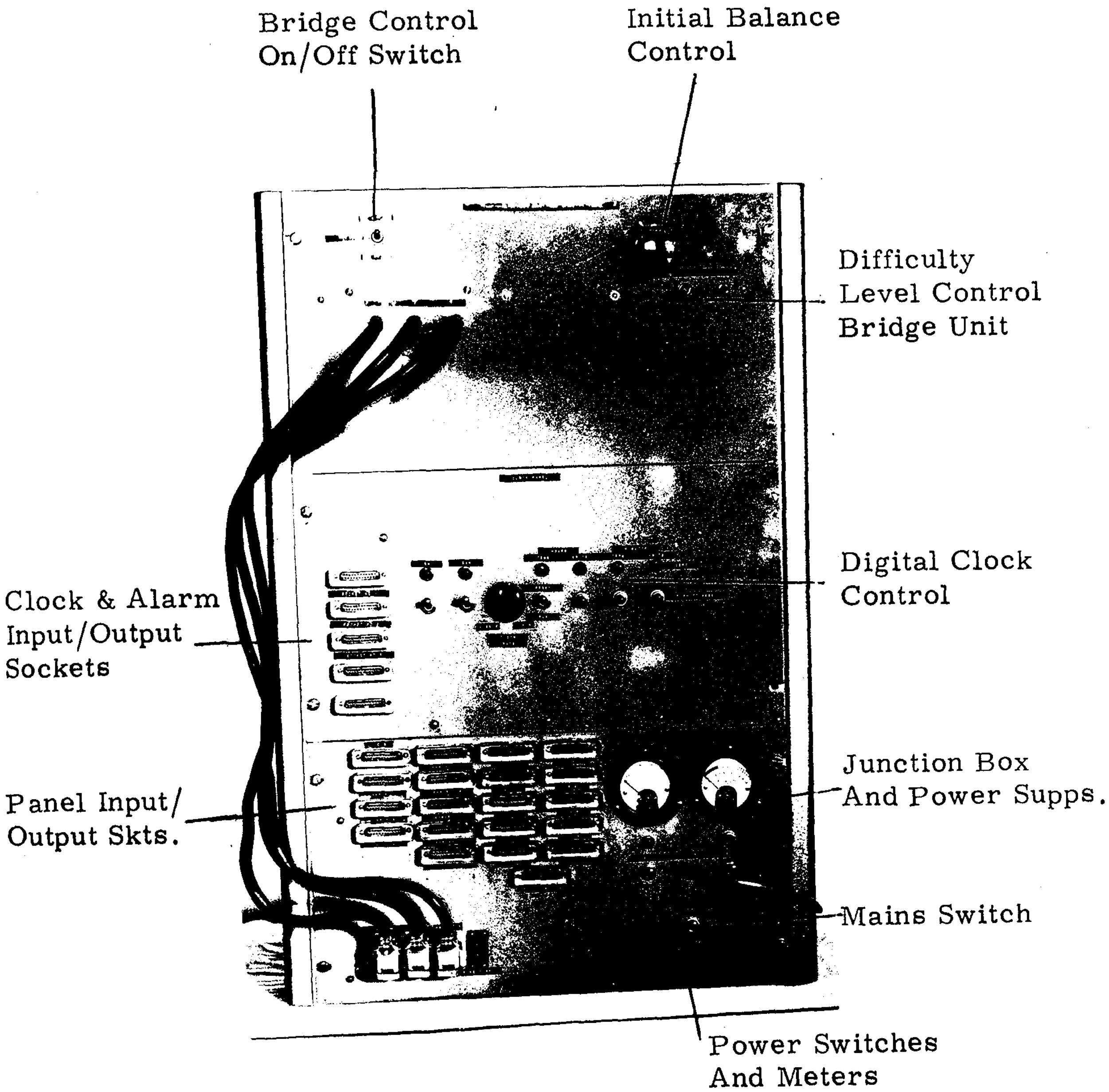

Fig. 7 Power, Clock, and Control Unit Layout

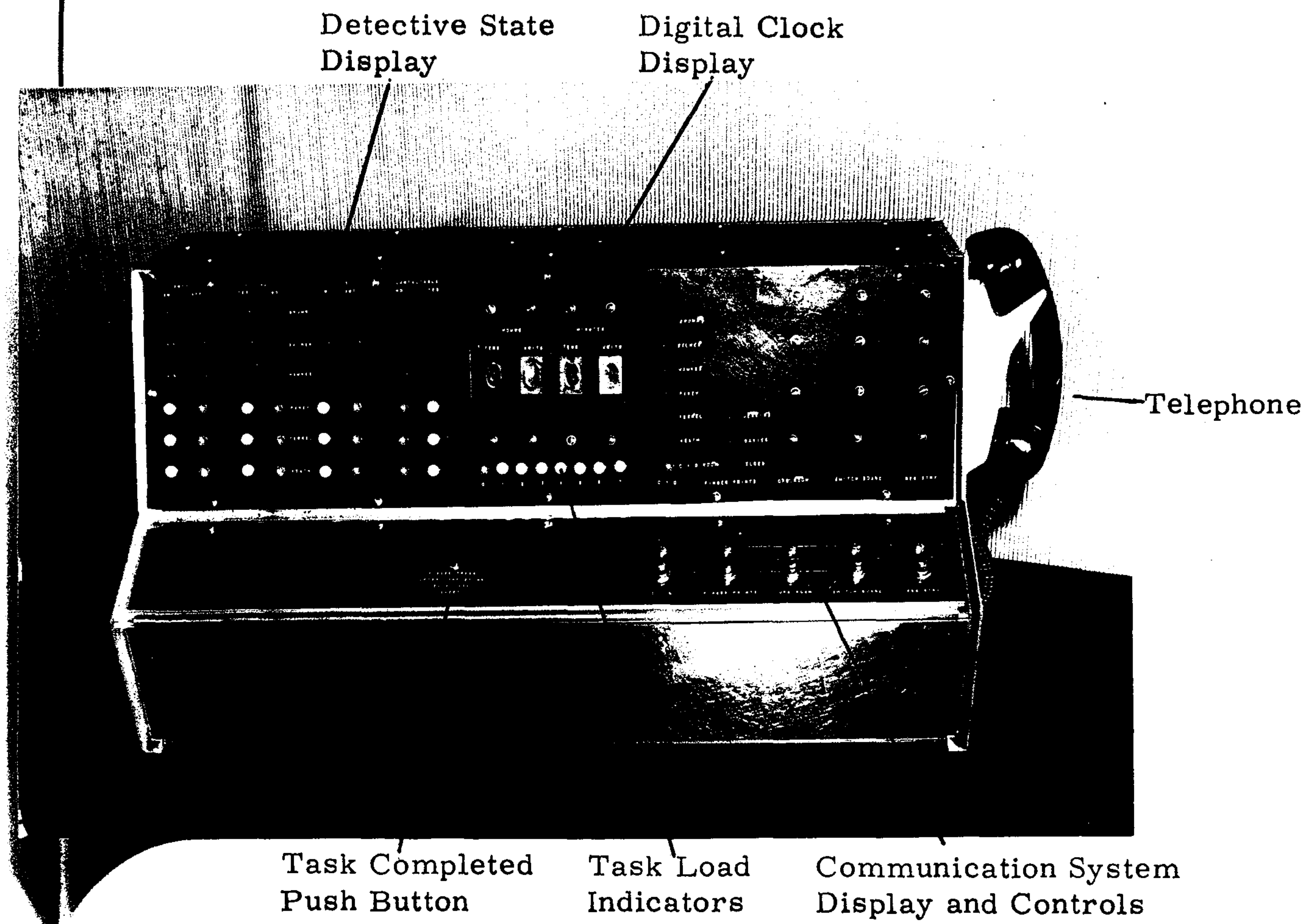

Fig. 8 Subject's Console Layout

3.1.1 Boxes A and B

These two boxes and the functions of Ops 1 and 2 are identical so that a description of Box A only will be given.

The state of each detective at any instant during the simulation is indicated by the values of four attributes. These attributes, their corresponding values and their meanings are shown in Table 3 below.

Attribute	Value	Comments
Duty	On/Off	<u>On Duty</u> Detective has reported for duty <u>Off Duty</u> Detective not available but can be contacted in emergency
Active	Yes/No	<u>Active Yes</u> Detective has been given work by the subject and is currently doing it <u>Active No</u> Detective has not been given work by the subject or has completed his work and is available for more
Office	In/Out	<u>Office In</u> Detective is in the station <u>Office Out</u> Detective has left the station
Contactable	No/Yes	<u>Contactable No</u> Detective cannot be contacted <u>Contactable Yes</u> Detective can be contacted, eg he is in a radio car and can be contacted through Ops Room

<u>Table 3 Detective States</u>

Note that when a detective is off duty, he is contactable through his home telephone but all his other states are negative.

The upper left hand quadrant of Panel A (see Fig 4) contains the state display controls. A row of 8 lamps (one for each of the 8 possible states) and 8 push buttons, is provided for each detective. The push button beneath any lamp brings that lamp on, switching being carried out by relays inside the box. Each operator must update the states of his three detectives when the programme demands. All detective states are displayed to S and Op 4.

Beneath the state display control are the communication system lamps and push buttons. Corresponding to each detective are two lamps, one green, one red and one push button. The green light on indicates that the detective is being called by S. The operator then presses the detective's push button to bring the red light on and indicate that this communication channel is engaged.

At the same time, a 'detective identification' light is automatically switched on at the subject's console and a side-tone in S's earphone is energised. (Each detective is characterised a) by the operator's voice, and b) by a side-tone of either 50 c/s, 100 c/s or 200 c/s). The operator now switches his 'speak' control to the 'speak' position and he can now communicate with the subject.

The 'clear' button allows the operator to disconnect his line to S.

A row of lights in the upper right quadrant of the panel indicates the current difficulty level of input crimes. This, coupled with some knowledge of the difficulty level selection procedures, helps the operator to synthesise correct replies to subject queries.

The two power switches should always be down during a simulation.

3.1.2 Box C

Op 3 is required to operate Box C. The upper left hand quadrant contains the state display controls for the two Scenes of Crime Officers. These states are On Duty and Off Duty, Active Yes and Active No, where the meanings of the states are as set out in Table 3.

The Finger Print Bureau communication system lamps and push buttons are situated below the SOCO state display controls. There is a single green 'call' lamp which, when on, indicates that S is calling the Finger Print Bureau. Three red lamps and three push buttons provide links to the subject for each of the three members of the Finger Prints Department.

When the push button is pressed, the red lamp comes on, indicating that this channel is engaged. At the same time, an identification lamp on the subject's console specifies which officer is talking, and an identifying side-tone in S's earphone is energised. The operator now switches his 'speak' switch to the speak position, and he can communicate with S. He can disconnect the line by pressing the 'clear' button.

Two other communication channels are provided in Box C for the Operations Room and the CID office. Each comprises a green 'S calling' lamp and a red 'line engaged' lamp. When these lines are engaged, an identifying lamp on S's console is illuminated; if no side-tones are generated. The 'talk' switch and the 'clear' push button are common to all communication channels in the panel.

In the centre of Box C is a rotary switch labelled CID Office Switchboard (see Fig 5). This enables Op 3 to call any of the six detectives in the CID office. Turning the switch to the required name switches on that detective's green 'call' lamp, and automatically makes a contact allowing that detective to talk directly to S. On completion of a call, the CID Office Switchboard must be reset to the CID office position.

Above the CID Switchboard, are controls for the amplifiers and side-tone generators. Knob A (see Fig 5) is the volume control on the amplifier feeding the loudspeakers from the subject's microphone. Switch S_1 switches this amplifier on or off. Knob B controls the volume of the side-tones in the subject's earpiece and switch S_2 switches them all on or off. The push button, C, is the 'call S' push button, which when pressed, energises a buzzer in S's console.

The loudspeaker, which provides the output from S so that all operators can hear, is plugged in to terminals T_1 and T_2.

The row of lights in the upper right corner of the front panel indicates the current difficulty level of input crimes. This, coupled with some knowledge of the difficulty level selection procedures, helps the operator to synthesise correct replies to subject queries.

The two power switches should always be down during a simulation.

3.1.3 Box D

Box D is shown in Fig 6. This is operated by Op 4 who controls the simulation and represents Sgt Whitton in Registry and the Switchboard allowing communication with the outside world.

The communication lamps and push buttons for Registry and the Switchboard are situated in the central lower position of the front panel. Each communication system has a green 'S calling' lamp and a red 'line engaged' lamp and a push button. Common to both systems are the 'clear' button which disconnects the operator from S and the 'speak' switch. The push button brings on the red 'line engaged' lamp and an identifying lamp on S's console. There are no side-tones on these channels.

The upper portion of panel D is divided in two, the left half containing state displays and the right half containing the simulation control devices.

The detective state display consists of a row of eight lamps for each of the six detecting officers and a row of four lamps for each of the two SOCO's. The two rows of lamps labelled 'spare' are not used. Op 4 then has at his disposal the complete sort of states for all the detectives and SOCO's. He monitors these and instructs updating when necessary. The detecting officer state display is an exact duplicate of that presented to S.

Most of Op 4's control duties are operated by the switches and push buttons in the upper right quadrant of panel D. The top row of fire lights indicates the current difficulty level of input crimes, and is controlled by the row of push buttons shwon as level control push buttons in Fig 6. On the box these are labelled from left to right as follows:- 1) Work in 2) Work Done 3) Set Level 4) Zero and 5) Compute, and the operating rules are as follows.*

When crimes complaints are sent to S, the 'work in' button and the 'set level' button are each pressed once for each input crime.

Whenever a crime is detected, the 'work done' button is pressed once.

*Assuming it is required to stabilise the subject's performance at about 50% detection rate.

Now, for the purposes of control, the simulated day is divided into a number of sampling intervals. At the end of each interval, the case difficulty level control computer is interrogated and the case difficulty level is changed automatically by the control computer, depending on performance up to that instant.

A functional description of the control computer is contained in Section 3.1.4c.

The row of eight lamps and one push button is the auxiliary task loading control. The display of eight lamps which is duplicated on S's console, indicates the number of auxiliary task sheets to be completed by the end of the simulated day. This can be increased and is set initially at the desired loading by the push button on Box D; it can be decreased only by the 'Task Completed' push button on the subject's console. Information from both these buttons is fed also to the case difficulty control computer.

The four rotary switch knobs marked from left to right 1) Tens Hours, 2) Units Hours, 3) Tens Minutes, 4) Units Minutes, are the "Operator's Alarm' set switches. The switch positions are labelled so that any time between 00 hours 00 minutes and 23 hours 59 minutes can be set. When clock time reaches the time set on the alarm, a buzzer warns the operators. The alarm is used by Op 4 in conjunction with the Waiting Reply File. The functioning of this system is fully described in Section 4.

3.1.4 Power, Timing and Control Unit

This unit is shown in Fig 7. There are three main units. From bottom to top, these are:-

1 Power Supplies and Signal Distribution Unit.

2 Timing Unit, incorporating variable clock rate control, and set zero controls.

3 Difficulty Level Control Computer, incorporating an initial balance control and out of balance indicator lamps.

3.1.4.a. Power Supply and Signal Distribution Unit

All the power for the simulator equipment is derived from a single mains (240V AC) input supply, through a switch labelled mains ON-OFF in the lower right hand quadrant of the bottom panel. A 6V AC and a 24V half wave rectified supply are derived for energising lamps and relays respectively. The meters on the front of the power unit monitor these two supplies, which are individually switched ON or OFF by the labelled switches. Two full wave rectified smoothed 9V supplies and one 18V are also derived for microphones, amplifier and side-tone generator and clock pulse generator.

The twenty 25-way sockets are each labelled with the name of the socket to which it must be connected. Thus the socket labelled A1 on this unit must be connected to Socket 1 of Box A, etc.

Connection is made by lengths of 25-way cable with plugs at each end. All the connecting cables and plugs are identically wired so that any connecting cable can be used for any connection.

Details of inter-box connections are given in Section 4.

3.1.4.b. Timing (Clock) Unit

This consists of a variable repetition rate pulse generator driving a series of uni-selectors to give digital readouts in minutes from

00.00 to 23.59. The pulse rate is variable by means of the control knob indicated, from approximately 1 pulse every 3 secs. to 1 pulse every 60 secs., where 1 pulse drives indicated time on by 1 minute. Hence, with the control provided, simulated time can be made to run faster than real time by a factor of from 1 to 20. The clock can be set manually to indicate any desired time by using the reset switch and the three reset push buttons.

To reset, switch the reset switch to the reset position. Pulse the push button labelled 'units of minutes' until the required digit appears in the display. Repeat for the 'tens of minutes' push button. Only one reset button is provided for the 'hour' indicators. 24 pulses from this button move the indicated hours from 00 to 23.

The row of 'zero' lamps is energised when indicated time is 0000.

The 24V and 6V supply switches should both be ON (down) during the simulation.

The top three 25-way sockets provide outputs to the subject's console and the alarm set switches on Box D via the signal distribution unit.

The lower two 25-way sockets provide outputs for the operator's clock indicator. This presents the operators with a display of tens and units of hours and tens of minutes. It is not necessary for operators to know the time more accurately than this.

3.1.4.c. Difficulty Level Control Computer

This consists of a simple Wheatstone Bridge arrangement adjusted by the control buttons on Box D so that the sense and magnitude of the out of balance voltage, Vo, gives a measure of S's performance. When Vo exceeds a certain positive threshold, a relay is set so that when Op 4 presses the 'compute' button, a reversible uni-selector is moved up one position, thus increasing the indicated difficulty level by one unit. Conversely when Vo exceeds a negative threshold, another relay is set so that pressing the 'compute' button reduces the indicated difficulty level by one unit. If neither threshold is exceeded, neither relay is set and the 'compute' button has no effect on the indicated difficulty level.

A schematic circuit diagram of the bridge circuit is shown in Fig. 9. The potentiometers VR2 and VR3 can be pulsed in either direction through modified uniselector drive mechanisms. VR2 is increased by the 'work in' button and the 'increase task' button on Box D. It is decreased by the 'task sheet completed' button on the subject's console and by the 'work done' button on Box D. VR3 is increased by the 'set level' button and decreased by the 'zero' button, both on Box D.

Initially VR2 and VR3 must be set to zero by pulsing the 'work done' button and the 'zero' button on Box D.

The manual balance control VR1 on the computer unit is then adjusted so that the negative out of balance lamp is ON. The 'compute' button is then pressed to reduce the starting difficulty level to the lowest value, 1. The manual balance is then adjusted so that BOTH out of balance lamps are Off. The computer is now set and will automatically adjust the difficulty level if the procedures described in Section 3.1.3 are carried out.

The procedures have been evolved for controlling subject performance at about the 50% mark. If it is required to stabilise performance around another level, the ratio of the number of pulses on the 'set level' button to the number of pulses on the 'work in' button must be changed. This ratio is given by the following formula:

$$R = \frac{\text{Number of 'set level' pulses}}{\text{Number of 'work in' pulses}} = 2(1-0.01P)$$

where P = required performance level (%).

Alternatively the maximum value of VR3 may be altered according to the following formula:

$$VR3 = (1-0.01P)VR2$$

For mounting arrangements, reference should be made to the Technical Manual.

The capacity of the bridge is limited to 40 'set level' pulses. Hence, after each simulated day, it will normally be necessary to reset the control bridge to zero without, however, altering the current difficulty level.

N.B. A 240V mains supply is brought from the bottom power unit to the control unit so great care must be taken that the control unit connecting cables are connected to the correct sockets before switching on the main unit.

3.1.5 Crime-Suspect Relationships Display

When a suspect is arrested, it is necessary to know if he was concerned in any crimes committed after the time of his arrest. For example, if suspect X commits one crime on Day 1, one on Day 2, one on Day 3 and one on Day 4, conceivably he could be arrested on Day 2. Then it is illogical that his crimes of Days 3 and 4 be included in the programme. The crime-suspect relationship display indicates which crimes cannot be used in the simulation for the above reason.

The display (see Fig. 3) consists of an upper row of 20 amber lamps each of which has an on-off switch associated with it. Each lamp and switch of this set corresponds to one criminal.

Below this set are a row of red lamps, a row of green lamps and another row of switches. Each triple (red lamp, green lamp and switch) corresponds to one crime.

On the right of these sets of lamps and switches is a plug board, consisting of a matrix of 8X20 sockets. This is divided in two halves of four columns each. Each row of four black sockets corresponds to one crime, and each row of four red sockets corresponds to one suspect. If 15 crimes are to be used as a day's input, then rows 1 to 15 of the black sockets are connected, using the wander plug leads to the appropriate suspects.

Note that the suspect numberings are fixed i.e. amber lamp and switch 10 <u>always</u> represents suspect 10. But the numbering of the crime rows lamps and switches depends on the particular section of input programmed, and hence will vary from simulated day to simulated day.

The device is reconnected at the beginning of each simulated day.

Its capacity limits the number of crimes associated with any suspect to four, and the number of suspects involved in any crime to four.

When a crime complaint is set in to the subject, its corresponding switch (in the bottom row) is switched UP to bring on the green lamp. This indicates that this crime is in the game and cannot now be affected by the arrest of the suspect concerned.

When a suspect is arrested, his switch is switched UP to bring on the amber lamps. This indicates that this suspect is in custody. Simultaneously, a relay is energised so that the red lamps for the crimes not already in the game committed by this suspect are switched ON.

Those crimes which have red lamps ON must not be sent in to the subject.

Op 4 is responsible for updating the information in this display as the simulation progresses.

3.1.6 Operators Clock Display

This is mounted in a separate box which can be moved to a position convenient for all the operators. It consists of a display of tens of hours, units of hours and tens of minutes. Thus it runs from 00.0 to 23.5.

It was found that operators took on the average between 5 and 10 simulated minutes to deliver a reply to S so it is not necessary for the operators to know the time to within less than ten minutes.

