

A Microcomputer Accident Analysis Package and its
use in Developing Countries.

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ABSTRACT

The programs and facilities currently available in the TRRL Overseas Unit Microcomputer Accident Analysis Package for Developing Countries are described and examples of its various outputs given. Since it is intended to be part of a wider Accident Investigation and Prevention process, the different objectives and techniques of accident analysis at National, Regional and Local levels are briefly summarised. The need to identify the location of accident sites accurately from an accident report form is given a high priority and the system adopted is described. The Package itself is designed for users with no previous computing experience; hard disc and bilingual versions have now been developed for both the Concurrent CP/M and MSDOS operating systems. At present, it is under evaluation in six countries.

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1. INTRODUCTION

Experience gained in the 1970's by the Overseas Unit of TRRL had shown that hand analysis of accident records in developing countries was a very slow, inconsistent and error-prone process. Computer analysis was clearly required; mainframe computers however, have had a chequered history in developing countries and for many years there has been a widespread concern among International Aid Agencies about the appropriateness of mainframe computing to developing countries. The rapid development of microcomputers in recent years, therefore, has offered an exciting opportunity to overcome some of these difficulties. Microcomputers potentially offer a number of advantages to developing countries:

- (i) They are cheap;
- (ii) Relative to mainframes, they are physically robust and tolerant of high temperatures, humidity and dust (although air conditioning is generally to be recommended);
- (iii) They are relatively easy to maintain, with even do-it-yourself maintenance possible at a module level;
- (iv) They are readily accessible, ideally being in or close to, the user's office;
- (v) They are not intimidating.

In addition to these physical advantages, the style of programming that developed with microcomputers, with its emphasis on interaction and 'user friendliness', would seem to be particularly helpful to developing country users.

It was against this background that the Overseas Unit of TRRL began development of the Microcomputer Accident Analysis Package in about 1981.

The package was originally developed as part of a co-operative programme of road safety research between the Egyptian Government and the Overseas Unit of the Transport and Road Research Laboratory, and was developed in parallel with an easy-to-use Police Accident Report Booklet (Gaber & Yerrell, 1985). The package was first described in Hills and Kassabgi (1984) and since then, the microcomputer system has been further developed, partly under contract to the Transportation Research Group of Southampton University. The main enhancements have included the introduction of 16-bit and 16/32-bit versions using either MSDOS or Concurrent CP/M operating systems, and the introduction of Hard Disc and bilingual options. In addition to Egypt, the system is being evaluated on a trial basis in Saudi Arabia (Arabic version), Ethiopia, Botswana,

Pakistan and Papua New Guinea and is currently under consideration for trial in a number of other developing countries. French and Spanish version are now available.

The purpose of Section 2 of this paper is to give an up-to-date description of the facilities now available with the system. Sections 3 and 4 give a brief description of how these types of facilities may be used in analysing accidents at three distinct levels: National, Regional and Local. The package itself has been designed primarily for use at a Regional and Local level and for use by staff with little or no previous computing experience.

2. THE TRRL MICROCOMPUTER ACCIDENT ANALYSIS PACKAGE

2.1 Programs in the Accident Analysis Package

Table 1 shows the various programs so far developed which fall into two main groups:

- (i) Those for establishing and updating files of accident records - the accident database; and
- (ii) Those for analysing the accidents.

2.1.1 Inputting New Accident Records

New accident records are entered directly from the police accident report using the first program option (NEWACCS). This work is normally carried out by a junior member of the office. Before doing so, each police report is checked for missing data and various items given code numbers. An example of an accident record is shown in Figure 1. The user is prompted for each item in the accident report in turn, and after entering a value for an item, various checks for valid values and logical consistency are carried out. With experience, 10-20 accidents an hour can be entered. This creates a small file of 'New Accidents' which will later be checked and added to a 'master file' by the supervisor of the system.

2.1.2 Creating Master Accident Files

To enable rapid retrieval of an accident, the master files are of a type known as 'Random Access'. To start a new file of accidents, say, at the beginning of the year, it is necessary to create a large, but empty, file using program option 3 (NEWFILE).

TABLE 1
PROGRAMS IN MICRO ACCIDENT ANALYSIS PACKAGE

A. PROGRAMS FOR CREATING ACCIDENT FILES	
1. NEW ACCIDENTS (NEWACCS)	Used by typists to enter New Accidents
2. FILE HANDLING (FILEHAND)	Used to ADD new accidents to Master File, and to INSPECT, PRINT, CHANGE or DELETE accident records
3. NEW FILE	Creates new (but empty) accident file
4. COPY FILE	Makes backup copies of Master File
B. PROGRAMS FOR ANALYSING ACCIDENTS	
5. SELECT	Lists code numbers of SELECTED accidents eg Km 306 on the Highlands Highway
6. STANDARD CROSS-TABULATIONS	For either ACCIDENT numbers or CASUALTY numbers eg DAY OF WEEK by TIME OF DAY
7. NON-STANDARD CROSS-TABULATIONS	For ACCIDENT numbers, CASUALTY numbers or VEHICLE numbers
8. GRAPHICS (i) (ii) (iii)	Histograms of accidents on a major city or inter-city route Accident map of a town or city Stick Diagram Analysis - a technique for identifying patterns in accidents

This may be thought of as the equivalent of bringing into the office a new, but empty, filing cabinet in which to store the new year's accident reports. The size of this file is determined by the storage capacity of the floppy discs used by the microcomputer. For example, in the case of the Apricot or ICL Quattro, the floppy disc capacity is such that about 2,500 accidents can be stored in one file; for the standard IBM-PC format, about 1,200 accidents can be stored on a floppy disc. If, say, about 5,500 accidents per year needed to be recorded, three files would be required for one year's data under the Apricot or ICL format. In this case, the hard disc version of the package would be recommended, which would enable these three files to be selected for analysis together.

The master versions of each file should have TWO floppy disc backup copies, a 'Father' and 'Grandfather' copy. These two discs are inserted in the floppy disc drive as part of the NEWFILE file creation process. This file structure is illustrated in Figure 2.

2.1.3 Adding 'New Accidents' to a master file

Section 2.1.1 described how a file of New Accidents is created. To add these accidents to a Master ('Son') file, the second program option (FILEHAND) is used. This enables the supervisor of the accident analysis system (or his deputy) to check and, if necessary, correct the work of the person who has entered the new accidents. Thus, each accident record is checked and then added to the Master file and deleted from the New Accident file. It should be appreciated that the file of New Accidents would normally contain of the order of 1-50 new accident records, whereas the Master file will accumulate up to 2,500 accident records.

The program FILEHAND also allows the user to find rapidly any particular accident record in the Master file (defined by Year, Police Region and Accident Serial Number). The user can then Print, Change or Delete that record.

2.1.4 Making Backup Copies of a Master File

The fourth program option (COPYFILE) is used to copy the Master ('Son') file to the backup 'Father' or 'Grandfather' floppy discs. The need to be meticulous in making backup copies of the master file on a regular basis cannot be overstressed.

Many man-weeks of time can be wasted if the master file is corrupted and no backup copy is available. It is suggested that the first backup ('Father') copy should be updated daily and the second backup ('Grandfather') weekly.

Dependent upon the version, the 'Son' file can either be on hard or floppy disc. However, the backups are always on floppy disc.

2.1.5 Identifying accident records satisfying particular conditions

The fifth program option, SELECT, is the first of the programs that allows the user to analyse the accident files. It enables the accident investigator to identify those records that meet some particular criterion. Examples might include:

- (i) A particular length of a selected road e.g. Kms 100-105 on the Highlands Highway
- (ii) A particular area in a city region e.g. Map 2; X-coordinates 25-30
Y-coordinates 5-10
- (iii) A particular time on a specified day on a selected road e.g. 1500-1530 hrs on 12/1/86 on Waigani Drive.

The user can choose to have printouts of either the code number only of each record found or the full details of each record. The first option, 'code number only', might be required if it were intended to go back to the original police accident reports, perhaps to look at the collision sketches. A third option now available is that the records can be stored on disc as a Working File. Working Files can be most useful and save considerable time when investigating a specific accident problem, by drawing together relevant data from a number of files.

2.1.6 Cross-tabulations

Cross-tabulations are one of the most important tools of accident analysis, particularly in establishing the general pattern of accidents. Three types are available: ACCIDENT, CASUALTY and VEHICLE. The difference between these types are perhaps best understood by a specific example. Suppose cross-tabulations of POLICE REGION by MONTH were of interest. The three different cross-tabulation types would give:

1. ACCIDENT CROSS-TABULATION - Counts of the number of accident in each month and police region
2. CASUALTY CROSS-TABULATION - Counts of the number of casualties in each month and police region
3. VEHICLE CROSS-TABULATION - Counts of the number of vehicles involved in accidents for each month and police region.

An example of an Accident Cross-tabulation is shown in Figure 3.

There are a very large number of possible cross-tabulations. For example, if there are 85 items in an Accident Report Form, for Casualty and Vehicle cross-tabulations there are 85 x 84 possible cross-tabulations. In practice, only a small subset of these is normally of interest. Therefore, both STANDARD and NON-STANDARD cross-tabulation programs are available. (Standard Vehicle cross-tabulations have yet to be defined but Non-standard Vehicle tabulations are available). If a particular cross-tabulation required is one of the Standard ones, then it is quicker and easier to select it through the 'menu' presented in the Standard version of the program rather than to have to specify the two axes in the Non-standard version.