3.1.7 Subject's Console

The subject's console is shown in Fig. 8. The left hand portion of the display consists of the detectives' state display. This is six rows of eight lamps. Hence, there is one row for each detecting officer and one column for each possible state. Those are clearly labelled so that lamp ON shows which state the detective is in.

The centre portion of the display includes the clock display clearly labelled and reading from 00.00 to 23.59 in stops of one minute.

Below the clock display is a row of lights numbered 0, 1, ... 7. The number illuminated indicates the number of auxiliary task sheets remaining to be completed before the end of the simulated day. S is instructed to press the push button in the centre of his control panel (see Fig. 8) whenever he completes a task sheet. This reduces the displayed number by one and also informs the control computer.

The right hand section of the console is taken up with the communication system. The display part consists of labelled identifying lamps for all possible voices in the system, so that S can tell at a glance to whom he is talking. The subject makes a call by lifting the receiver and then pressing the appropriate button on the control panel.

As well as the console, the subject is provided with a map of the locality, a street map and index mounted on a metal sheet so that he can position magnetic 'counters' to represent his detectives, a set of detective characteristics, a tray containing auxiliary task sheets, a bin for depositing completed task sheets and a supply of scribbling paper.

It is essential for proper working of the simulator that the subject be far enough from the operators so that he cannot hear or see the activities of the operators. This is most easily achieved by installing S in a separate room from the operators.

3.2 Information Storage System

3.2.1 Crimes

The basic information relating to crimes is stored in the 48 drawer filing cabinet. See Fig. 3. The drawers are labelled with the identifying numbers of the crimes which they contain.

Information about a crime is stored on special format cards under three group headings. These group headings are

1	Group 1(a)	- Scene (General)
	Group 1(b)	- Scene (detailed)
2	Group 2	- Loser
3	Group 3	- Local Enquiries

Each card contains Case No., address of attacked premises, loser's name, property stolen and its value, plus the information relevant to its group heading. Front and rear of a typical card are shown in Fig. 10.

Crime difficulty for the first experiments, was directly related to these information groups in the following way.

The least difficulty level m=1 was defined when all information from all groups was available.

The medium difficulty level n=2 was defined when all information from Group 1a, 2 and 3 only was available.

The highest difficulty level n=3 was defined when all information from Groups 1a and 2 only was available.

CASE 41

Address	17 Fleet Street	Loser	John Raymond
Prop. Stolen	Cash, watch	V-£	10.0.0d
GROUP 2 - LOSER			
Source	A) Mr Raymond. He is a bus conductor with the local bus company. He and his wife are only occupiers of the house.		
Statement	A) Locked up the house as usual at about 11.30 last night. Went to bed heard nothing suspicious during the night. Discovered the break when he came down at about 09.30 next morning.		

Front

Statement (cont.)	Heard nothing suspicious during the night, seen no-one suspicious hanging about. Can offer no further info.
Other Features	Mrs Raymond can offer no further info.

Rear

Fig 10. Front and Rear of Typical Crime Information Card

In practical terms this meant that a n=1 crime could be detected from finger print evidence, and/or witness descriptions, and/or loser evidence. A n=2 crime could be detected from loser evidence and/or witness description only, and a n=3 crime could be detected by loser evidence only.

This scheme, coupled with detective characteristics also related to these information groups (see Section 3. 3), resulted in suitably varied detection probabilities.

3.2.2 Registry

Registry is a set of cards containing information, records, descriptions, associates, vehicle registration numbers, etc., for all the criminals in the game. A typical registry card is shown in Fig. 11.

Registry also receives information from Scotland Yard over a teleprinter link.

3.3 Programmed Detective Characteristics

The following table specifies the information groups from which each detective may retrieve criminal identifying information. Information from groups other than those specified may, of course, be presented, but it must not contain identifying information. The time (simulated) taken by each detective to retrieve the information is also given.

CROOK, Hugh Francis (Hughie) CRO 1

Address: No fixed abode. Last address
96 Centurian Road, Alderton (D6)

Age: 43 yrs.

Description: 5'9" black hair, well greased and brushed back. Brown eyes. Thin build. Has a slight stoop. Tattoo on left forearm - a heart with Masie written underneath.

Record: 14 previous convictions for housebreaking and larceny totalling 5 yrs. in jail. 9 previous convictions for assault and drunkenness.

Style: Sticks to small jobs such as gas meters and elec. meters. Usual method of entry is to smash a window, release catch and climb through.

PTO

Front

Idiosyncracies: Usually operates after pub closing time. That is he gets drunk then discovers he has no money, so does a job. He rolls his own cigarettes and is a chain-smoker. His 'local' is the 'Tradesmans Arms' in White Lion Street.

Associates: Herring (CRO 11). Mistress is Maisie Cummings of 22 Craighouse Ave.

Rear

Fig 11. Front and Rear of Typical Record Office Card

Detective	Information Group from which he may retrieve identifying information	Time per crime to retrieve information
D.S. Brown	1a, 2, 3	1 hour
D.C. Salmer	1a, 2, 3	1 hour
D.S. Pavey	1a, 2	$1\frac{1}{2}$ hours
D.C. Hawkes	1a, 2	$1\frac{1}{2}$ hours
D.C. Terrel	1a	2 hours
D.C. Keath	1a	2 hours

Table 4. Detective Characteristics

The times taken by finger prints and registry to perform their various functions are given below.

S.O.C.O.'s Davies and Jenkins	Time per scene visited	=	1 hour
Sgt. Eldon	Time to process marks	=	4 hours
	Time to find suspect's record	=	immediately
	Time to do album check with witness	=	$\frac{3}{4}$ hour
	Time to find car owner identity from records	=	1 hour

4. Running a Simulation

4.1 Connecting up the Equipment

It is recommended that the simulator equipment be laid out in the pattern indicated in Fig. 3. This provides Op 4 with convenient access to the control equipment and the crime information store. Op 3 also has access to the crime information store and all operators are close enough together to allow an easy flow of cards and complaint sheets among them.

It is essential that the subject be placed out of earshot of the operators. Ideally he should be in a neighbouring room so that delivery of complaint sheets is not too inconvenient. There are three sets of connecting cables of different lengths. Connection-wise all cables are identical and are thus interchangeable.

The longest cables connect the subject's console to the distribution unit. There are five of these cables. Socket 1 in the console is connected to Subject Socket 1 on the distribution unit, etc.

The intermediate length cables connect the four operators' boxes to the central unit. There are twelve of these cables, five for Box D, three for Box C, and two each for Boxes A and B. Socket 1 on Panel D is connected to Panel D socket 1 on the distribution panel, and so on.

The shortest cables connect the clock outputs to the distribution unit.

The operator's clock display has its own fixed connecting cables.

The crims-suspect display and the difficulty level control bridge also have their own fixed connecting cables. It is very important that these be correctly connected, leftmost cable to leftmost plug.

WARNING. DO NOT SWITCH ON UNTIL YOU HAVE CHECKED THAT THE CONTROL BRIDGE UNIT IS CORRECTLY PLUGGED IN.

Before use, the system should be checked out for correct functioning and to test for broken lamp bulbs, the most likely fault. After check out, the volumes of the amplifiers and side-tone generators should be set at convenient levels using the controls on Panel C.

4.2 Subject Preparation and Briefing

Notes indicating how subjects should approach the simulator have been prepared and are attached to this manual as Appendix 1.1 These were the notes given to our experimental subjects and space is provided for subject criticisms.

We assume then that a subject comes to the simulation familiar with the general operation of the system. However, it is worth explaining to him the operation of his console in more detail. Emphasise that time is speeded up and that simulated time is presented digitally in 24 hour notation on the display in the centre of his console. The indicator lamps on the right hand side of the clock indicate which simulated detective or service is talking. (Each detective also has a characteristic side-tone with the voice). The group of push buttons on the right of the sloping front panel enables him to call the service he requires. Review the meaning and functioning of his state displays.

A simulated paper work task involves crossing out all of a specified group of three letters wherever they occur in a random sequence of letters. Each sheet represents one paper work task. The number of tasks to be completed during the simulated day is indicated by the row of lamps beneath the clock display. This is reduced by one when the small push button in the centre of the sloping front panel is pressed. This should be pressed only when he completes a task. He should aim to do as much as possible, as accurately as possible. The paper work task loading can be increased during the simulated day but the load indicator lamps will always show how many sheets remain to be done before the end of the simulated day.

Subjects are informed about cases by means of complaint sheets, an example of which is shown in Fig. 12. These are delivered to the subject at the time the crime is reported. It is recommended that subject's notes and records about what actions have been taken should be made in the relevant crime sheet. However, additional scribbling paper should be provided in case a subject wishes to adopt some other personal recording method.

Complaint No.	Notes
Time ______ Via ______ Mr J Gower 17 Maida St. (D6) House burgled during evening. Gas meter broken open contents stolen. Small travelling clock missing.	
Action Taken	
Passed to DI for further action at ______	

Fig 12. Typical Crime Complaint Sheet

The street map of Alderton is provided with magnetic markers so that the subject can locate his men easily. The map is divided by a fairly large grid and an index relating street names to this grid is provided.

Should the subject wish to leave his post temporarily, he may do so after informing the switchboard not to put through calls till his return. The simulation will continue in his absence.

A simulated day starts at 0900 hours and finishes at 1800 hours. A break of about 15 minutes real time was allowed in the experiments between each simulated day. Any crimes reported after 1800 hours and before 0900 hours next day are dealt with by a night officer and any reports are left on his desk as part of the work to be done during the next day. Any queries about the running of the simulation should be addressed to the switchboard.

4.3 Preparation of Input Data and Setting up Routines

A typical complaint sheet for a crime is shown in Fig 12. Complaint sheets for each crime are stored in a folder tagged with the crime number, the loser's name and the address of the attacked premises. A crime programme is a series of crimes ranked in order of their "reported" times, with the first crime reported at the head of the sequence. Two crime programmes were used in the experiments. The first of these was a 10 crime/day 6 day programme and the second a 15 crime/day 4 day programme. Since running procedures for both programmes are identical, we shall discuss these in relation to the first programme, that is, the 10 crime/day 6 day programme. There are 60 crimes in this programme and main details of these are given in Tables 5 a b c.

The programme for each of the 6 days constructed from these crimes is shown in Tables 6 a b c d e f, below.

Table 5a. Connection Between Crimes and Criminals

SUSPECT	CRIME	TIME COMMITTED	TIME REPORTED	PLACE	PROPERTY STOLEN
1. Crook	1	(Day - 2) 23.00	(Day - 1) 18.30	196 Dyke Rd. (B2)	Gas & Elec. Meters
	25	(" 1) 11.15	(" 1) 11.20	North St. (E5)	Purse & Cig. Ltr.
	23	(" 1) 21.30	(" 1) 22.00	Hove Stdm. (C2)	Tr. radio fr. Car
	24	(" 2) 23.00	(" 3) 00.35	17 Maida St. (D6)	Gas meter, tr. clock
2. Bushby	43	(" 3) 01.00	(" 3) 10.45	19 Parbury Le. (E6)	Cash, camera
	44	(" 3) 10.30	(" 3) 12.15	3 Rothell Gdns. (D7)	Cash, tr. radio
	45	(" 3) 10.00	(" 3) 13.20	12 Moordown Pl. (E7)	Camera, gram. records
	36	(" 3) 11.30	(" 3) 17.10	37 S. W. Ave. (E2)	Cash, records, saxaphone
3. Bristoll	3	(" 1) 03.00	(" 1) 09.05	137 Cuckmere Way (B6)	Gas & elec. meters
	4	(" 1) 03.30	(" 1) 09.10	56 Denton Dr. (B6)	Gas & elec. meters
	10	(" 1) 12.00	(" 1) 15.30	Surrenden Cr. (B5)	
	26	(" 1) 23.30	(" 2) 01.05	8 Woodland Ave. (B5)	Cutlery, slr. teaspoons
4. Prior	3	See Bristoll			
	4	See Bristoll			
	27	(" 2) 02.30	(" 2) 09.00	14 Aspen Rd. (C5)	Gas meter
	28	(" 3) 01.30	(" 3) 10.00	23 Hackett Le. (C5)	Gas & elec. meters
5. Dixon	12	(" 2) 10.00	(" 2) 11.35	12 Melrose Rd. (C2)	Gas meter
	9	(" 2) 10.45	(" 2) 16.37	2 Lyndhurst Ave. (D3)	Tr. radio & some rings
	29	(" 2) 11.30	(" 2) 17.15	4 Ralston Way (E2)	Cash, elec. meter
	2	(" 3) 10.30	(" 3) 15.50	14 Rudgewick Rd. (D2)	Cig. ltr. gas meter
	21	(" 2) 02.00	(" 2) 09.05	51 North St. (E5)	Cash, ½lb box chocolates

Table 5b. Connection Between Crimes and Criminals

SUSPECT	CRIME	TIME COMMITTED	TIME REPORTED	PLACE	PROPERTY STOLEN
6. Butler	34	(Day - 4) 01.30	(Day - 4) 08.30	4 Horton Drive (C4)	Box of tools
	40	(" 4) 02.30	(" 4) 09.45	54 Dyke Rd. (B2)	Musical instruments
	57	(" 5) 01.30	(" 5) 09.00	6 Harland Rd. (D4)	Garden tools
	49	(" 6) 01.30	(" 6) 09.05	4 Harrow Rd. (D6)	Cash, cig. lighters
7. Teegan	20	(" 2) 02.00	(" 2) 09.15	Sydney Street (E4)	Tr. radios etc.
	8	(" 1) 23.30	(" 2) 10.45	43 Withdean Rd. (B4)	
	18	(" 2) 01.30	(" 2) 12.30	68 Tivoli Cresc. (B6)	Silver plates
	31	(" 2) 23.00	(" 3) 11.30	22 Landover Terr.(B3)	Jewellery
	30	(" 3) 22.15	(" 3) 23.00	Rutland Cresc. (C3)	Camera, small silver cups
8. Fell	37	(" 5) 16.35	(" 5) 16.30	Public Baths (E4)	Cash
9. Kimber	35	(" 4) 01.30	(" 4) 09.00	58 Rutland Pl. (C3)	Tr. clock, slvr. inlaid pr. knife
	33	(" 4) 02.30	(" 4) 09.35	3 Fulwell Rd. (D7)	Golf clubs
	41	(" 4) 03.15	(" 4) 10.15	17 Fleet St. (C6)	Cash, watch, cig. lighter
	42	(" 4) 23.30	(" 5) 09.15	2 Hirst Close (D6)	Gas & Elec. meters
11. Herring	1	See Crook			
	24	See Crook			
	32	(" 4) 22.30	(" 4) 23.35	421 Huntingfield Rd.(E5)	Record Player
	47	(" 5) 01.00	(" 5) 09.45	18 Roxby Street (E6)	Spirits & Cigs.
12. Rushman	38	(" 6) 01.30	(" 6) 08.45	293 Queens Rd. (E7)	5,000 cigs.
	46	(" 6) 02.15	(" 6) 09.00	32 North Street (E5)	Suits & other clothing
	48	(" 6) 02.45	(" 6) 09.15	32 Queens Rd. (E6)	Record player, radios
	53	(" 6) 13.30	(" 6) 15.00	23 Manby Street (C3)	Slvr. plate & tankards
13. Newton	56	(" 6) 10.30	(" 6) 11.15	14 Brooklands Pk.(E4)	Silver plate
	51	(" 6) 12.00	(" 6) 14.30	2 Haverhill Rd. (B4)	Jewellery, tankards
	54	(" 6) 12.45	(" 6) 15.10	1 Haddon Close (E2)	Small slvr. tankards
	55	(" 6) 13.15	(" 6) 15.45	28 Crabwell Gdns. (E3)	Cash, jewellery

Table 5c. Connection Between Crimes and Criminals

SUSPECT	CRIME	TIME COMMITED	TIME REPORTED	PLACE	PROPERTY STOLEN
14. Wright	6	(Day - 1) 02.50	(Day - 1) 02.30	19 Marlborough Pl. (E6)	Cig. lighters
	7	(" 1) 02.30	(" 1) 09.15	23 Queens Road (E6)	Cash, cigarettes
	5	(" 1) 21.30	(" 1) 10.30	3 Friar Road (C2)	Brooch and rings
	14	(" 1) 22.15	(" 1) 12.05	16 Rectory Road (D2)	Cash, clock, rings
15. Lycett	60	(" 4) 23.30	(" 5) 09.30	14 Hackley Road (E1)	Cash, cheque book
	58	(" 5) 11.00	(" 5) 14.30	12 Newlyn Road (D2)	Record player, radio, rcds.
	59	(" 5) 12.00	(" 5) 16.15	18 Eltham Road (B4)	Pictures, slvr., jewellery
	52	(" 6) 11.30	(" 6) 14.45	10 Sturgess Ave. (C3)	Records, record player
16. Fitzgerald	11	(" 2) 01.30	(" 2) 09.01	Rockkill Road (E6)	100,000 cigarettes
17. Fitzgerald					
18. Sullivan	22	(" 4) 09.30	(" 4) 11.25	12 Cannon Place (E4)	Slvr. cups, plates etc.
	50	(" 5) 06.15	(" 5) 10.30	11 Marlborough Pl. ( )	Cigs.
19. Kavanagh	11	See Fitzgeralds			
	39	(" 3) 13.55	(" 3) 14.00	Hospital (D6)	Wage snatch
20. Mason	13	(" 4) 16.00	(" 4) 11.35	32 Manor Road (D7)	Purse and cash
	13	(" 4) 12.00	(" 4) 14.15	53 Stapleton Dr. (D7)	Slvr. tea-pot
NR Milligan	16	(" 1) 13.30	(" 1) 14.10	27 Queens Road (E6)	Cash
" Robinson	17	(" 5) 10.45	(" 5) 10.47	2 Penderton Road (D5)	Cash
" Miller	19	(" 4) 15.00	(" 4) 16.15	36 Admiralty Dr. (D2)	Cash
" Jarrow	20 - see Teegan				
" Fairfax	11 - see Fitzgerald				

DAY 1

CRIME NO	SUSPECTS	TIME REPORTED
1	Crook (1) Herring (11)	Overnight
6	Wright (14)	Overnight
3	Bristoll (3) Prior (4)	0905 hrs.
4	Bristoll (3) Prior (4)	0910 hrs.
7	Wright (14)	0915 hrs.
5	Wright (14)	1030 hrs.
25	Crook (1)	1120 hrs.
14	Wright (14)	1205 hrs.
16	Milligan (no record)	1410 hrs.
10	Bristoll (3)	1530 hrs.

Table 6a. - 10 per day. Crime Programme

DAY 2

CRIME NO	SUSPECTS	TIME REPORTED
23	Crook (1)	Overnight
27	Prior (4)	0900 hrs.
11	B Fitzgerald (16) K Fitzgerald (17) Kavanagh (19) Fairfax (no record)	0901 hrs.
21	Dixon (5)	0905 hrs.
20	Teegan (7) Jarrow (no record)	0915 hrs.
8	Teegan (7)	1045 hrs.
12	Dixon (5)	1135 hrs.
18	Teegan (7)	1230 hrs.
9	Dixon (5)	1637 hrs.
29	Dixon (5)	1715 hrs.

Table 6b. - 10 per day. Crime Programme

DAY 3

CRIME NO	SUSPECTS	TIME REPORTED
26	Bristoll (3)	Overnight
24	Crook (1) Herring (11)	Overnight
28	Prior (4)	1000 hrs.
43	Bushby (2)	1045 hrs.
31	Teegan	1130 hrs.
44	Bushby (2)	1215 hrs.
45	Bushby (2)	1320 hrs.
39	Kavanagh (19)	1400 hrs.
2	Dixon (5)	1550 hrs.
36	Bushby (2)	1630 hrs.

Table 6c. - 10 per day. Crime Programme

DAY 4

CRIME NO	SUSPECTS	TIME REPORTED
30	Teegan (7)	Overnight
34	Butler (6)	0830 hrs.
35	Kimber (9)	0900 hrs.
33	Kimber (9)	0935 hrs.
40	Butler (6)	0945 hrs.
41	Kimber (9)	1015 hrs.
22	Sullivan (18)	1125 hrs.
13	Mason (20)	1135 hrs.
15	Mason (20)	1415 hrs.
19	Miller (no record)	1615 hrs.

Table 6d. - 10 per day. Crime Programme

DAY 5

CRIME NO	SUSPECTS	TIME REPORTED
32	Herring (11)	Overnight
57	Butler (6)	0900 hrs.
42	Kimber (9)	0915 hrs.
60	Lycett (15)	0930 hrs.
47	Herring (11)	0945 hrs.
50	Sullivan (18)	1030 hrs.
17	Robinson (no record)	1047 hrs.
58	Lycett (15)	1430 hrs.
59	Lycett (15)	1615 hrs.
37	Fell (8)	1630 hrs.

Table 6e. - 10 per day. Crime Programme

DAY 6

CRIME NO	SUSPECTS	TIME REPORTED
38	Rushman (12)	Overnight
46	Rushman (12)	0900 hrs.
49	Butler (6)	0905 hrs.
48	Rushman (12)	0915 hrs.
56	Newton (13)	1115 hrs.
51	Newton (13)	1430 hrs.
52	Lycett (15)	1445 hrs.
53	Rushman (12)	1500 hrs.
54	Newton (13)	1510 hrs.
55	Newton (13)	1545 hrs.

Table 6f. - 10 per day. Crime Programme

As well as a complaint sheet for each crime, there are complaint cards. These contain only the crime number, name and address of complainant, time reported and the actual complaint. They are used in the "Waiting-Reply" file, which is discussed in a moment.

The first step in setting up a simulation run is to arrange the crime folders in the sequence specified by the programme. This stack of folders should then be stored for convenient access by OP 4. Ideally a drawer in OP 4's desk should be used.

The second step is to arrange the complaint cards for the first day's crime programme in sequence in the "Waiting-Reply" (hereafter called W-R) file. The third step is to set up the Crime-Suspect display for the first day's sequence of crimes. To do this, the crime switches are numbered from right to left with the programmed sequence of crime numbers. (The suspect switches are already labelled with suspect names and CRO numbers. These remain fixed during the simulation). Thus, for this particular programme, only ten of the crime switches are numbered.* Connections are then made on the plug-board between the crimes and the suspects responsible. When each suspect switch is switched down bringing his amber "in custody" lamp on, all the red lights associated with the crimes he committed in the day's programme should come on.

The fourth step consists of putting any "overnight" crime complaint sheets in the subject's "in-tray" and switching down the appropriate crime switches on the Crime-Suspect display.

*In this case two days of input <u>could</u> be set up on this display since it will hold 20 crimes. However, for generality, we shall assume only one day's programme is set up.

After these four steps, the input data for the first day is prepared and ready for use.

To prepare the programme for subsequent days, carry out steps 2, 3 and 4 before each new simulated day.

Having prepared the input data, OP 4 must now set up the control equipment. The difficulty level control bridge unit is balanced by zeroing the potentiometers, by pressing the "work done" and "set zero" buttons on Panel D and adjusting the balance control until both balance indicator lamps are off. If the simulator is being used in the teaching mode, then the first day's simulation will be at the lowest difficulty level. Difficulty level is set by adjusting the balance control so that the appriate out of balance indicator comes on (- to move difficulty level down; and + to move it up), and pressing the "Compute" button. When the required level is set, the bridge is rebalanced, so that both indicator lamps are again off. The control bridge is now ready for use.

The auxiliary paper work task loading is now set at is initial level. This is done by pressing the "Set task load" button on Panel D until the required loading lamp is illuminated. During the experiments it was found that most subjects managed to complete an average of four task sheets during a simulated day. It is recommended that the task loading be set at four initially and reset later during the simulated day if necessary. Information about task load level is automatically fed to the difficulty level control bridge. Information about "overnight" crimes waiting to be dealt with by the subject, is put into the control bridge by pressing both the "Work In" and the "Set Level" buttons a number of times equal to the number of crimes awaiting attention.

The alarm is set to the time indicated on the first card in the W-R file. This will in fact be the reporting time of the next complaint. The clock is set to indicate 0900 hours.

The other operators, meanwhile, must check that they have boards and clips for each of their detectives and must initialise their dectective state displays. At the beginning, all detectives are ON duty, NOT active, IN office and Contactable.

OP 4 now checks that all detective states are in fact set correctly on his display. Having done so, he warns the subject that the simulation is about to begin and starts the clock.

The steps in the setting up prodcedure are summarised below.

Operator 4 Setting Up Procedure

Step 1 Put crime folders containing the complaint sheets into the sequence specified by the simulation programme.

Step 2 Put complaint cards for first day's simulation in sequence in the Waiting-Reply file.

Step 3 Set up the first day's crime programme on the Crime-Suspect display.

Step 4 Put any "overnight" crimes in Subject's "in tray" and switch these into the simulation on the Crime-Suspect display.

Step 5 Set the control bridge potentiometer to zero. Set the required initial difficulty level and then balance the bridge.

Step 6 Set initial auxiliary task loading.

Step 7 Set the "overnight" crimes on the control bridge.

Step 8 Set alarm to time on card at front of Waiting-Reply file and set clock to read 0900 hours.

Step 9 Check that all detective states are correctly set, and that operators are ready.

Step 10 Warn subject and start clock.

Steps 2-10 are repeated at the beginning of each simulated day, with the exception that difficulty level is not reset at Step 5.

Operators 1, 2, 3 Setting Up Procedure

Step 1 Set detective states to initial conditions. These are ON duty, NOT active, IN office and Contactable.

4.4 Operating Procedures

The flow diagram representing the organisation of the simulation is shown in Fig 13. This reproduced from Report 2. There is one major difference between this and the organisation used in the experiments. Because of the modified and simplified form of crime information storage, it was not necessary to use the "Director Cards". However, if more realistic and therefore more complex crimes are used, as they can be in the teaching situation, it will be necessary to re-introduce the "Director Cards" to determine information retrieval.

The central item in the organisation of the simulation is the Waiting-Reply (W-R) file. This based on the concept of the "Pop Up" list mechanism in computer programming. This mechanism ensures that the next item to be processed is always at the head of the list. When an item is processed, it is deleted from the list and is replaced by the next item to be processed. All other items in the

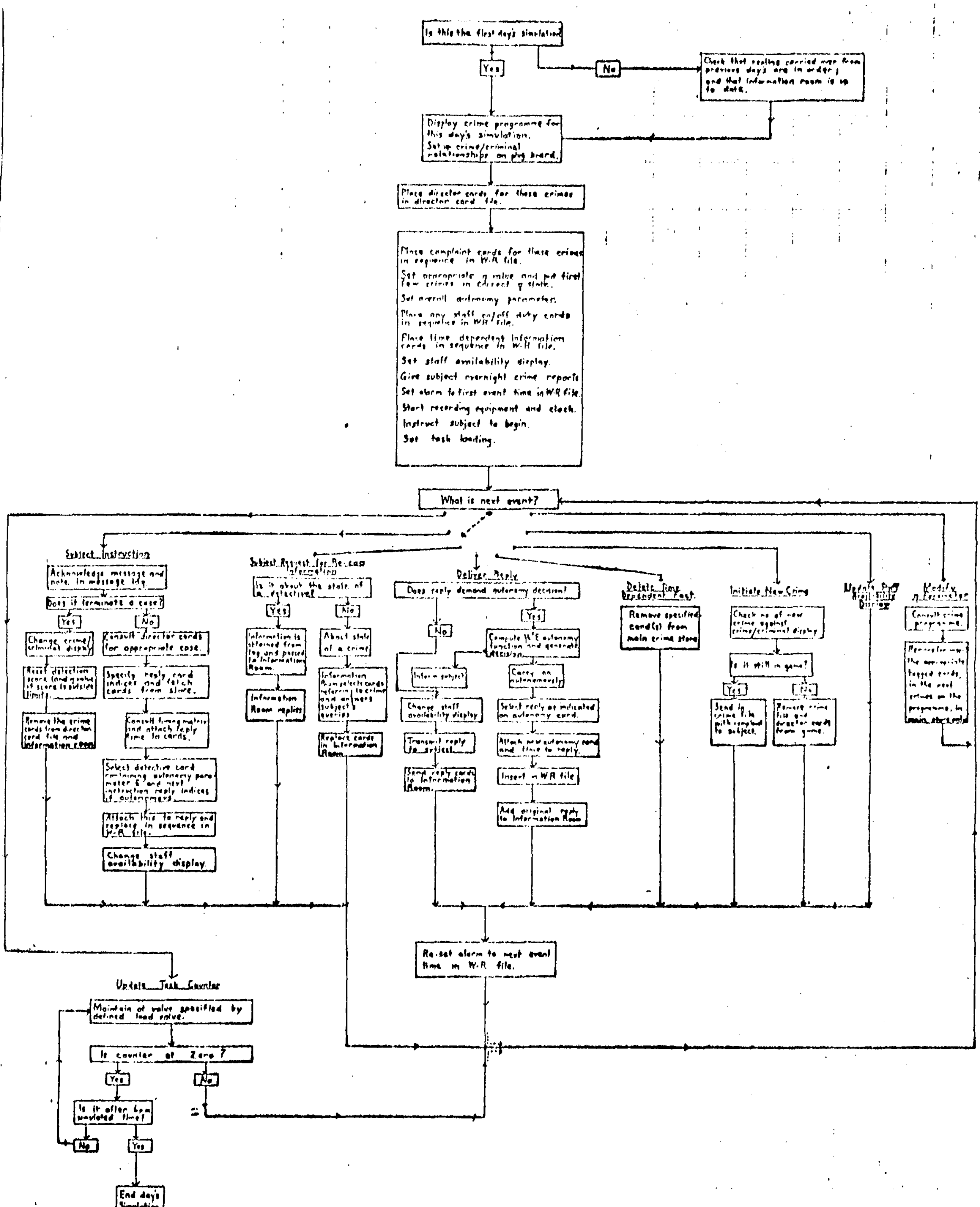

Fig 13 BASIC FLOW DIAGRAM FOR SINGLE LEVEL POLICE UNIT SIMULATION

list are then moved up one position. The W-R file functions because items are loaded into it in time sequence. For example, if a reply is due at 1300 hours, its position in the W-R file is in front of one due at 1330 hours. If now a reply due at 1315 hours is loaded into the file, its position is between the 1300 and 1330 replies. If the W-R file is always loaded in this manner, then when the first reply is received, the one behind it must be the next one in sequence. ITEMS MUST BE LOADED INTO THE W-R FILE IN THEIR CORRECT SEQUENCE POSITIONS.

The alarm is set to the time marked on the item at the head of the file. This is the next event in the simulation. Items stored in the W-R file are of two sorts only.

1 Replies which are tagged with a relevant detective (Ops room or registry, etc.) marker.

2 Complaint cards. Initially the W-R file is loaded only with these.

Operator Procedures

Operator procedures will be described under two headings, (1) Control - those procedures which control the running of the simulation and (2) Programmed - those functions demanded by virtue of the operator's role in the simulated police force.

Operator 4 Control Procedures

1 When a crime is due for input, the crime number on the Crime-Suspect display must be checked. If there is a red light by that crime number then a further check is carried out since the suspect responsible must be in custody. The further check consists in determining the times a) of arrest of the suspect concerned, and

b) the time when the crime was committed. See Table 4. If it was committed after the suspect was arrested, then it cannot be used as an input crime and is ignored. Otherwise the crime switch is switched to bring on the green lamp indicating this crime is valid input, and the complaint sheet is passed to Op 1 or 2 for delivery to the subject. When the crime sheet goes in to the subject, the difficulty level control bridge unit is updated by pressing once the "Work In" and "Set Level" buttons. (See section 3.1.4).

2 When a crime is solved the "Work Done" button on the control panel is pressed once.

3 When a suspect is brought in to custody either arrested or just for questioning, the appropriate switch on the Crime-Suspect display is switched to bring on the suspect's amber "In Custody" lamp.

4 When the alarm sounds, the action specified by the loading item in the W-R file is taken, the item is removed and the alarm reset to the time indicated on the next item.

5 Assuming the simulation is being used in the teaching mode, (see Report 6), the difficulty level will be set initially at its lowest value and computed at the end of each simulated day (1800 hours), by pressing the "Compute" button on the control panel.

6 For setting up procedures at the beginning of each simulated day, see Section 4.3.

7 Reply Operation Procedures (this involves several operators).

When a detective is allocated a crime by the subject, Op 4 passes the complaint sheet for that crime to the appropriate operator. The characteristics of the detective determine which cards from the crime store are selected and the time at which the detective should respond with the information. Op 4 then passes these cards to the appropriate operator who transcribes a summary of the reply and then gives the cards to Op 3. He clips them to a detective tag and time of delivery marker and loads the reply into the W-R file in its correct position. Note that the absence of a card representing a particular information group, implies that no identifying information is obtainable from that group.

Operator 4 Programmed Procedures

1 Registry (or Records Office)

The information usually required from registry is mostly for the "form" and addresses of suspects or for the names of owners of suspect vehicles. Requests for this information can come either from the subject or from any of the other operators. In the latter case, the information is given verbally to the operator who records it on his appropriate crime sheet. In the case of a request from the subject, Op 4 records this on a Requesting Sheet and generates a reply which he puts into the W-R file tagged with time and a registry marker. The time of reply is obtained from Registry Characterisation (see Section 3.2).

Another registry function is showing photographs of suspects to witnesses in the hope of getting an identification. The results of these album checks are loaded into the W-R file by Op 4.

2 Police Station Switchboard

The subject is instructed to direct queries he may have regarding his role to the switchboard.

The programmatic functioning of the switchboard requires no information retrieval. Typical use of this facility was an instruction to a detective of the form "Leave a message for Mr Smith to 'phone me when he returns". Then Op 4 places a card in the W-R file at the time of Mr Smith's return and switchboard then calls the subject when the card specifies, to say Mr Smith is on the line. Op 4 will then represent Mr Smith.

Operator 3 Control Procedures

1 Initially, Op 3 is responsible for testing the communication system and setting the volume controls for the amplifier and side tone generators.

2 During the simulation he will attach reply cards to detective markers and load replies in their correct positions in the W-R file.

3 He will also assit Op 4 in retrieving crime information from the main store.

Operator 3 Programmed Procedures

1 Control of CID Room Switchboard

Most calls from the subject are directed to the CID office.

Op 3 receives all of these calls and switches them through only if that detective is available as indicated by the detective's state display. After each conversation when the line is cleared, Op 3 must reset the rotary switch to the CID room position.

2 Finger Prints Bureau

Op 3 has one state display for each of the two Scenes of Crime Officers (SOCO's). These displays are not presented to the subject, though they are displayed to Op 4. They are purely for operator convenience.

There are three recording sheets for each of the three Finger Prints Bureau staff. On the two SOCO sheets (Jenkins and Davies are the SOCO's), are recorded which crime scenes were visited, time and duration of visits, which detective was in charge of the investigation and what marks were found. The other sheet corresponds to Sgt Eldon's information. On this is recorded the crime concerned, the SOCO and detectives involved, when the marks were received for processing and what the results of the processing are. The time for processing is determined by the Bureau Characteristics (see Section 3.2). It was found that subjects preferred finger prints reports to be as terse as possible, e.g. "Crime X. No identifiable marks found". "Crime Y. Smith CRO 53 thumb print found on kitchen door handle".

3 Operations Room

There is no information retrieval involved in this function, although messages from subject to the Ops Room must be recorded on an Ops Room record sheet. Usually instructions were of the form "Get this message to Detective X" or "Get patrol car to 32 May Road, a break has been reported. Tell the complainant a detective is on his way". Occasionally Ops Room received instructions of the type "Get a patrol car to the scene and tell them to report back to me as soon as possible". In this case Op 4 provides a suitable reply containing only the loser's statement and a request for a SOCO and detective to visit the scene. This is then inserted in the W-R file marker and also recorded on the Ops Room record sheet.

Operators 1 and 2 Procedures

Each of these operators performs identical programmed functions, so only Op 1 procedures will be described. The only control function carried out by these operators is the delivery of complaint sheets to the subject. Whichever operator is free at the time in question does this.

Op 1 Programmed Procedures

Op 1 has three boards (size 13" x 10"), one for each of the three detectives he represents (these are Sgt Brown, Constable Hawkes and Constable Salmer). When the subject allocates an investigation to say, Constable Hawkes, Op 4 passes the appropriate crime sheet to Op 1 who clips it to Hawkes' board. He records the time, the difficulty level and the detective's name on this crime sheet. The actual instructions received are then summarised in the "Action Taken" column. Time of reply and information retrieved from the cards supplied by Op 4 are recorded below this. The cards are then returned to Op 3 who loads them into the W-R file at the appropriate time location. The crime sheets contain a complete history of the activity and information associated with that crime.

When an investigation is completed, the crime sheet is clipped to the underside of the detective's board. If an investigation is transferred from one detective to another, the crime sheet is transferred to the appropriate board and the fact and time of transfer noted. If detectives are told to co-operate on an investigation, the crime sheet is given to the senior detective, or the specified leader of the group, who records further activity.

Note that the timing and content of replies are fully specified by detective characteristics if the device is in the teaching mode. Operators must not give more actual information than is specified. Detective states are changed according to the instructions received. The instruction "Go to this scene" entails a change in the "Office" state from "In" to "Out" and if a detective goes on foot or on a bus or in his own car, then he becomes "uncontactable". If, however, he goes out in a CID radio equipped car, he remains "contactable".

Operators 1 and 2 have access to the street map of the locality and can place markers on this to indicate the locations of their detectives at any one time.

5 Conolusions

Complete specification of instructions to cover every contingency would lead to a completely unmanageable document. This Manual has laid out the essential functions of equipment and operators. Full efficiency of operation will only be achieved when operators have worked together for two of three simulation runs, understand their roles and have some knowledge of the crimes. Experience with the experimental runs indicates that a minimum operator training period is two simulation runs.

References

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5 A Cybernetic Model for a Typical Police Unit Report 5. System Research Report. Nov. 1966.

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7 Technical Specification of Police Simulator Equipment System Research Report. Jan. 1967.

APPENDIX 1.1

Subject Briefing Data

1. Introduction

As the subject in this initial series of simulation experiments you are asked to assume control of a hypothetical C.I.D. unit and to use it to detect hypothetical crimes occurring in a hypothetical urban community named Alderton. In other words, we have tried to construct a working model of a police force and we now require your co-operation, as professional policemen, to test our model and subsequently to criticise it.

By definition a model lacks realism. Ours is unrealistic in so far as it embodies only a very restricted class of crimes, namely break-ins, where the value of property stolen is fairly low, and also in so far as it does not include in detail the enormous amount of paperwork involved in running even a small force. In our model a single process, called the Auxiliary Task, represents this detailed paperwork.

The main components of the model are outlined in section 2.

2. The Model

a. Geography of Alderton and surrounding district

The County Borough of Alderton is a seaside town in the county of Sussex, with a population of some 100,000. It is set on the South Coast and surrounded on its landward boundaries by the South Downs. Access is gained from the north via a main dual carriageway, the A23, and via a frequent rail service from London 60 miles to the north. Road and rail services also run East West along the coast. There is a small airport some ten miles to the west, used mainly for private flying and charter services using small aircraft.

Nearest neighbours to Alderton are, Shorehaven ten miles to the west connected by the railway and the A27, Horsefold twenty miles north west, connected by second class roads, Milton twenty miles north up the A23, near which is a single runway airport, Gatrow, serving some of London's continental and Channel Island air traffic. To the east, connected by rail and the A27 coast road, is Newham fifteen miles distant. This is a Channel port serving Dieppe with a passenger and car ferry.

The County of Sussex is divided into two parts for administration purposes, East Sussex and West Sussex. The dividing boundary runs round the western perimeter of Alderton.

The town of Alderton itself is mainly residential with a large number of hotels and boarding houses to cope with summer holiday traffic. In recent years there has been a gradual influx of light industry, mainly manufacture of electronic components and electrical control gear. The main shopping or business area forms the nucleus of the town. There are the usual large department stores and high quality businesses, but also there is a large number of 'antique' and secondhand dealers who operate in a section of the town known as 'the Lanes'. These form the oldest part of town in the centre of the business area and are a maze of narrow alleyways inaccessible to motor transport. They are lined with secondhand bookshops, junk shops and a small number of genuine antique dealers.

Outside the town, three miles north east is situated one of the new universities. The establishment is not yet completed and the student halls of residence are not built so that students tend to live in flats and lodgings in Alderton. On the north east limits of the town is a new College of Technology. So that of the young people in Alderton a large percentage are students.

Alderton has its own concert hall, two theatres, six cinemas and large indoor sports arena for skating, swimming, wrestling and pantomime, etc. There are also some twelve registered night clubs and a casino in one of the larger hotels.

The wealthier residential districts of Hove to the west and Withdean to the north are occupied in the main by retired business and professional people, though an increasing number of proprietors of the more lucrative type of business, such as estate agents and bookmakers are making their homes in those areas. In the surrounding countryside are situated a number of large country houses occupied by people of wealth. The main residential area is in a sector stretching from large council estates on the eastern boundaries to new blocks of flats being built over rows of small artisan type terraces nearer the town centre. Of course, these areas are not rigidly defined and there are pockets of 'prosperity' in many 'depressed' areas and vice versa.

b. Alderton C.I.D.

In the simulation you will have control over a team of six Detecting Officers plus two scenes of crime specialists (S.O.CO.s). In principle, then, your status corresponds roughly with that of a Detective Inspector, but it should be noted that it is not the objective of the simulator to reproduce exactly the working conditions of a typical D.I.

The Detecting Officer team comprises four Detective Constables, Salmer, Hawkes, Terrel and Keath, two Detective Sergeants, Brown and Pavey, and two Scenes of Crime Officers, Constables Davis and Jenkins. As in real life these detectives have various abilities and aptitudes and these are summarised at the end of this section. You should try to select the best man to do a particular job and, in fact, the amount and value of the information you receive will depend on the characteristics of the man you send to retrieve it.

When a Detecting Officer reports back with information, this information will be in the form of a list of facts. Therefore should you ask simply "What have you found out?", you will be supplied with a number of facts, some which you will consider to be of minor significance and only confuse the issue. To avoid this confusion it is recommended that you interrogate the detective in such a manner as to get the information you require in a form suitable to your individual methods of operation.

The four Detective Constables and two Detective Sergeants operate from a C.I.D. office with which the subject has direct telephone communication. The S.O.CO.s operate from the Finger Prints Bureau which is in the charge of Sgt. Eldon. This bureau holds finger prints records of all known local criminals and has a direct telephone link with the subject.

A Registry (or Records Office), containing all records of local criminals photographs, modus operandi, distinguishing marks, etc., is run by Sgt. Whitton, who also has a telephone link to the subject. This Records Office has a teleprinter link with New Scotland Yard for receiving information about finger print searches, stolen vehicles, criminal movements and so on.

The Operations Room receives all crime complaints and records then. It cannot be assumed that any action is taken by the Ops. Room on receipt of a complaint other than recording it and sending it to you, the subject, on a form which has space for your own notes. However if any action is taken, for example, overnight, then this will be recorded in the complaint sheet when you receive it.

The Ops. Room is in radio contact with two C.I.D. general purpose cars and the S.O.CO.s van, and with uniformed branch cars, beat patrols and so on. The switchboard enables you to place outside calls, to a neighbouring force, for example. Using this C.I.D. force you are asked to solve as many of the crimes presented as possible. You can consider a case finished when, and only when, a suspect admits he did the crime.

c. The Equipment

The simulation of an 8-hour day takes a real time-period of 2 hours. This time is speeded up by a factor of four during the simulation. In this way three days work can be simulated in three 2 hour sessions, i.e. in one real day, working on a time table of 10.00 hrs to 12.00 hrs, 13.00 hrs to 15.00 hrs, 15.15 hrs to 17.15 hrs. The digital indicator on the right hand side of the display shows the simulated time in 24 hour notation.

The display, consisting of six rows of four pairs of different coloured lights gives an indication of the availability of members of the D.O. team in the C.I.D. office. Each detective is represented by one row of four pairs of lights. The first pair say whether he is on or off duty, the second pair tell whether he is engaged on a job, i.e. is active or inactive, the third pair tell whether he is in the office or out on a job and the fourth pair indicate whether or not he can be contacted if he is out of the office.

This display is meant as an aide-memoire for the subject. A further aid for the subject regarding the disposition of his forces is the map of Alderton with magnetic 'men' which can be positioned to indicate the location of his men at any time.

The subject can contact each of his services by the telephone. There are six labelled buttons in the lower centre portion of the panel and the subject makes contact with the service he desires by lifting the receiver and pressing the appropriate button, a light above the button indicating the service he has chosen. The C.I.D. office telephone is always answered by the same person (a cadet, say) who then fetches the requested detective. In general, Sgt. Eldon will always answer the 'Finger Prints' and 'Scenes' Bureau telephone, and Records Office will always be answered by Sgt. Whitton. Should the subject change his mind after he has selected a service, i.e. pressed a button, he must replace the telephone, to clear the line before selecting another.

Named lights indicate which of the detectives is talking. Messages coming in to the subject are received in the normal way.

The simulated paper work task mentioned previously consists of crossing out specified letters from a sheet containing a string of random letters. This is dull, but requires considerable concentration and is, therefore, fairly representative of the sort of time consuming paper work which loads an officer at the Detective Inspector level in a modern Police Force. The sheets containing the latter are contained in a box under the left hand side of the desk. A task counter situated beneath the digital clock indicator shows how many sheets the subject still has to complete. Each time he removes a sheet from the box the counter is reduced by one.

The simulation cannot end till the task counter is at zero. (see attached page for d. Detective Characteristics).

3. Final Comments

a) Remember that simulated time is running four times faster than real time, so make your instructions to your D. O. s as brief and precise as you can.

b) If one of your D. O. s makes a blunder or fails to carry out an instruction don't hesitate to "tear him off a strip", if you think this will buck him up.

c) All verbal conversation is tape recorded for subsequent analysis.

d) These are pilot experiments. We need your criticisms, as professional policemen, of our device. Two pages are provided after this section for your evaluation and comments, and we hope you will use this space for your criticisms, after you have used the simulator, and return them to us.

S.O.C.O.

D.C. Davies

Methodical

Good at finding clues and marks

Good memory

Willing to take responsibility

3 years service as S.O.C.O.

D.C. Jenkins

Photographer

Competent

Unimaginative

Will carry out instructions to the letter but no more

2 years service as S.O.C.O.

FINGERPRINTS

Sgt. Eldon

Very experienced fingerprint expert

No interest in Detective work outside this field

Jealous of his position

Sick man (heart trouble)

15 years Police exp;
10 years f.p.s. exp:

REGISTRY

Sgt. Whitton

Very long service

Very dull

Not keen on responsibilities

Due for retirement soon

D.C. Terrel

- Methodical, will stick to the letter of the rules
- Not willing to take decisions alone
- Good eye for physical clues
- Patient but unskilled interviewer
- 2 yrs experience

D.C. Hawkes

- Cannot be relied upon to stick to the rules
- Imaginative
- Tends to miss rather obvious clues while trying to find obscure ones
- Very sound knowledge of locality and local crooks
- Good interrogator
- 4 yrs service as D.C.

D.Sgt. Brown

- Methodical
- Imaginative
- Very good memory
- Enquiring and logical turn of mind
- Excellent local knowledge
- Wide range of contacts
- Very good interrogator
- 10 yrs service

D.C. Salmer

- Methodical & careful
- Shows initiative & independence
- Excellent memory and facility for finding links in a series of crimes
- An efficient interrogator
- 5 yrs service as D.C.

D.C. Keath

- Methodical
- Unimaginative
- Excellent memory for facts and figures
- Good knowledge of local crooks
- Unskilled interrogator
- 7 yrs service as D.C.

D.Sgt. Pavey

- Methodical
- Unimaginative
- Will stick to the letter of the rules
- Not keen to take responsibility
- Patient but unskilled interrogator
- 15 yrs service

Evaluative Comments and Queries

APPENDIX 1.2

Criminal Records

Name: Crook, Hugh Francis (known as Hughie) CRO 1

Address: No fixed abode. Last address 96, Centurian Road,
Alderton.

Age: 43 years

Description: Height 5ft. 9 ins. Black hair, well greased and brushed back; brown eyes; thin build; has a slight stoop; tattoo on left forearm - a heart with Maisie written underneath.

Record: Fourteen previous convictions for housebreaking and larceny, totalling five years in jail. Nine previous convictions for assault and drunkenness.

Style: Sticks to small jobs such as gas meters and electricity meters. Usual method of entry is to smash a window, release catch and climb through.

Idiosyncrasies: Usually operates after pub closing time. That is, he gets drunk then discovers he has no money, so he does a 'job'. He rolls his own cigarettes and is a chain-smoker. His 'local' is the 'Tradesmans Arms' in White Lion Street.

Associates: Herring (CRO 11)
Mistress is Mrs Maisie Cummings
of 22 Craighouse Avenue.

Name: Bushby, John Alfred (Jonnie) CRO 2

Address: Rents a flatlet at 4, Ivory Place, Alderton.

Age: 27 years.

Married: Yes. Wife, Hazel, lives with him at above address.

Occupation: Drives a delivery van for Glendale Laundry Ltd., (of Shoreham Road).

Description: Height 6 feet. Black hair, brushed back at sides, forelock tends to drop over his eyes; strongly built; fresh complexion; pleasant looking; grey eyes.

Record: Four previous convictions for housebreaking; two years in prison.

Style: Previous breaks have been in good class neighbourhoods where the haul has been of the order of £200-£300 worth of jewellery, silver and cash. Usually enters by smashing a window, opening it and climbing through. An intelligent operator. Always seems to operate alone.

Idiosyncrasies: Has a slight speech impediment, giving him a tendency to stutter, particularly over the letter K. Is very proud of his sports car (a 1960 Austin Healey).

Social Habits and Associates:

Name: Bristoll Henry (known as Fred) CRO 3 (Prior) (See CRO4)

Address: Rents a flatlet at 96, Centurian Road, Alderton

Age: 23 years

Married: No

Occupations: Casual labouring.

Description: Height 5ft. 8ins. Fair hair, worn long and brushed back. Pock marked complexion, high cheek bones, close set grey eyes, slim build. Two warts on the back of his left hand.

Record: Large number of convictions for petty larceny as a juvenile career includes periods in Borstal. Since he was 18 he has spent 18 months in jail for housebreaking and assault.

Style: No fixed techniques tends to be impulsive. Usually forces an entry to empty houses by means of smashing a window. Steals anything available.

Idiosyncrasies: Has a passion for gambling.

Social Habits and Associates: Albert James Prior (CRO4) and Bristoll are close friends. Use the 'Continental Coffee Bar' and known Dixon CRO5.

Name: Prior, Albert James (Jim) CRO 4.

Address: Shares a flatlet with Bristoll (CRO 3) at
96 Centurian Road.

Age: 22 years.

Married: No.

Description: Height 5ft. 6ins; tends to be plump; dark hair brushed sideways; fresh complexion; round face; brown eyes set well apart.

Record: Long list of juvenile crimes, periods spent at Borstal. Has spent a year in jail for housebreaking since he was 18.

Style: No fixed technique. Usually goes for small game; e.g. gas meters, transistor radios etc. As a juvenile was involved with Bristoll in a number of cases.

Idiosyncrasies: Gambling and dog racing.

Social Habits and Associates: Bristoll (CRO 3)
Dixon (CRO 5)
"Continental" Coffee Bar.

Name: Dixon Barry John (Barry) CRO 5.

Address: Lives with his mother Bessie Dixon at
45 Shorehaven Road.

Unmarried

Occupation: Casual labourer.

Age: 19 years

Description: Height 5ft. 11ins. Slim build, fair skin, red hair, freckled face, grey eyes. Has a slightly deformed left leg which makes him walk with a slight limp.

Record: 3 previous convictions as a juvenile. One period in Borstal.

Style: As a juvenile larceny from unattended vehicles and one shoplifting.
No convictions since he was 18.

Idiosyncrasies: Seems to be purely impulsive and a lone operator.

Social Habits: Girl friend Molly Briggs (17) who works as a waitress in the 'Continental' coffee bar. So Dixon tends to frequent this place.
Knows Bristoll (CRO 5) Prior (CRO 4).

Name: Butler Harold (Harry) CRO 6.

Age: 35

Address: No fixed abode.

Unmarried

Occupation: Bricklayer

Description: Height 5ft. 10ins. medium build, thin gingery hair receding at temples, blue eyes. Has a scar running across his forehead, received he says, during an air raid during the war.

Record: Twenty three previous convictions for housebreaking shopbreaking, larceny and assault.

Style: A known and expert safe cracker: works confidently with most types of explosive.

Idiosyncrasies: Doesn't smoke but chews gum incessantly.

Associates:

Name: Teegan Michael (Nick) CRO 7

Age: 24 years

Address: Lodges with Mrs Brown, 37 Circus Street.

Occupation: Garage mechanic with New Service Motors Ltd., London Road.

Unmarried

Description: Height 6ft. 2ins. strong build, black hair, brown eyes, small moustache, the little finger of his left hand is missing from the first joint.

Record: Three previous convictions. Two of these were for housebreaking and larceny of goods valued at £50-£100. The third in 1962 was for being an accessory in the theft of valuable silverware from large houses. His associate was John Albert Newton (CRO 13); sentenced to 18 months.

Style: Not known.

Idiosyncrasies: Powerful sports car Owns 1953 Blue Jaguar XK120

Associates & Habits: John Newton (CRO 13)
Jack Crawford (Electrolux service man)
See Crime 8.

Name: Fell Thomas (Tommie) CRO 8

Age: 52 years

Address: 5b, Patcham Place. These premises are used as a second hand junk shop. Fell lives in a flat above this shop.

Occupation: Second hand car dealer.

Unmarried.

Description: Height 5ft. 3ins. thin build, stooping, very thin grey hair, watery grey eyes, shuffling gait.

Record: Forty seven previous convictions. Mainly for larceny and housebreaking. Used to be an expert safe cracker. His most recent convictions were for receiving (6-months) and larceny from unattended vehicles (3-months) in 1962 and 3.

Style: Formerly a good class safe breaker. Now reduced to impulsive snatching from motor cars and receiving stolen items of dubious value.

Idiosyncrasies: Heavy smoker, has bronchial trouble.

Associates:

Name: Kimber James Henry (Jimmy) CRO 9

Age: 28 years

Address: Lives with his mother Mrs Jane Kimber at
23 Clifford Avenue.

Occupation: Casual labourer.

Unmarried

Description: Height 5ft. 9ins. medium build, dark brown hair, receding at temples, high forehead, close set brown eyes.

Record: Five previous convictions for housebreaking and assault, last conviction in 1959 was five years for attempted armed robbery.

Style: Has always operated by himself, against large houses. But shows no discrimination about what property he steals.

Idiosyncrasies: Usually operates in a semi-drunken state. Claims blackouts, i.e. can never remember anything about crime.

Associates: Drinking partner Charles Coombes (CRO 10).

Name: Coombes Charles (Bushy) CRO 10.

Age: 35 years

Address: 14 Edgefield Road, Caravan Site.

Occupation: Casual labourer.
Married but separated from his wife for ten years.

Description: Height 5ft. 10ins. slim build, thinning ginger hair, burn mark on right cheek.

Record: Six previous convictions for drunk and disorderly.
Two convictions for indecent assault.

Style: Indecent assault cases were both against fifteen year old girls. In one case there was an attempted rape.

Idiosyncrasies:

Associates: Kimber CRO 9.

Name: Herring, George (Fishy) CRO 11.

Age: 31 years.

Address: No fixed abode. Has lodged at 96 Centurian Road.

Occupation: Casual labourer.

Married: No.

Description: Height 5ft. 6ins, stocky build, receding brown hair, large nose, close set brown eyes.

Record: Many convictions for being drunk and disorderly.
Four convictions for larceny from unattended vehicles.
One conviction for shopbreaking.

Style: A petty impulsive criminal. Given to blustering and noise when drunk but never actually violent. Seems to steal only cash for booze.

Idiosyncrasies: Chain-smoker, rolls his own cigarettes.

Associates: Crook (CRO 1).

Name: Rushman Anthony (Tony) CRO 12.

Age: 19 years

Address: 203 Shoreham Road, with his mother and two sisters.

Occupation: Car salesman at New Service Motors Ltd.

Married: No.

Description: 5ft. 11ins. well built, black hair, brushed back, grey eyes.

Record: Three convictions as a juvenile for breaking and entering and stealing contents of gas and electricity meters. Was recently acquitted of a charge of receiving stolen vehicles in company with Paul James Carron (CRO 23). (Carron is 'director' of New Service Motors Ltd. and he was convicted).

Style: Was as efficient breaker as a juvenile; was picked up only once by a returning householder.

Idiosyncrasies:

Associates: Paul James Carron (CRO 23).

Name: Newton John Albert (Bert) CRO 13

Age: 29 years

Address: Flatlet at 10 Lansdowne Place.

Occupation: Salesman.

Married: No.

Description: Height 5ft. 10ins. slim build, smoothed back black hair, grey eyes, small moustache.

Record: Convicted in 1962 (2 years sentence) for theft of valuable silver from large house on outskirts of Alderton. Four previous convictions for housebreaking.

Style: Is a clean and tidy operator being highly selective and a good judge of silverware.

Idiosyncrasies:

Associates: Nick Teegan CRO 7.

Name: Wright Terence Charles (Terry) CRO 14.

Age: 18 years

Address: Stays with his mother, father and sister at
5 Twyford Road.

Occupation: Window cleaner.

Married: No.

Description: Height 5ft. 6ins. medium build, fair hair, long and brushed back, blue eyes, fresh complexion.

Record: 4 convictions as a juvenile for housebreaking and larceny.

Style: Seemed to go to quite some length to plan his breaks but overlooks details, i.e. left prints on two occasions.

Idiosyncrasies: Has always worked alone. Meticulous about the appearance of his scooter (a Lambretta LD II) No. SCD 512.

Associates:

Name: Lycett Geoffrey Malcolm (Jeff) CRO 15

Age: 20 years.

Address: Flat at 23 Lansdowne Place.

Occupation: Salesman.

Married: No.

Description: Height 6ft. slim build, black hair, blue eyes, pleasant looking.

Record: Petty larceny as a juvenile. Convicted in 1962 of shopbreaking and stealing transistor radios and tape recorders. One year in jail.

Style: Impulsive as a juvenile. However, now seems to have learned to plan and execute efficiently.

Idiosyncrasies:

Associates:

Name: Fitzgerald Robert George (Bob) CRO 16

Age: 33 years

Address: 22 Rutledge Place (Ground floor flat).

Occupation: Owns and runs a second hand furniture business at 12 North Road.

Description: 5ft.11ins. slim build, fair hair, wears horn-rimmed spectacles, usually dresses well, blue eyes.

Record: One previous conviction for attempted fraud; was given an 18 month sentence. This was four years ago.

Style: Is not really well known to the police. The above fraud was an attempt to 'con' a wealthy customer into buying some worthless furniture by forging documents purporting to give the furniture real antique value. His wife (CRO 17) was involved in this as well.

Name: Fitzgerald Kathleen (Mrs) CRO 17

Age: 28 years

Address: 22 Rutledge Place.

Description: Wife of Bob Fitzgerald (CRO 16). 5ft. 3ins. tall. well built, hair dyed blonde, blue eyes.

Record: Was convicted four years ago of fraud along with her husband. Was fined £100.

Style: Is not well known to the police; the above is her only conviction.

Name: Sullivan Gordon Patrick (Pat) CRO 18

Age: 43 years

Address: Flatlet at 14 Regent Square.

Occupation: Night watchman.

Married: Unmarried.

Description: 5ft. 10ins. good build, swarthy complexion, greying, black hair, squashed nose.

Record: Ten convictions for housebreaking and larceny. Two for robbery with violence.

Style: A violet stop-at-nothing sort of operator.

Idiosyncrasies: Very keen on motor cycles. Has two - Vincent and a Norton.

Associates:

Name: Kavanagh Barry Joseph CRO 19

Age: 28 years

Address: 36 Lansdowne Place (Flat).

Occupation: Sales Director of New Service Motors Ltd., London Road.

Description: Height 5ft. 10ins. strong build, black hair, fresh complexion, brown eyes, usually dresses well.

Record: Four previous convictions for house and shop breaking. Last conviction was two years ago - a two year sentence. With full remission he has been out for two months.

Style: Usually co-operates with others on fairly high quality breaks. Tends to be reckless or careless since each of his previous convictions has been brought about by finger prints left behind.

Name: Mason Johnnie CRO 20

Age: 19 years

Address: 53 Tudor Lane. Rents a bed-sitter.

Description: 5ft. 8ins. stocky build, swarthy complexion, long black hair, black eyes, usually wears jeans and sweater.

Record: Has a record of larceny and housebreaking as a juvenile. The last conviction was 12 months ago when he had a 6 month sentence.

Style: Usually operates alone without much forethought. Tends to be careless.

APPENDIX 2

SIMPOL 111 Subject Questionnaires

SIMPOL 111

Subject Questionnaires

Name and Rank:			Date:
Force:			
Number of Years' Service:	Uniform:	CID:	Other:

The following are some statements about the simulation. For each one, mark whether you agree or disagree with it. If you wish to amplify your response you may do this in the comment column. For example, you may, in general, disagree with Statement 1, but yet feel that some crimes are unrealistic. In this case you would tick the "Disagree" column but might add "But some unrealistic" in the Comment column.

No.		Agree	Disagree	Comments
1	The crimes in the simulation are not really realistic.			
2	Some of the detectives should not be in the CID at all.			
3	The pace of the simulation is too fast to allow one to make sensible decisions.			
4	I found that one voice representing all the detectives was confusing.			

No.		Agree	Disagree	Comments
5	I felt pretty tired after a day operating the simulator.			
6	The number of crimes reported was unrealistically high.			
7	In general, I thought the crimes were cleared up too easily.			
8	An unrealistically high proportion of crimes were solved through information contacts and informants.			
9	I would have expected more success from the scenes of crime department.			
10	Most of the crimes presented would never normally be cleared up within an 8 day period.			
11	There were an unrealistically high number of fruitful leads obtained from enquiries made at the scene and the immediate surroundings.			
12	I would have expected more property to have been recovered as a result of circulating shops, etc.			
13	The detectives, on the whole, did not seem to have much knowledge about their local criminals.			

No.		Agree	Disagree	Comments
14	With the more serious cases I felt very disatisfied that I could not leave the office and direct investigations on the ground.			
15	At certain times I found myself muddled about which crime was which.			
16	Some of the less serious crimes should never have been presented to the CID for attention.			
17	I think the detective team was very overloaded with crimes.			
18	All in all, I do not think the simulation is, in any sense, realistic.			
19	A large proportion of the crimes, through force of circumstance, could only receive very superficial investigation.			
20	I felt the lack of personal knowledge of the criminal population very hampering.			

Subject Questionnaire

CRIME QUESTIONAIRE

COMPLAINT NO.

Initial Estimate of Seriousness of the Crime (Complete when you receive the complaint) Base your estimate on the information contained on the complaint sheet when you receive it.	Not very serious ... very serious
Final Estimate of Seriousness of the Crime (Complete when you feel you have sufficient information to make a final judgement)	Not very serious ... very serious
In general, how heavily loaded with work do you consider your team to have been during the period this crime was actively investigated?	Lightly loaded ... very heavy load
Based on your own experience, what is your estimate of the likelihood of clearing up a crime of this kind?	Very likely to clear up ... Not at all likely to clear
How long, on average, would you expect it to take to clear up a crime of this type?	One day / One week / One Mnth / More than one month

Estimate as accurately as you can, the number of man hours of effort that have been expended on this case. Enter the result below.

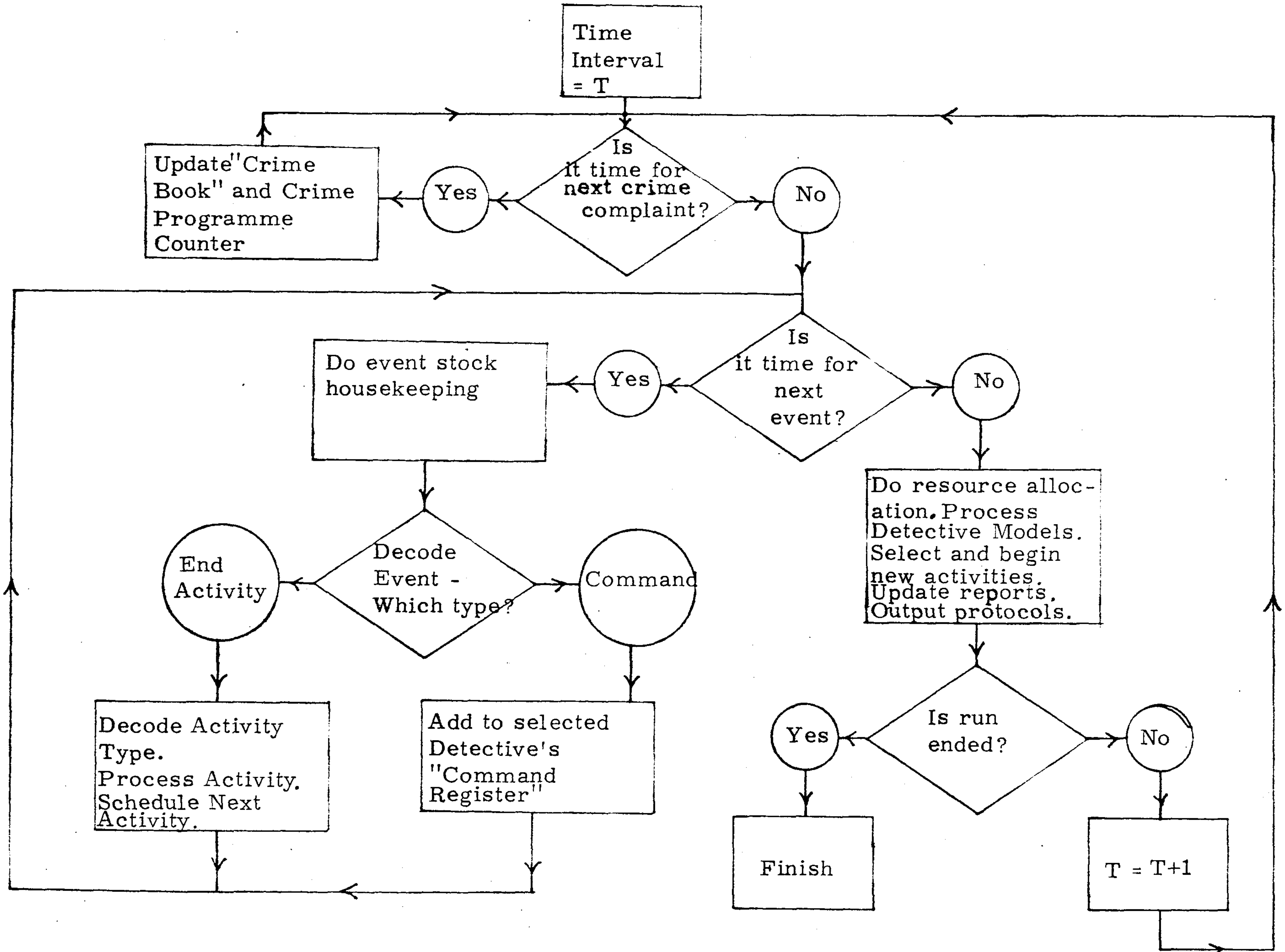
NUMBER OF MAN HOURS ON THIS CASE	

Specific comments on this crime, e.g. on realism or on detective performance.

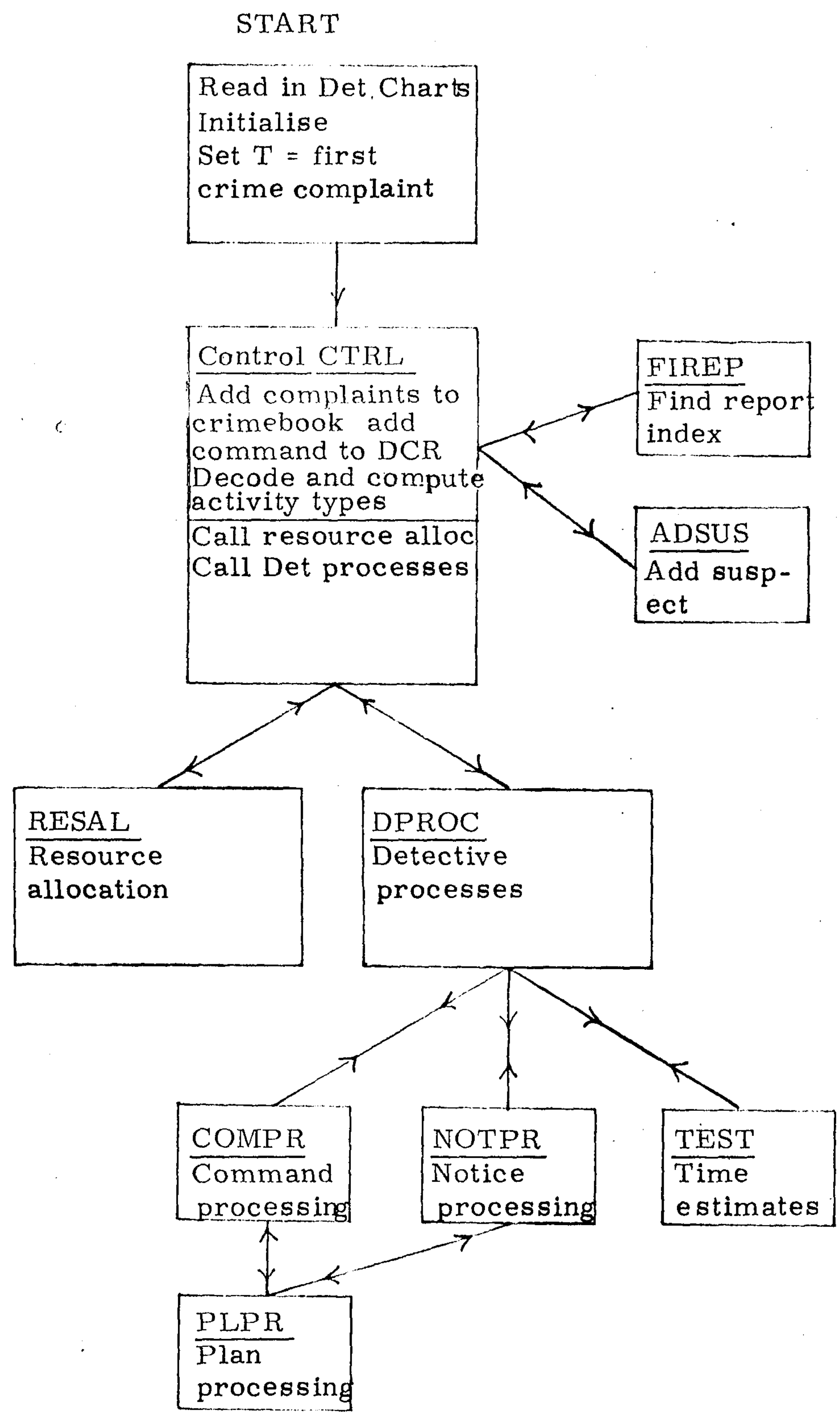
Crime Report Form

APPENDIX 3

SIMPOL - Computer Program Flow Charts and Listings



SIMPOL Computer Program Outline Flow Chart



SIMPOL Program Subroutine Structure

START .


```
// JOB

LOG DRIVE    CART SPEC    CART AVAIL   PHY DRIVE
  0000         1101          1101         0000

V2 M11   ACTUAL  8K  CONFIG  8K

// FOR
*ONE WORD INTEGERS
*LIST SOURCE PROGRAM
*IOCS(1132 PRINTER)
*IOCS(DISK)
*IOCS(CARD)
      DEFINE FILE 1(100,160,U,NREC)
      DEFINE FILE 2(100,160,U,NREC)
      DEFINE FILE 3(95,4,U,NREC)
      DEFINE FILE 4(120,13,U,NREC)
      DEFINE FILE 5(95,6,U,NREC)
      DEFINE FILE 6(95,6,U,NREC)
      INTEGER ACT,SER,DET,CN,TEMP,T,TIM,NDET,CRBKP,CRBKS,EVSTS,FEV
      INTEGER PR
      INTEGER CPROG(4),EV(30,7),EGY(30),CRBK(6),DCR(6,21),
     +DCRI(13),SOCOR(21),DNOT(6,21),DSL(6,41),SL(100),
     +DINT(6,21),DPLAN(6,40),DPL(6,10),FRED(7),DRATE(6,5),
     +DSTAT(7),UBR(21),NREP(6)
      REAL INF(30,2),CR(20,4)
      COMMON CPROG,EV,EGY,CRBK,DCR,DCRI,SOCOR,DNOT,DSL,SL,DINT,DPLAN,
     +DPL,FRED,DRATE,DSTAT,UBR,INF,CR,ACT,SER,DET,CN,TEMP,T,TIM,NDET,
     +CRBKP,CRBKS,EVSTS,FEV,IN,PR,LOC,NC,NXTCR
      COMMON LMAX,MARK,NREP
      NC=95
      READ(2,500)NDET
      READ(2,501)((DRATE(I,J),J=1,5),I=1,NDET)
      DO 1 DET=1,NDET
      DCR(DET,1)=0
      DNOT(DET,1)=0
      DPL(DET,1)=-99
      DPL(DET,2)=0
      DPL(DET,3)=0
      DSL(DET,1)=0
      DINT(DET,1)=0
      DSTAT(DET)=4
      NREP(DET)=0
    1 CONTINUE
socor(1)=0 →  UBR(1)=0
      NXTCR=1
      READ(3'NXTCR)(CPROG(J),J=1,4)
      T=CPROG(2)
      WRITE(3,200)T
      FEV=0
      CRBKS=0
      CRBKP=1
      EVSTS=0
      EGY(1)=0
      SL(1)=1
      MARK=0
      CALL LINK(CTRL)
  200 FORMAT(' INTERVAL ',I4/)
  500 FORMAT(I2)
```

```
 501 FORMAT(5I3)
     END

FEATURES SUPPORTED
 ONE WORD INTEGERS
 IOCS

CORE REQUIREMENTS FOR
 COMMON   1680  VARIABLES     52  PROGRAM    250

END OF COMPILATION

// XEQ        02

*FILES(1,CRIME),(2,CRINF),(3,CPROG),(4,DCRI),(5,CRBK),(6,CRCR)

*LOCALCTRL,RESAL,DPROC

INTERVAL  128
R 40  02C2 (HEX) ADDITIONAL CORE REQUIRD
R 18 CTRL  LOADING HAS BEEN TERMINATED
```

CTRL


```
// JOB

LOG DRIVE   CART SPEC   CART AVAIL  PHY DRIVE
  0000        1101        1101        0000

V2 M11   ACTUAL  8K   CONFIG  8K

// FOR
*ONE WORD INTEGERS
*LIST SOURCE PROGRAM
*IOCS(1132 PRINTER)
*IOCS(DISK)
      DEFINE FILE 1(100,160,U,NREC)
      DEFINE FILE 2(100,160,U,NREC)
      DEFINE FILE 3(95,4,U,NREC)
      DEFINE FILE 4(120,13,U,NREC)
      DEFINE FILE 5(95,6,U,NREC)
      DEFINE FILE 6(95,6,U,NREC)
      INTEGER ACT,SER,DET,CN,TEMP,T,TIM,NDET,CRBKP,CRBKS,EVSTS,FEV
      INTEGER PR
      INTEGER CPROG(4),EV(30,7),EGY(30),CRBK(6),DCR(6,21),
     +DCRI(13),SOCOR(21),DNOT(6,21),DSL(6,41),SL(100),
     +DINT(6,21),DPLAN(6,40),DPL(6,10),FRED(7),DRATE(6,5),
     +DSTAT(7),UBR(21),NREP(6)
      INTEGER DC,CD,SG,CRCR(6)
      REAL INF(30,2),CR(20,4)
      COMMON CPROG,EV,EGY,CRBK,DCR,DCRI,SOCOR,DNOT,DSL,SL,DINT,DPLAN,
     +DPL,FRED,DRATE,DSTAT,UBR,INF,CR,ACT,SER,DET,CN,TEMP,T,TIM,NDET,
     +CRBKP,CRBKS,EVSTS,FEV,IN,PR,LOC,NC,NXTCR
      COMMON LMAX,MARK,NREP
    1 IF(T-CPROG(2))2,3,2
    3 CRBKS=CRBKS+1
      CRBK(1)=CPROG(1)
      CRBK(2)=T
      CRBK(3)=0
      CRBK(4)=0
      CRBK(5)=CPROG(3)
      CRBK(6)=CPROG(4)
      WRITE(5'CRBKS)(CRBK(K),K=1,6)
      WRITE(3,208)CPROG(1),CPROG(3),CPROG(4)
      NXTCR=NXTCR+1
      READ(3'NXTCR)(CPROG(J),J=1,4)
      GOTO 1
    2 IF(FEV)4,5,4
    4 IF(T-EV(FEV,1))5,7,5
    7 J=FEV
      FEV=EV(J,3)
      EGY(1)=EGY(1)+1
      K=EGY(1)+1
      EGY(K)=J
      K=EV(J,2)
      GOTO(8,9),K
    8 I=EV(J,4)
      K=DCR(I,1)
      IF(K)14,13,14
   14 TEMP=0
      DO 10 L=1,K
      M=4*L-2
      IF(DCR(I,M))10,12,10
```

```
   12 TEMP=L
      L=K
   10 CONTINUE
      IF(TEMP)11,13,11
   13 DCR(I,1)=DCR(I,1)+1
      TEMP=DCR(I,1)
   11 K=4*TEMP-2
      DCR(I,K)=T
      DCR(I,K+1)=EV(J,5)
      DCR(I,K+2)=EV(J,6)
      DCR(I,K+3)=EV(J,7)
      DSTAT(I)=3
      WRITE(3,201)I,EV(J,6)
      GOTO 2
    9 CN=EV(J,5)
      ACT=EV(J,6)
      DET=EV(J,4)
      WRITE(3,202)ACT,CN,DET
      GOTO(15,16,17,18,19,20,21,22,23,24,25,26),ACT
   15 READ(1'CN)((CR(J,K),K=1,4),J=1,20)
CR(1,2)  LMAX=CR(1,3)
      READ(2'CN)((INF(J,K),K=1,2),J=1,LMAX)
      IF(CR(2,1))27,28,27
   27 CALL FIREP
      I=CR(2,1)+2
      DO 35 K=3,I
      L=CR(K,1)
      M=L
   35 DCRI(M)=CR(K,2)
      DCRI(13)=CN
      WRITE(3,203)
      WRITE(4'LOC)(DCRI(J),J=1,13)
   28 IF(CR(2,2)-DRATE(DET,4))38,36,36
   36 SOCOR(1)=SOCOR(1)+1
      IF(SOCOR(1)-10)85,85,86
   86 SOCOR(1)=1
   85 K=SOCOR(1)*2
      SOCOR(K)=DET
      SOCOR(K+1)=CN
   38 DNOT(DET,1)=DNOT(DET,1)+1
      K=DNOT(DET,1)*4-2
      DNOT(DET,K)=1
      DNOT(DET,K+1)=4
      DNOT(DET,K+2)=CN
      DNOT(DET,K+3)=2
      DSTAT(DET)=3
      GOTO 2
   16 READ(1'CN)((CR(J,K),K=1,4),J=1,20)
CR(1,2)  LMAX=CR(1,3)
      READ(2'CN)((INF(J,K),K=1,2),J=1,LMAX)
      WRITE(3,205)
      IF(CR(2,3))57,57,37
   37 K=CR(2,1)+CR(2,2)+3
      L=K+CR(2,3)-1
      DO 39 M=K,L
      N=CR(M,1)
      GOTO(40,41,42,43,44),N
   40 CALL FIREP
      DCRI(8)=CR(M,2)
```

```
      WRITE(4'LOC)(DCRI(J),J=1,13)
      UBR(1)=UBR(1)+1
      NN=UBR(1)*3-1
      UBR(NN)=DET
      UBR(NN+1)=CN
      UBR(NN+2)=13
      GOTO 39
   41 CALL FIREP
      DCRI(9)=CR(M,2)
      WRITE(4'LOC)(DCRI(J),J=1,13)
      DNOT(DET,1)=DNOT(DET,1)+1
      NN=DNOT(DET,1)*4-2
      DNOT(DET,NN)=1
      DNOT(DET,NN+1)=4
      DNOT(DET,NN+2)=CN
      DNOT(DET,NN+3)=6
      DSTAT(DET)=3
      GOTO 39
   42 LOC=CR(M,2)
      CALL ADSUS
      GOTO 39
   43 GOTO 39
   44 GOTO 39
   39 CONTINUE
   57 DNOT(DET,1)=DNOT(DET,1)+1
      NN=DNOT(DET,1)*4-2
      DNOT(DET,NN)=1
      DNOT(DET,NN+1)=5
      DNOT(DET,NN+2)=CN
      DNOT(DET,NN+3)=3
      DSTAT(DET)=3
      GOTO 2
   17 READ(1'CN)((CR(J,K),K=1,4),J=1,20)
MAX=CR(1,2) →  LMAX=CR(1,3)
      READ(2'CN)((INF(J,K),K=1,2),J=1,LMAX)
      WRITE(3,206)
      IF(CR(2,4))29,29,30
   30 K=CR(2,1)+CR(2,2)+CR(2,3)+3
      L=K+CR(2,4)-1
      DO 31 M=K,L
      N=CR(M,1)
      GOTO(34,32,33),N
   34 LOC=CR(M,2)
      CALL ADSUS
      GOTO 31
   32 GOTO 31
   33 GOTO 31
   31 CONTINUE
   29 DNOT(DET,1)=DNOT(DET,1)+1
      NN=DNOT(DET,1)*4-2
      DNOT(DET,NN)=1
      DNOT(DET,NN+1)=5
      DNOT(DET,NN+2)=CN
      DNOT(DET,NN+3)=7
      DSTAT(DET)=3
      GOTO 2
   18 GOTO 2
   19 GOTO 2
   20 DSTAT(DET)=4
```

```
      GOTO 2
   21 DSTAT(DET)=4
      WRITE(3,216)
      GOTO 2
   22 M=DSL(DET,1)
      WRITE(3,207)
      M1=0
      DO 50 I=1,M
      II=2*I
      IF(CN-DSL(DET,II))50,51,50
   51 M1=II
      I=M
   50 CONTINUE
      IF(M1)53,53,52
   52 M2=DSL(DET,M1+1)
      K=SL(M2)
      L=M2+K
      K=K+1
      M3=0
      DO 54 J=K,L
      IF(SL(J))54,54,55
   55 M3=J
      SL(J)=-SL(J)
      J=L
   54 CONTINUE
      IF(M3)121,121,56
  121 DSTAT(DET)=4
      GOTO 2
   56 DINT(DET,1)=DINT(DET,1)+1
      J=DINT(DET,1)*2
      DINT(DET,J)=CN
      DINT(DET,J+1)=-SL(M3)
      DNOT(DET,1)=DNOT(DET,1)+1
      NN=DNOT(DET,1)*4-2
      DNOT(DET,NN)=1
      DNOT(DET,NN+1)=6
      DNOT(DET,NN+2)=CN
      DNOT(DET,NN+3)=8
      DNOT(DET,1)=DNOT(DET,1)+1
      NN=DNOT(DET,1)*4-2
      DNOT(DET,NN)=1
      DNOT(DET,NN+1)=7
      DNOT(DET,NN+2)=CN
      DNOT(DET,NN+3)=9
   53 DSTAT(DET)=3
      GOTO 2
   23 CD=0
      SG=0
      TEMP=0
      M=0
      WRITE(3,209)
      K=DINT(DET,1)
      IF(K)98,98,117
  117 DO 96 J=1,K
      J2=2*J
      IF(CN-DINT(DET,J2))96,97,96
   97 M=J2
      J=K
   96 CONTINUE
```

```
      IF(M)98,98,99
   99 TEMP=DINT(DET,M+1)
      WRITE(3,210)CN,TEMP
      K=2*K-1
      DO 46 J=M,K
   46 DINT(DET,J)=DINT(DET,J+2)
      DINT(DET,1)=DINT(DET,1)-1
      READ(6'CN)(CRCR(J),J=1,6)
      K=CRCR(1)+1
      DO 105 L=2,K
      IF(TEMP-CRCR(L))105,106,105
  106 SG=1
      L=K
  105 CONTINUE
      IF(SG)23,23,118
  118 CD=1
   98 CALL FIREP
      DCRI(12)=CD
      WRITE(4'LOC)(DCRI(J),J=1,13)
      DC=DC+CD
      IF(CD)49,49,48
   48 WRITE(3,214)CN,DET
      GOTO 58
   49 WRITE(3,215)CN,DET
   58 DNOT(DET,1)=DNOT(DET,1)+1
      NN=DNOT(DET,1)*4-2
      DNOT(DET,NN)=1
      DNOT(DET,NN+1)=3
      DNOT(DET,NN+2)=CN
      DNOT(DET,NN+3)=10
      DSTAT(DET)=4
      GOTO 2
   24 GOTO 2
   25 GOTO 2
   26 GOTO 2
    5 CALL RESAL
      CALL DPROC
      IF(CPROG(2)-EV(FEV,1))87,87,88
   87 T=CPROG(2)
      GOTO 89
   88 T=EV(FEV,1)
   89 WRITE(3,213)T
      GOTO 1
  201 FORMAT(' D',I3,' TO CR',I4)
  202 FORMAT(' E ACT',I3,' CR',I3,'D',I2)
  203 FORMAT(' G INF')
  205 FORMAT(' LOSER INT.')
  206 FORMAT(' LOCAL ENQS.')
  207 FORMAT(' SRCH ')
  208 FORMAT(' CRIME',I3,' REPORTED.TYPE',I2,' SER',I3)
  209 FORMAT(' INTERR')
  210 FORMAT(' CRIME',I3,' SUSPECT',I3)
  213 FORMAT('  INTERVAL ',I4)
  214 FORMAT('  CRIME',I3,'DETECTED BY DET',I2)
  215 FORMAT('  CRIME',I3,' NOT DETECTED BY DET ',I2)
  216 FORMAT('  C+I')
      END
```

FEATURES SUPPORTED

```
 ONE WORD INTEGERS
 IOCS

CORE REQUIREMENTS FOR
 COMMON   1680  VARIABLES      74  PROGRAM   2390

END OF COMPILATION

// DUP

*STORE        WS  UA  CTRL
CART ID 1101   DB ADDR  368D   DB CNT   0099
```

RESAL


```
// JOB

LOG DRIVE   CART SPEC   CART AVAIL  PHY DRIVE
  0000        1101        1101        0000

V2 M11   ACTUAL 8K  CONFIG 8K

// FOR
*ONE WORD INTEGERS
*LIST SOURCE PROGRAM
*IOCS(CARD)
*IOCS(DISK)
*IOCS(1132 PRINTER)
      SUBROUTINE RESAL
      INTEGER ACT,SER,DET,CN,TEMP,I,TIM,NDET,CRBKP,CRBKS,EVSIS,FEV
      INTEGER RR
      INTEGER CPROC(4),EV(30,7),EGY(30),CRBK(6),DCR(6,21),
     +DCRI(12),SOCOR(21),DNOT(6,21),DSL(6,41),SL(100),
     +DINT(6,21),DPLAN(6,40),DPL(6,10),FRED(7),DRATE(6,5),
     +DSTAT(7),UBR(21),NREP(6)
      REAL INF(30,2),CR(20,4)
      COMMON CPROC,EV,EGY,CRBK,DCR,DCRI,SOCOR,DNOT,DSL,SL,DINT,DPLAN,
     +DPL,FRED,DRATE,DSTAT,UBR,INF,CR,ACT,SER,DET,CN,TEMP,I,TIM,NDET,
     +CRBKP,CRBKS,EVSIS,FEV,TM,RR,LOC,MC,NXTCR
      COMMON LMAX,MARK,NREP
      FRED(1)=0
      WRITE(3,299)
      DO 103 DET=1,NDET
      IF(DSTAT(DET)-4)103,104,104
  104 FRED(1)=FRED(1)+1
      L=FRED(1)+1
      FRED(L)=DET
  103 CONTINUE
      DO 100 J=CRBKP,CRBKS
      READ(5'J)(CRBK(K),K=1,6)
      IF(CRBK(3))102,102,100
  102 IF(FRED(1))100,100,101
  101 DET=FRED(2)
      TEMP=DRATE(DET,1)
      LOC=2
      IF(FRED(1)-1)113,113,108
  108 I1=FRED(1)+1
      DO 109 I2=3,I1
      I3=FRED(I2)
      IF(TEMP-DRATE(I3,1))110,109,109
  110 DET=I3
      TEMP=DRATE(I3,1)
      LOC=I2
  109 CONTINUE
      IF(LOC-I1)112,113,113
  112 IK=I1-1
      DO 111 L=LOC,IK
  111 FRED(L)=FRED(L+1)
  113 FRED(1)=FRED(1)-1
      IF(EGY(1))114,114,115
  115 K=EGY(1)+1
      I=EGY(K)
      EGY(1)=EGY(1)-1
      GOTO 115
```

```
  114 I=EVSTS+1
      EVSTS=EVSTS+1
  116 EV(I,1)=T+1
      EV(I,2)=1
      EV(I,4)=DET
      EV(I,5)=CRBK(6)
      EV(I,6)=CRBK(1)
      EV(I,7)=1
      IF(FEV)93,93,94
   93 EV(I,3)=-99
      GOTO 95
   94 EV(I,3)=FEV
   95 FEV=I
      WRITE(3,210)DET,CRBK(1)
      CRBK(3)=T+1
      CRBK(4)=DET
      WRITE(5'J)(CRBK(K),K=1,6)
      CRBKP=J
  100 CONTINUE
      RETURN
  200 FORMAT(' RES ALL')
  210 FORMAT(' ORDER DET',I3,' TO CRIBE',I3)
      END

INVALID STATEMENTS
 C 15 ERROR AT STATEMENT NUMBER 00000+001

COMPILATION DISCONTINUED

// DUP

 13 DUP SUPPRESSED
```

DPROC

PAGE 1

// JOB

LOG DRIVE   CART SPEC   CART AVAIL   PHY DRIVE
  0000   1101   1101   0000

V2 M11   ACTUAL 8K CONFIG 8K

```
// FOR
*ONE WORD INTEGERS
*LIST SOURCE PROGRAM
      SUBROUTINE DPROC
      INTEGER ACT,SER,DET,CN,TEMP,T,TIM,NDET,CRBKP,CRBKS,EVSTS,FEV
      INTEGER PR
      INTEGER CPROG(4),EV(30,7),EGY(30),CRBK(6),DCR(6,21),
     +DCRI(13),SOCOR(21),DNOT(6,21),DSL(6,41),SL(100),
     +DINT(6,21),DPLAN(6,40),DPL(6,10),FRED(7),DRATE(6,5),
     +DSTAT(7),UBR(21),NREP(6)
      REAL INF(30,2),CR(20,4)
      COMMON CPROG,EV,EGY,CRBK,DCR,DCRI,SOCOR,DNOT,DSL,SL,DINT,DPLAN,
     +DPL,FRED,DRATE,DSTAT,UBR,INF,CR,ACT,SER,DET,CN,TEMP,T,TIM,NDET,
     +CRBKP,CRBKS,EVSTS,FEV,IN,PR,LOC,NC,NXTCR
      COMMON LMAX,MARK,NREP
      WRITE(3,211)
      DO 60 DET=1,NDET
      IF(DSTAT(DET)-4)61,62,62
   62 IF(DCR(DET,1))70,70,63
   63 K=DCR(DET,1)
      DO 65 LOC=1,K
      CALL COMPR
   65 CONTINUE
      DCR(DET,1)=0
   70 IF(DNOT(DET,1))66,66,67
   67 K=DNOT(DET,1)
      DO 68 LOC=1,K
      CALL NOTPR
   68 CONTINUE
      DNOT(DET,1)=0
      GOTO 66
   61 IF (DSTAT(DET)-3)69,62,62
   69 IF(DSTAT(DET)-2)60,62,62
   66 IF(DPL(DET,2))60,60,84
   84 I=4*DPL(DET,1)
      ACT=DPLAN(DET,I)
      CN=DPLAN(DET,I-1)
      DPL(DET,3)=DPL(DET,3)+1
      IF(DPL(DET,2)-DPL(DET,3))90,90,91
   90 DPL(DET,1)=-99
      DPL(DET,2)=0
      DPL(DET,3)=0
      GOTO 92
   91 JJ=DPL(DET,3)+3
      DPL(DET,JJ)=DPL(DET,1)
      DPL(DET,1)=DPLAN(DET,I-3)
      IF(DPL(DET,1)+99)90,90,92
   92 CALL TEST
      TIM=T+TIM
      IF(EGY(1))71,71,72
   72 K=EGY(1)+1
      I=EGY(K)
```

```
      EGY(1)=EGY(1)-1
      GOTO 83
   71 I=EVSTS+1
      EVSTS=EVSTS+1
   83 EV(I,1)=TIM
      EV(I,2)=2
      EV(I,4)=DET
      EV(I,5)=CN
      EV(I,6)=ACT
      WRITE(3,212)DET,ACT,CN,TIM
      IF(TIM-EV(FEV,1))73,74,74
   73 EV(I,3)=FEV
      FEV=I
      GOTO 80
   74 I1=FEV
   77 I2=EV(I1,3)
      IF(I2+99)75,75,76
   75 EV(I1,3)=I
      EV(I,3)=-99
      GOTO 80
   76 IF(TIM-EV(I2,3))78,79,79
   78 EV(I,3)=I2
      EV(I1,3)=I
      GOTO 80
   79 I1=I2
      GOTO 77
   80 IF(ACT-3)81,82,82
   81 DSTAT(DET)=2
      GOTO 60
   82 DSTAT(DET)=1
   60 CONTINUE
      RETURN
  211 FORMAT(' ENTER DET. PROCESSES.')
  212 FORMAT(' D',I3,'ACT',I3,'CR',I3,' T',I4)
      END

FEATURES SUPPORTED
 ONE WORD INTEGERS

CORE REQUIREMENTS FOR DPROC
 COMMON    1680  VARIABLES     12  PROGRAM    560

RELATIVE ENTRY POINT ADDRESS IS 002D (HEX)

END OF COMPILATION

// DUP

*STORE       WS  UA  DPROC
CART ID 1101   DB ADDR  3669   DB CNT   0024
```

TEST

```
[illegible]

[illegible] LEVEL    CART SPEC    CART AVAIL    PHY DRIVE
[illegible]          1121         1121          [illegible]

[illegible]          ACTUAL [illegible] CONFIG [illegible]

// FOR
*LIST SOURCE PROGRAM
*ONE WORD INTEGERS
      SUBROUTINE TEST
      INTEGER [illegible]
      INTEGER [illegible]
      INTEGER [illegible](4)[illegible]
     [illegible]I(1[illegible])[illegible]
     [illegible](6,21)[illegible](6,1[illegible])[illegible](7)[illegible]
     [illegible](2)[illegible](21)[illegible](4)
      REAL [illegible](30,2)[illegible]
      COMMON [illegible]
     [illegible]
     [illegible]
      COMMON [illegible]
      WRITE(3,200)
      [illegible]
      RETURN
  200 FORMAT('  TEST')
      END

[illegible] SUPPORTED
[illegible] INTEGERS

[illegible] REQUIREMENTS FOR TEST
[illegible] VARIABLES [illegible]

[illegible]

[illegible] COMPILATION [illegible]

[illegible]

[illegible]
[illegible] 1121 [illegible]
```

COMPR

```
PAGE   1

// JOB

LOG DRIVE   CART SPEC   CART AVAIL   PHY DRIVE
  0000        1121        1121         0000

V2 M08   ACTUAL 8K   CONFIG 8K

// FOR
*ONE WORD INTEGERS
*LIST SOURCE PROGRAM
      SUBROUTINE COMPR
      INTEGER ACT,SEM,[illegible]
      INTEGER [illegible]
      INTEGER CPROG(4),[illegible](30,7),[illegible]
     1[illegible](12),[illegible](21),[illegible]
     2[illegible](6,21),[illegible](6,[illegible]),[illegible](7),[illegible](6,5),
     3[illegible]STAT(7),[illegible](21),[illegible]
      REAL [illegible](20,2),[illegible]
      COMMON [illegible]
     1[illegible]
     1[illegible]
      COMMON [illegible]
      WRITE([illegible],200)
      [illegible]=1
      [illegible]([illegible])
      CALL [illegible]
      [illegible](DFT,I[illegible]+1)=[illegible]       DR
      [illegible](DFT,I[illegible]+2)=[illegible]       CN
      [illegible](DFT,I[illegible]+3)=[illegible]       ACT
      RETURN
  200 FORMAT(' COMPR')
      END

FEATURES SUPPORTED
 ONE WORD INTEGERS

CORE REQUIREMENTS FOR COMPR
 COMMON  [illegible]  VARIABLES  [illegible]

[illegible]

[illegible]

[illegible]

[illegible]
[illegible] 1121 [illegible]
```

PAGE 1

NQTRR

```
// JOB

LOG DRIVE   CART SPEC   CART AVAIL   PHY DRIVE
  0000        1121         1121         0000

V2 M08   ACTUAL  8K  CONFIG  8K

// FOR
*LIST SOURCE PROGRAM
*ONE WORD INTEGERS
      SUBROUTINE NQTRR
      INTEGER ACT,SEP,LET,C[illegible],I[illegible],I,L[illegible],DET,CRBL[illegible],[illegible]
      INTEGER PR
      INTEGER CPROG(4),EV(2[illegible],7),E[illegible]Y([illegible]),[illegible]([illegible]),C[illegible]([illegible],21),
     1PCRI(1[illegible]),SOCOR(21),[illegible]([illegible],21),[illegible]([illegible],4[illegible]),[illegible]L(1[illegible]),
     1SINT(6,21),DPLAN(6,[illegible]),[illegible]([illegible],1[illegible]),[illegible](7),D[illegible]([illegible]),
     1ESTAT(7),UBR(21),[illegible](6)
      REAL INF(30,2),CR(2[illegible],4)
      COMMON CPROG,EV,ESY,CRB[illegible],PC[illegible],DCRI,SOCOR,DIST,LSL,SL,[illegible],DPLAN,
     1DEL,F[illegible],DRATE,ESTAT,URR,INF,CI,ACT,SEL,LET,CN,[illegible],I,[illegible],DET,
     1CRIKP,CRPKS,EVSTS,[illegible],IN,[illegible],LOC,[illegible],[illegible]
      COMMON LMAX,MARK,[illegible]
      WRITE(3,200)
      K=4*LOC-1
      IN=DIST(DET,K)
      CALL [illegible]
      DPLAN(DET,IN+1)=D[illegible](DET,[illegible])
      DPLAN(DET,IN+2)=D[illegible](DET,[illegible]+1)
      DPLAN(DET,IN+3)=D[illegible](DET,[illegible]+2)
      RETURN
  200 FORMAT(' NQTRR')
      END

FEATURES SUPPORTED
 ONE WORD INTEGERS

CORE REQUIREMENTS FOR NQTRR
 COMMON    1[illegible]   VARIABLES        [illegible]     [illegible]     [illegible]8

[illegible]

END OF COMPILATION

// [illegible]

[illegible]
[illegible] 1121 [illegible]
```

PLPR

```
// JOB

LOG DRIVE   CART SPEC   CART AVAIL   PHY DRIVE
  0000         1107        1107         0000

V2 M09   ACTUAL  8K  CONFIG  8K

// FOR
*ONE WORD INTEGERS
*LIST SOURCE PROGRAM
      SUBROUTINE PLPR
      INTEGER ACT,SER,DET,CN,TEMP,T,TIM,NDET,CRBKP,CRBKS,EVSTS,FEV
      INTEGER PR
      INTEGER CPROG(4),EV(30,7),EGY(30),CRBK(6),DCR(6,21),
     +DCRI(13),SOCOR(21),DNOT(6,21),DSL(6,41),SL(100),
     +DINT(6,21),DPLAN(6,40),DPL(6,10),FRED(7),DRATE(6,5),
     +DSTAT(7),UBR(21),NREP(6)
      REAL INF(30,2),CR(20,4)
      COMMON CPROG,EV,EGY,CRBK,DCR,DCRI,SOCOR,DNOT,DSL,SL,DINT,DPLAN,
     +DPL,FRED,DRATE,DSTAT,UBR,INF,CR,ACT,SER,DET,CN,TEMP,T,TIM,NDET,
     +CRBKP,CRBKS,EVSTS,FEV,IN,PR,LOC,NC,NXTCR
      COMMON LMAX,MARK,NREP
      WRITE(3,200)
      IF(DPL(DET,3))10,10,11
   10 IN=4*DPL(DET,2)+1
      DPL(DET,2)=DPL(DET,2)+1
      JK=DPL(DET,2)
      GOTO 9
   11 JJ=DPL(DET,3)+3
      JK=DPL(DET,JJ)
      IN=4*JK-3
      DPL(DET,3)=DPL(DET,3)-1
    9 I=DPL(DET,1)
      IF(I+99)12,12,13
   13 II=4*I-2
      IF(PR-DPLAN(DET,II))1,1,2
    2 DPLAN(DET,IN)=DPL(DET,1)
      DPL(DET,1)=JK
      GOTO 4
    1 IP=4*DPLAN(DET,II-1)-2
      IF(PR-DPLAN(DET,IP))5,5,6
    6 CONTINUE
      DPLAN(DET,IN)=DPLAN(DET,II-1)
      DPLAN(DET,II-1)=JK
      GOTO 4
    5 IF(DPLAN(DET,IP-1)+99)7,7,8
    7 CONTINUE
      DPLAN(DET,IN)=-99
      DPLAN(DET,IP-1)=JK
      GOTO 4
    8 II=IP
      GOTO 1
   12 DPLAN(DET,IN)=-99
      DPL(DET,1)=JK
      GOTO 4
    4 CONTINUE
      RETURN
  200 FORMAT(' PLPR')
      END

 FEATURES SUPPORTED
  ONE WORD INTEGERS
```

ADSUS

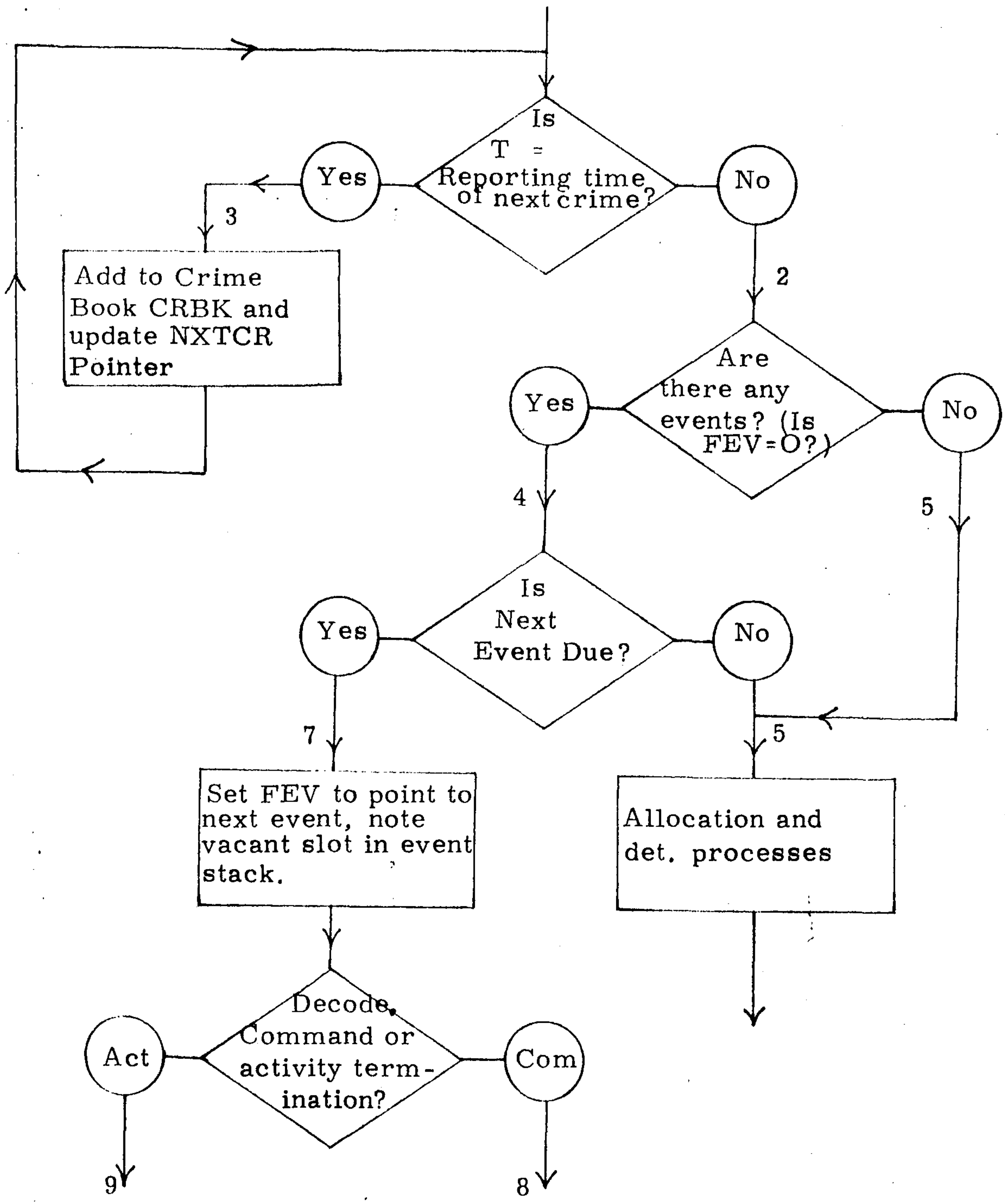
PAGE 1

```
// JOB

LOG DRIVE   CART SPEC   CART AVAIL  PHY DRIVE
  0000        1101        1101        0000

V2 M11   ACTUAL  8K  CONFIG  8K

// FOR
*LIST SOURCE PROGRAM
*ONE WORD INTEGERS
      SUBROUTINE ADSUS
      INTEGER ACT,SER,DET,CN,TEMP,T,TIM,NDET,CRBKP,CRBKS,EVSTS,FEV
      INTEGER PR
      INTEGER P,PP,SN
      INTEGER CPROG(4),EV(30,7),EGY(30),CRBK(6),DCR(6,21),
     +DCRI(13),SOCOR(21),DNOT(6,21),DSL(6,41),SL(100),
     +DINT(6,21),DPLAN(6,40),DPL(6,10),FRED(7),DRATE(6,5),
     +DSTAT(7),UBR(21),NREP(6)
      REAL INF(30,2),CR(20,4)
      COMMON CPROG,EV,EGY,CRBK,DCR,DCRI,SOCOR,DNOT,DSL,SL,DINT,DPLAN,
     +DPL,FRED,DRATE,DSTAT,UBR,INF,CR,ACT,SER,DET,CN,TEMP,T,TIM,NDET,
     +CRBKP,CRBKS,EVSTS,FEV,IN,PR,LOC,NC,NXTCR
      COMMON LMAX,MARK,NREP
      WRITE(3,200)
      P=LOC
      I=DSL(DET,1)
      IF(I)64,64,4
    4 M4=0
      DO 63 J=1,I
      J2=2*J
      IF(CN-DSL(DET,J2))63,71,63
   71 M4=1
      J=I
   63 CONTINUE
      IF(M4)64,64,65
   65 K=INF(P,1)
      KK=P+K
      K=K+1
      DO 66 L=K,KK
      SN=INF(L,1)
      M=DSL(DET,J2+1)
      M1=SL(M)
      M2=M+M1
      M1=M+1
      M4=0
      DO 67 L1=M1,M2
      TEMP=SL(L1)
      IF(TEMP)2,2,3
    2 TEMP=-TEMP
    3 IF(SN-TEMP)67,68,67
   68 M4=1
      L1=M2
   67 CONTINUE
      IF(M4)66,69,66
   69 SL(1)=SL(1)+1
      N2=SL(1)-M2-1
      DO 70 N=1,N2
      N1=SL(1)-N
   70 SL(N1+1)=SL(N1)
```

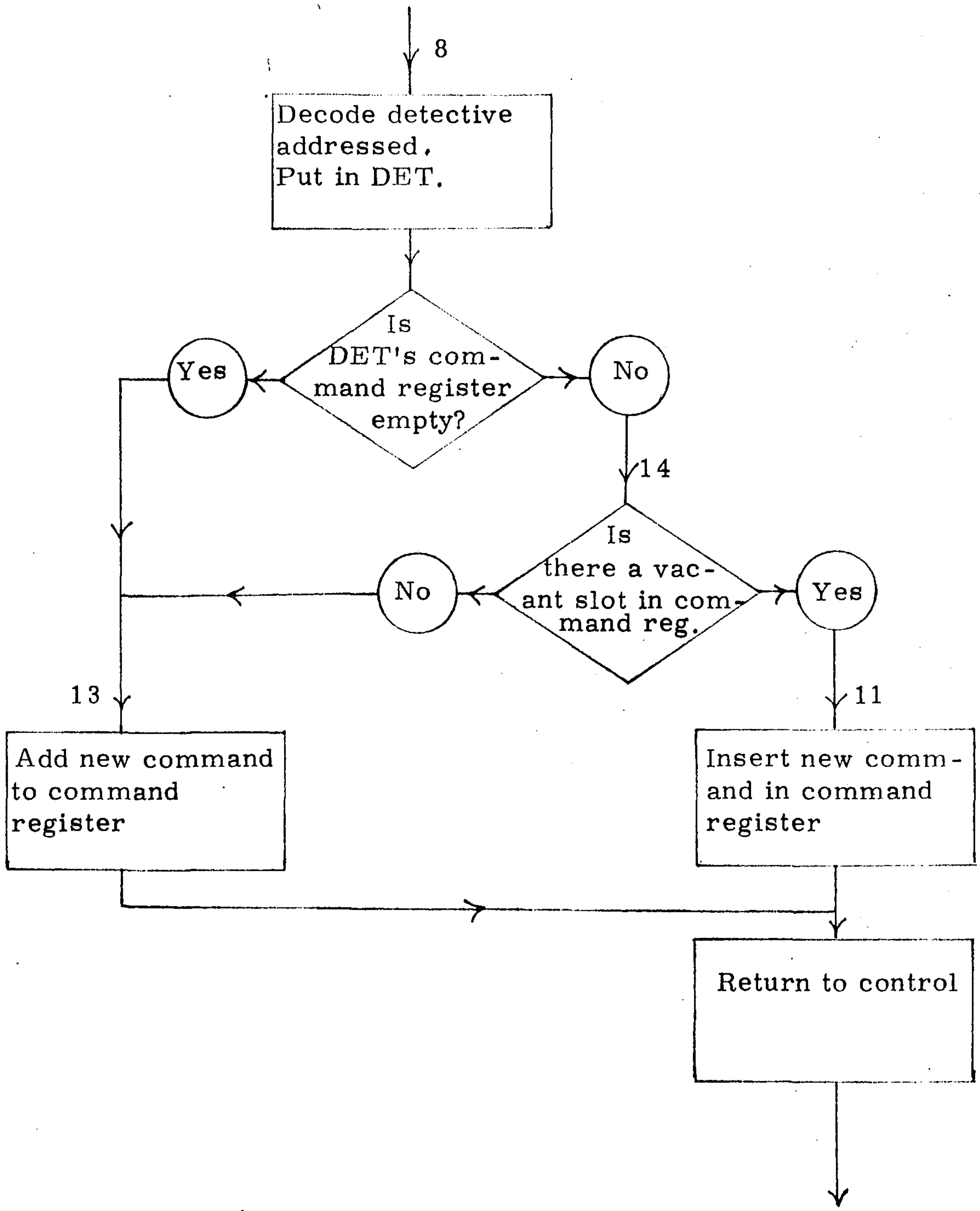
```
      SL(M2+1)=SN
      SL(M)=SL(M)+1
      J=J2+2
      J1=DSL(DET,1)*2
      DO 1 N1=J,J1,2
    1 DSL(DET,N1)=DSL(DET,N1)+1
   66 CONTINUE
      GOTO 74
   64 DSL(DET,1)=DSL(DET,1)+1
      J2=2*DSL(DET,1)
      DSL(DET,J2)=CN
      DSL(DET,J2+1)=SL(1)+1
      I2=SL(1)+INF(P,1)+1
      I1=SL(1)+1
      DO 72 I=I1,I2
      PP=P+I-I1
   72 SL(I)=INF(PP,1)
      SL(1)=I2
   74 DNOT(DET,1)=DNOT(DET,1)+1
      P=DNOT(DET,1)*4-2
      DNOT(DET,P)=1
      DNOT(DET,P+1)=5
      DNOT(DET,P+2)=CN
      DNOT(DET,P+3)=8
      RETURN
  200 FORMAT(' ADSUS')
      END
```

```
FEATURES SUPPORTED
 ONE WORD INTEGERS

CORE REQUIREMENTS FOR ADSUS
 COMMON    1680  VARIABLES      28  PROGRAM     528

RELATIVE ENTRY POINT ADDRESS IS 0028 (HEX)

END OF COMPILATION

// DUP

*STORE        WS  UA  ADSUS
CART ID 1101   DB ADDR  3671   DB CNT   0021
```

```
PAGE   1

// JOB

LOG DRIVE    CART SPEC    CART AVAIL   PHY DRIVE
  0000         1101          1101         0000

V2 M11   ACTUAL  8K  CONFIG  8K

// FOR
*LIST SOURCE PROGRAM
*ONE WORD INTEGERS
      SUBROUTINE FIREP
      INTEGER ACT,SER,DET,CN,TEMP,T,TIM,NDET,CRBKP,CRBKS,EVSTS,FEV
      INTEGER PR
      INTEGER CPROG(4),EV(30,7),EGY(30),CRBK(6),DCR(6,21),
     +DCRI(13),SOCOR(21),DNOT(6,21),DSL(6,41),SL(100),
     +DINT(6,21),DPLAN(6,40),DPL(6,10),FRED(7),DRATE(6,5),
     +DSTAT(7),UBR(21),NREP(6)
      REAL INF(30,2),CR(20,4)
      COMMON CPROG,EV,EGY,CRBK,DCR,DCRI,SOCOR,DNOT,DSL,SL,DINT,DPLAN,
     +DPL ,FRED,DRATE,DSTAT,UBR,INF,CR,ACT,SER,DET,CN,TEMP,T,TIM,NDET,
     +CRBKP,CRBKS,EVSTS,FEV,IN,PR,LOC,NC,NXTCR
      COMMON LMAX,MARK,NREP
      WRITE(3,200)
      J=NREP(DET)
      IF(J)3,3,4
    4 LOC=0
      DO 1 I=1,J
      L=DET*20-20+I
      READ(4'L)(DCRI(K),K=1,13)
      IF(CN-DCRI(13))1,2,1
    2 LOC=L
      I=J
    1 CONTINUE
      IF(LOC)3,3,5
    3 NREP(DET)=NREP(DET)+1
      LOC=DET*20-20+NREP(DET)
    5 RETURN
  200 FORMAT(' FIREP')
      END

FEATURES SUPPORTED
 ONE WORD INTEGERS

CORE REQUIREMENTS FOR FIREP
 COMMON    1680  VARIABLES      6  PROGRAM    126

RELATIVE ENTRY POINT ADDRESS IS 0011 (HEX)

END OF COMPILATION

// DUP

*STORE       WS  UA  FIREP
CART ID 1101   DB ADDR  3692   DB CNT   0009
```

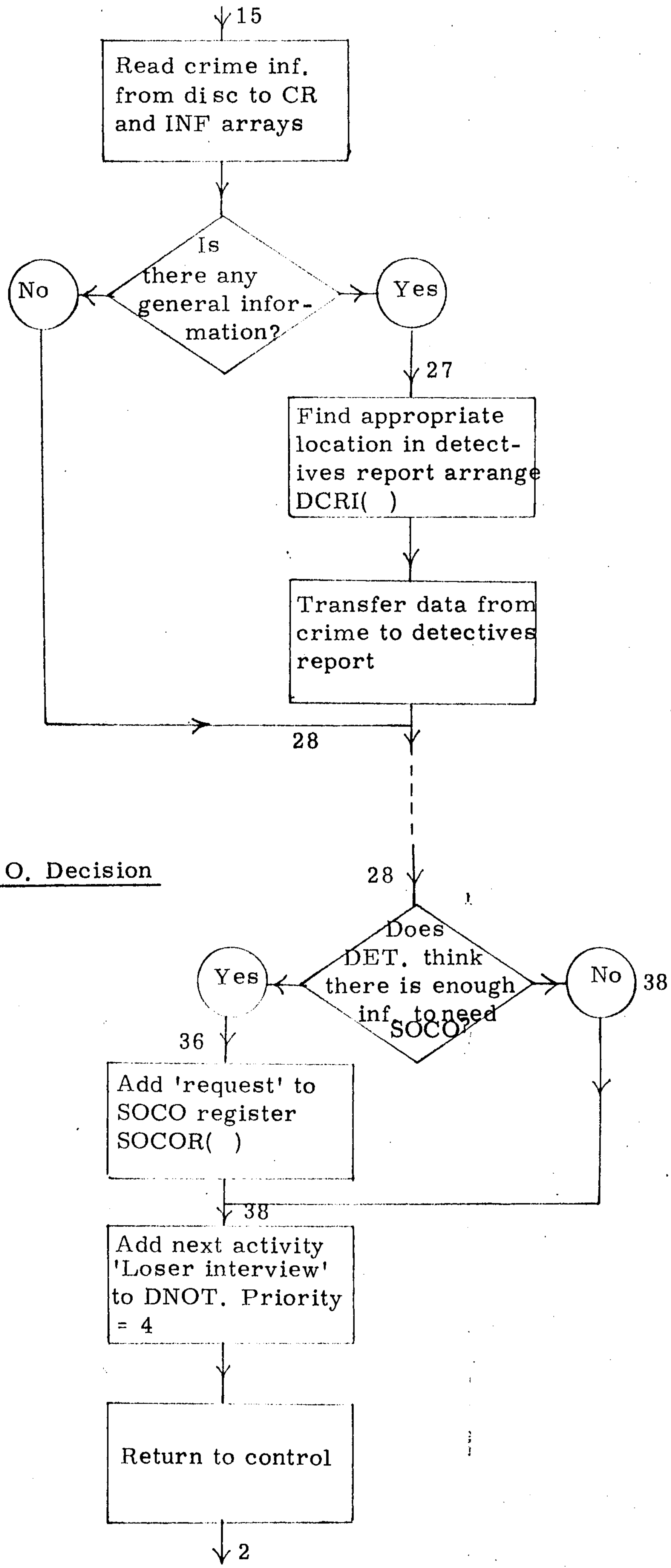


Program Control

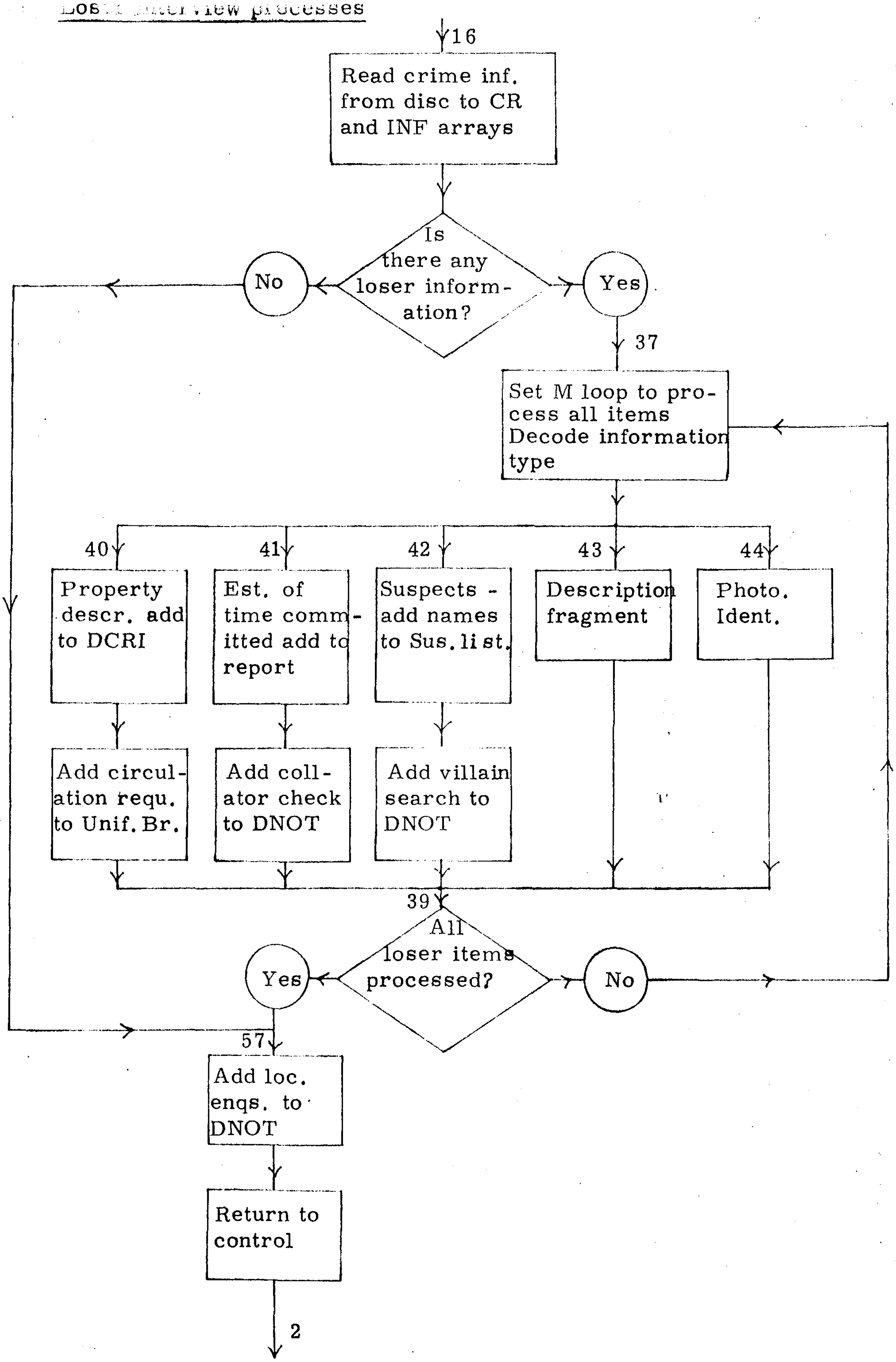


Event Processing Type 1 - Command

a) Decode general information and put in crime report

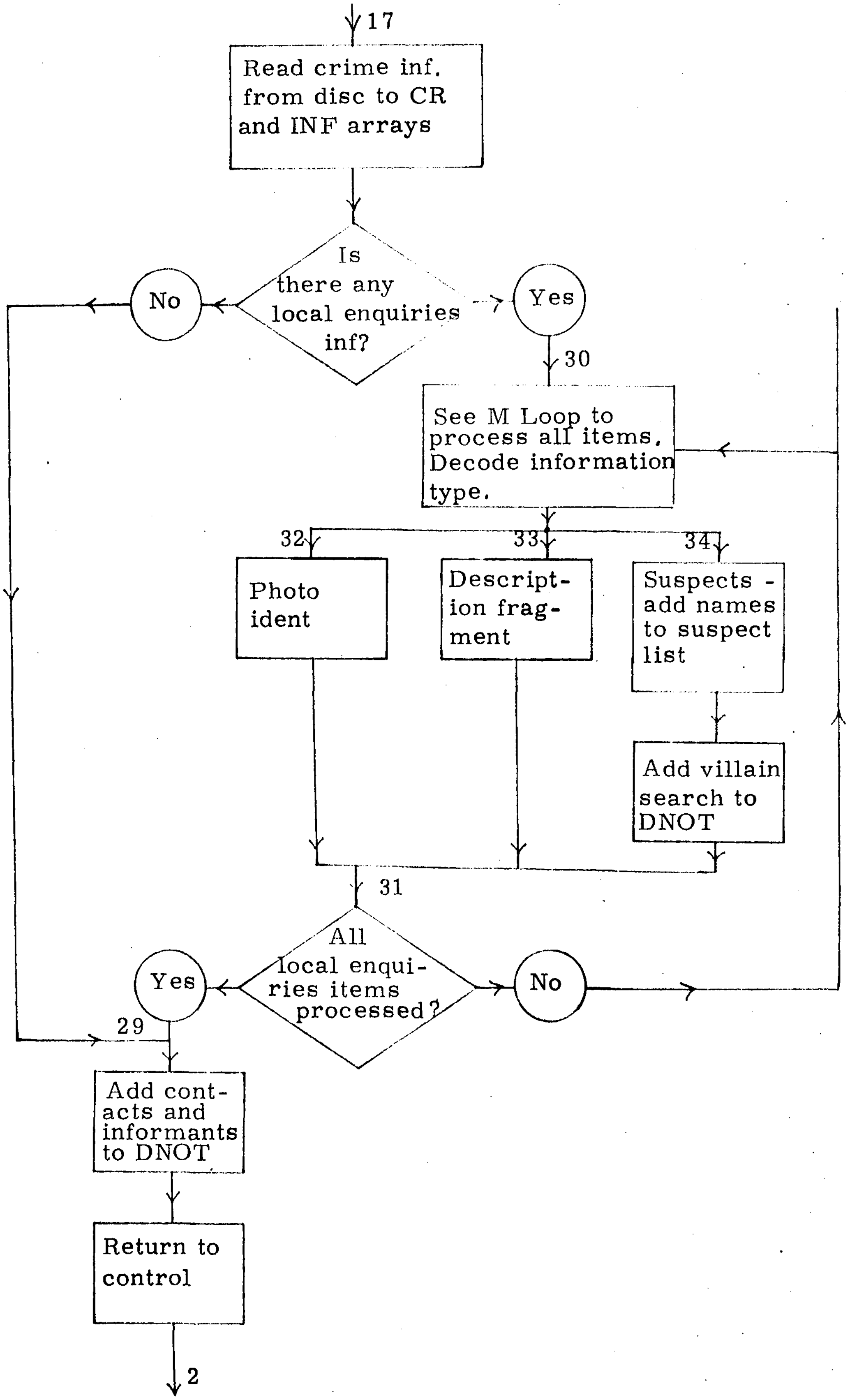


Event Processing Type 2 Activity Termination



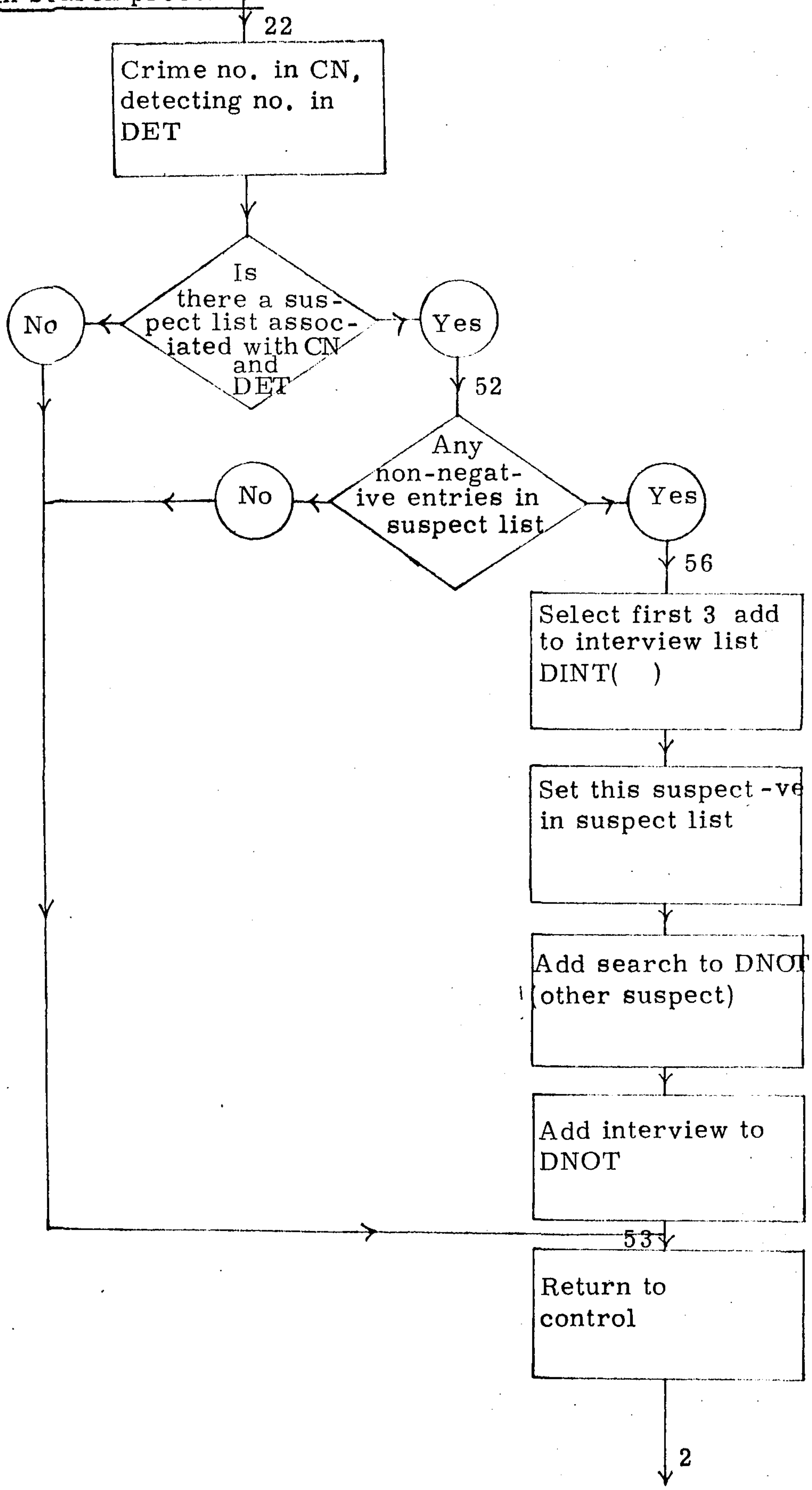
Event Processing Type 2 Activity Termination

d) Local enquiries processes

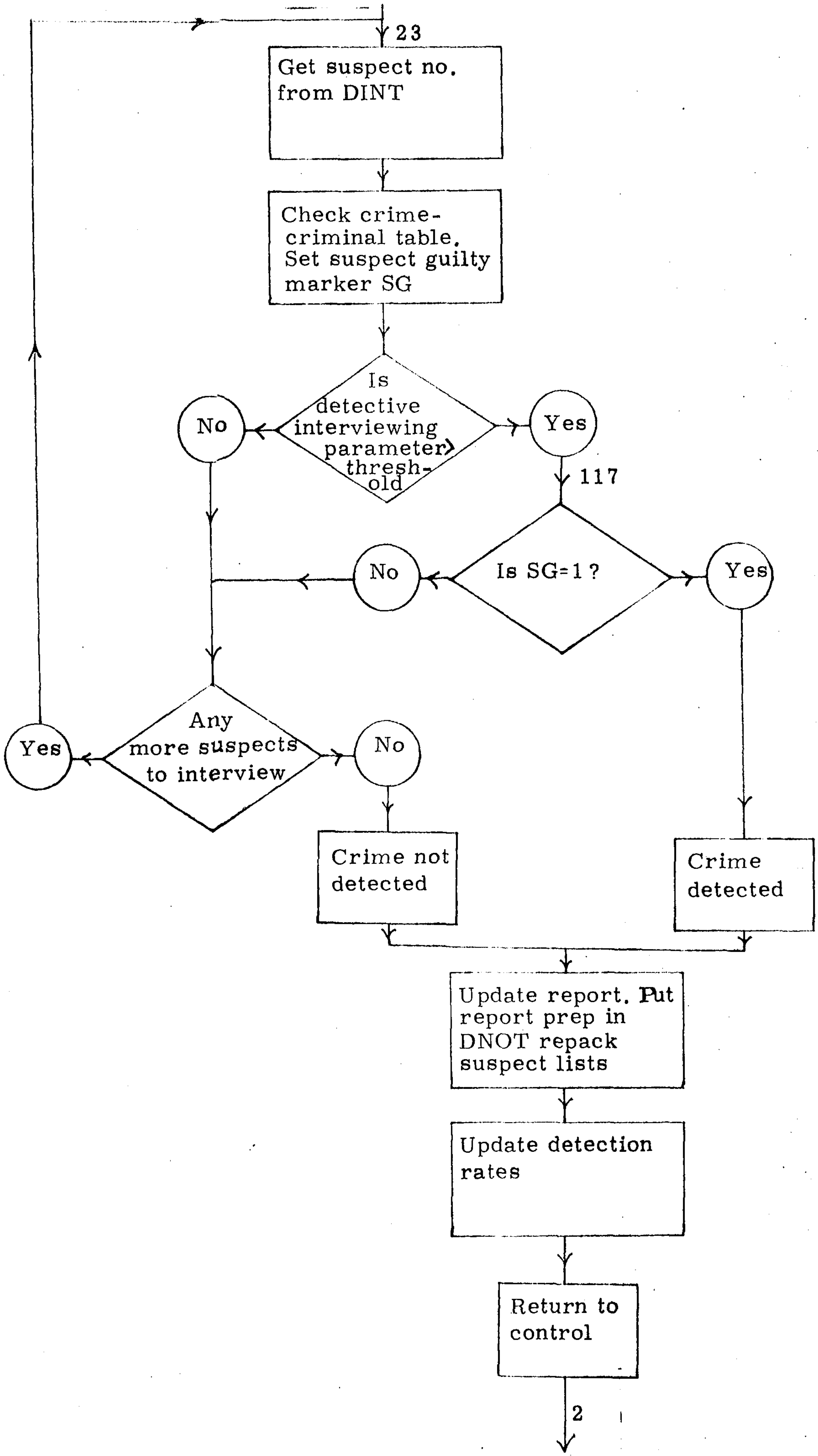


Event Processing Type 2 Activity Termination

e) Villain search processes

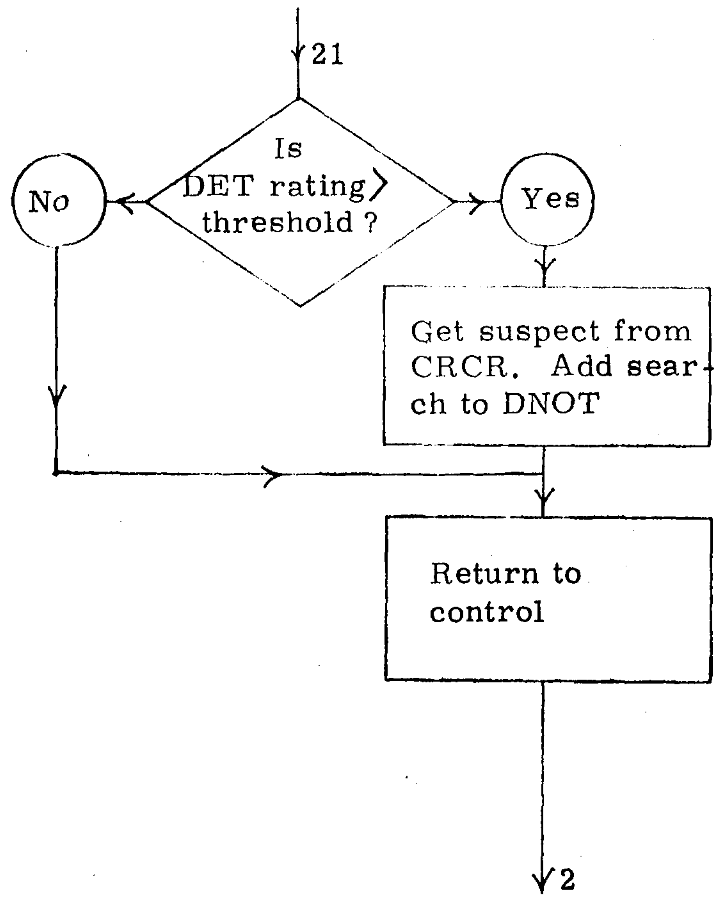


Event Processing Type 2 Activity Termination

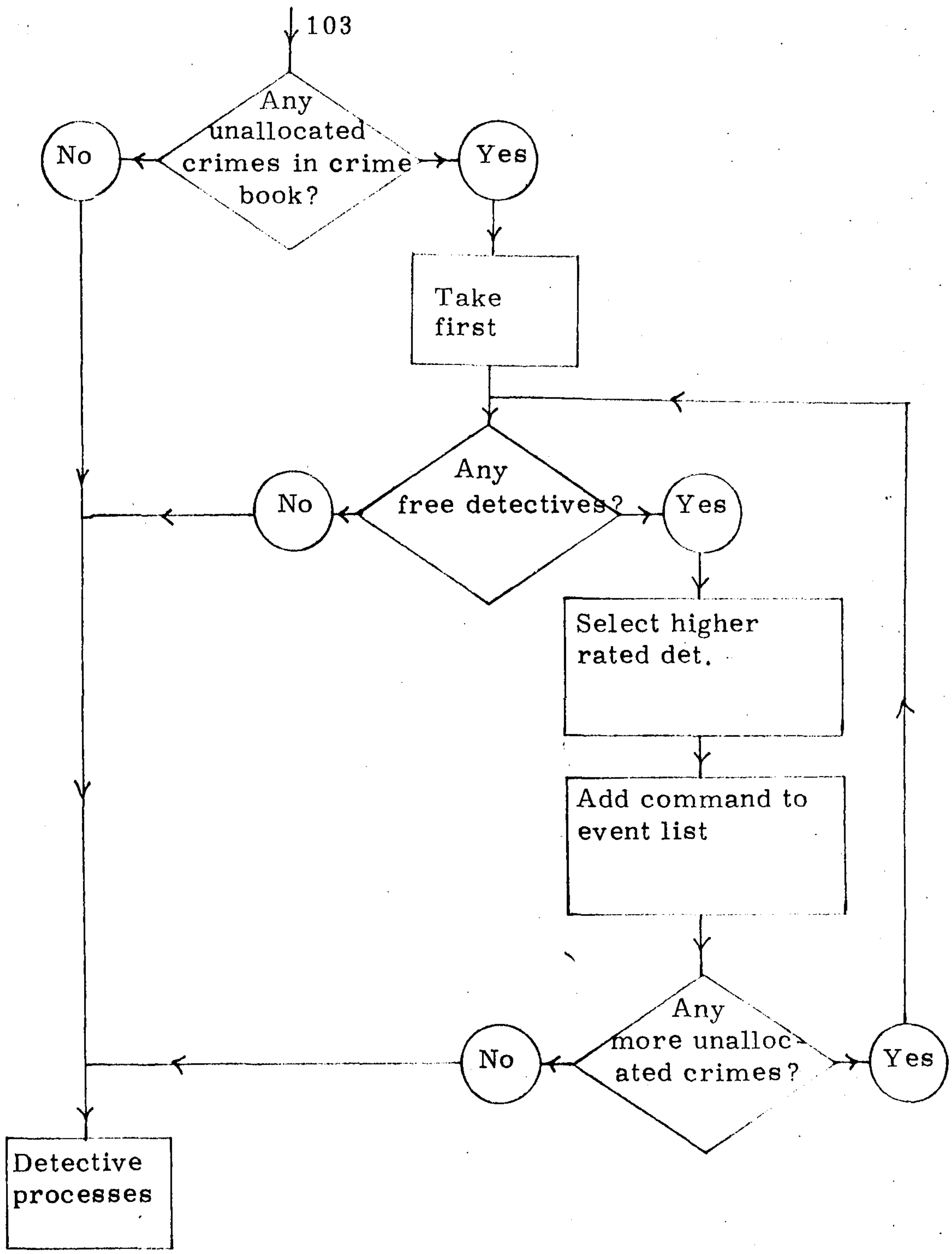


Event Processing Type 2 Activity Termination

g) Contacts & informants processes

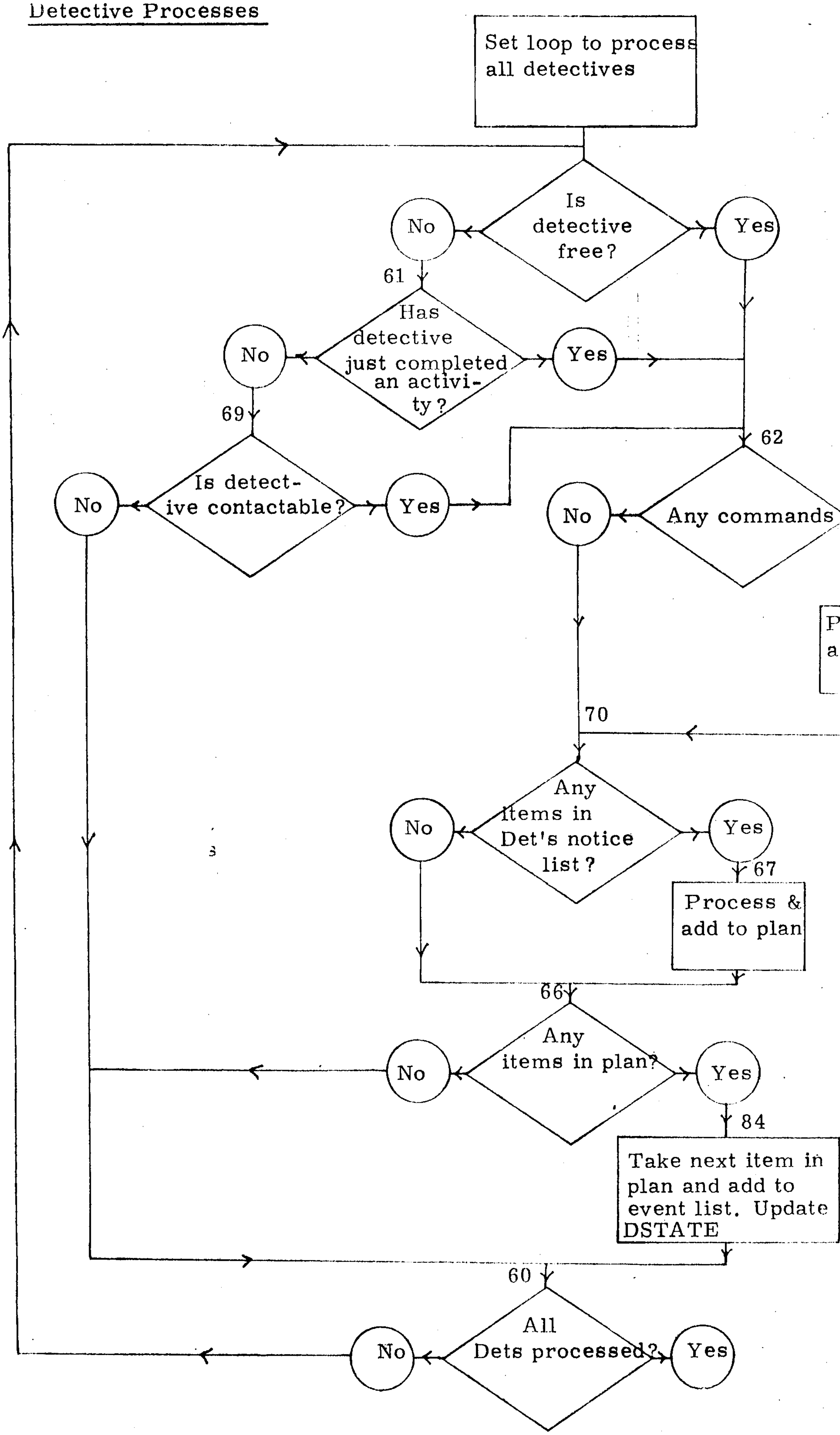


Event Processing Type 2 Activity Termination

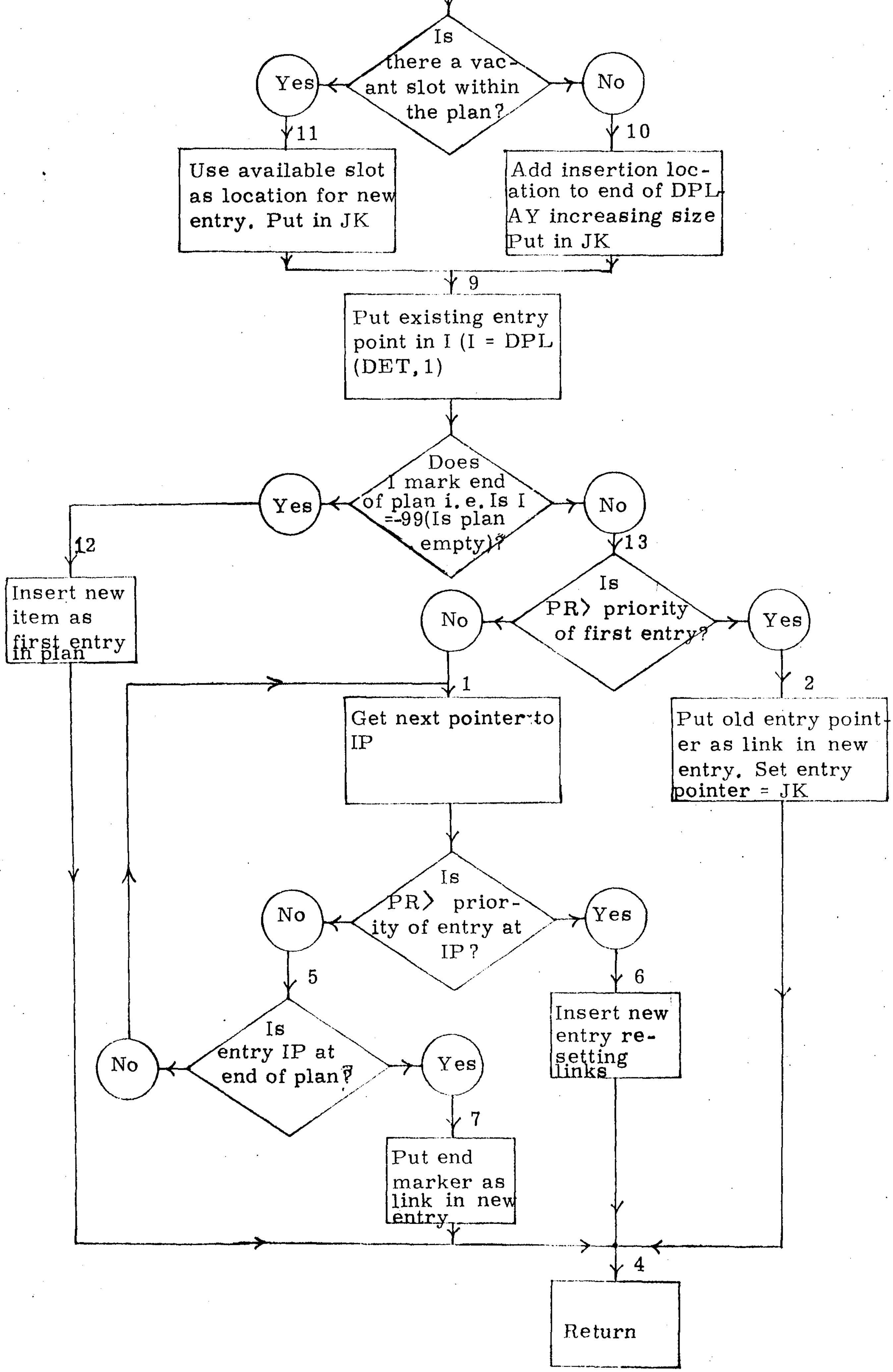


Simplified resource allocation procedure

Detective Processes



This subroutine inserts a new item in a plan in order of its priority, PR



Subroutine PLPR (Detective Plan Processing)

SIMPOL COMPUTER PROGRAM

MAIN ARRAY STRUCTURES

INPUT

a) Detective Characteristics

These are specified as card input, one card per detective. The first card specifies the number of detectives NDET in I2 Format.

Each detective card contains 5 numbers (Format 5I3) specifying the characteristics.

Example

NDET = 6 — 1st Card

Rating	Rank	Years Service	SOCO Decision Threshold	Villian Interr. Threshold	
4	1	2	1	0	Det. 1 - 2nd Card
3	1	4	1	0	Det. 2 - 3rd Card
2	1	6	1	0	Det. 3 - 4th Card
6	1	8	1	0	Det. 4 - 5th Card
6	2	6	1	0	Det. 5 - 6th Card
7	2	12	1	0	Det. 6 - 7th Card

STRUCTURES

a) Events   Array EV(I, J) I - Event address
J - Content

	J = 1	J = 2	J = 3	J = 4	J = 5	J = 6	J = 7
I = 1	Sched. Time	Type 1=Comm 2=Act	Next event pointer	Det. addr- essed			
I = 2		1			Prior- ity	Crime No.	Activity Code
etc.		2			Crime No.	Activ- ity Code	

Associated Structures

1) Event Graveyard EGY(K)

This lists vacant slots in E V( )

EGY(1) - contains no. of entries in EGY( )
EGY(2) - address of first vacant slot in EV( )

2) FEV - This is the First Event Pointer and contains address of next scheduled event.

STRUCTURES

b) Detective Command Registers DCR(I, J)

(This a buffer containing command inf. from DI before it gets scheduled in a Plan).

I - detective no.

J

DCR(I, J)

	J=1	J=2	J=3	J=4	J=5	J=6	J=7	J=8
I=1 1st Det.	No. of commands stored	Time 1st given	Priority of 1st	Crime No.	Activity	Time 2nd given	Priority of 2nd	etc.
2nd Det. etc.								

c) Detective Noticing Registers DNOT(I, J)

(This is a buffer containing actions for consideration before they are scheduled in a Plan).

	J=1	J=2	J=3	J=4	J=5	J=6	J=7	J=8
I=1 1st Det.	No. of entries	Type =1	Priority	Crime No.	Activity	Type=1	Priority	etc.
etc.								

STRUCTURES

f) Detective Crime Report Information DCRI(I)

This is data collected during investigation and stored on disc.

		Contents
DCRI(1)	-	Crime type
(2)	-	Seriousness
(3)	-	Type of premises
(4)	-	Address
(5)	-	Reporting time
(6)	-	M.O.
(7)	-	S.O.C.O.
(8)	-	Property Code
(9)	-	Est. time committed
(10)	-	Pointer to suspect list
(11)	-	Pointer to vehicle list
(12)	-	Detected or undetected
(13)	-	Crime no.

STRUCTURES

e) Detective Suspect Lists DSL(I, J) SL(I)

	J = 1	J = 2	J = 3	J = 4	J = 5	J = 6
I=1, 1st Det.	No. of entries	Crime No.	Suspect list pointer	Crime No.	Suspect list pointer	etc.
etc.						

SL(I)

I = 1	No. of entries
2	No. of suspects
	suspect no. suspect no. suspect no.
	no. of suspects
	⋮
	etc.

STRUCTURES

d) Detective Plans DPLAN(I, J)

(This array contains the schedule of detective planned activities)

	J = 1	J = 2	J = 3	J = 4	J = 5	J = 6	J = 7	
I=1, 1st Det.	Pointer to next item	Prior-ity	Crime No.	Activ-ity	Point-er	Prior-ity	Crime No.	etc.
I=2, 2nd Det.								

Associated Structure DPL (I, J)

This contains 'bookkeeping' information for organising DPLAN

	J = 1	J = 2	J = 3	J = 4	J = 5	J = 6
I=1, 1st Det.	Entry Pointer to DPL-AN	No. of entries in DPL-AN	No.of vacant-slots in DPL-AN	address of 1st vacant-slot	address of 2nd vacant slot	etc.
I=2, 2nd Det.						