If required, CONDITIONS can be applied to all of these cross-tabulations. Examples might be:-

- (i) Night-time only
- (ii) Fatal only
- (iii) Kms 256-262 on the Highlands Highway

2.1.7 Graphics

Until recently, there was little standardisation of the graphics systems available on microcomputers and printers. To enable the graphics programs of the TRRL Microcomputer Accident Analysis Package to run on different micros and printers, these programs were therefore written to produce 'pseudo-graphics', using ordinary character printing, rather than the true graphics facilities of the micros. (With the adoption of the internationally-agreed Graphics Kernal, this situation is now changing).

The three programs developed are:

- (i) ACCROUTE - a histogram of accidents along an urban or inter-urban route;
- (ii) ACCMAP - an accident map for a town or city;
- (iii) STICK - Stick diagram analysis of accidents, a technique for finding patterns in accidents, usually at black-spots.

ACCROUTE is designed to analyse accidents in two situations:

- (a) Where a major route through a city or town can be defined as a sequence of Nodes (major junctions - see Section 4);
- (b) Where locations along an inter-city highway are defined in the accident records by kilometrage.

For the second type, a summary histogram in 20 or 50 Km intervals is first generated, with each Fatal accident represented with the symbol * and each non-fatal accident represented with the symbol x. The investigator can then request a printout giving a histogram of accidents in 1 Km sections for the entire road. A section of such a printout is shown in Figure 4. Alternatively, the user can 'zoom in' on a particular section of road with any size of Km interval stipulated (e.g. 5 Km sections grouped together).

ACCMAP is primarily intended for analysing accidents in a town or city. The user is first asked which map is to be analysed and displayed, thus producing a summary map. Normally, this summary map provides accident counts over unit areas of 400 metres x 200 metres. The user can then 'zoom in' on a particular region of the map. The unit area at this level is 100 metres x 100 metres. Examples of each type are shown in Figures 5 and 6. A problem arises when accidents in a unit area, which covers one printable character, becomes larger than a single digit ie. 9. 10 accidents are therefore represented with the letter A, 11 by B, 12 by C and so on. More than 35 accidents are represented by the symbol *. A facility has been developed in ACCMAP whereby the worst locations on any particular map can be listed (see Figure 7), the length of the list being chosen by the user.

STICK is primarily intended for more detailed analysis of accidents at a high accident location (accident blackspot). This location can be defined by kilometrage, by map coordinates, or by specifying a node or link. Each accident is represented by the vertical listing (or "stick") of key information - each item occupying the same place in the stick. An example of a format (see Figure 8) is (from top to bottom):

- DD - Day of Week
- HH - Hour of Day
- Sev - Severity of accident
- Ped - Pedestrian accident
- NoV - Number of vehicles involved
- P-U - Pick-up involved
- Alc - Alcohol involvement suspected

- Head-on accident
- Rear-end accident
- Sid - Side collision
- Rol - Vehicle rolled-over
- Ob2 - Vehicle hit obstacle off the road
- P - Parked vehicled involved
- *N* - Nighttime accident
- Wet - Road surface was wet

Only one format is available to the user at present, although in the near future it is hoped that the user will be able to select which of a number of stick formats he wishes to use.

The value of Stick Diagram Analysis lies in arranging the sticks in groups; with skill, the accident investigator can find if there is any pattern to the accidents. By hand, this is a rather tedious process; it is very much simpler by computer. In Figure 8, all the sticks for nighttime accidents have been grouped together; then, within both daytime and nighttime accidents, the various collision types have been grouped together. Before the sticks were sorted in this way, the pattern of the accidents was much more difficult to comprehend. This technique has been found to be a valuable tool by accident investigators in the United Kingdom.

2.1.8 Hard Disc Menu of Files

The storage capacity of a hard disc unit is normally at least 15 times that of a floppy disc unit in the microcomputer. Consequently, a number of accident files can be stored on the hard disc at the same time. For all the analysis programs in the hard disc version of the package, the user is first asked whether the next accident file to be analysed is on the hard disc or on floppy disc. If on the hard disc, he is then offered a menu of the files stored on the hard disc, from which either a single file or group of files can be selected. The list of files is normally updated automatically as files are created or deleted from the hard disc. However, the user also has the option to amend this list of files himself.

2.2 Locating accidents

The accurate location of accidents is a most important aspect of the accident investigation process. In the TRRL system, a 'belt-and-braces' approach is normally adopted in which accident locations in towns are defined by both of two standard methods:

- (a) a version of the normal grid coordinate system; and
- (b) a NODE-LINK-CELL system, which gives reference numbers to:
 - (i) NODES - the main junctions, each node being given a unique code number;
 - (ii) LINKS - road sections between these main junctions. These are referenced by the code numbers for the nodes at each end of the road section; and
 - (iii) CELLS - areas of the town bounded by these Links, each cell being given a unique code number.

These reference numbers are entered as part of the accident record in the TRRL system.

With this system, special coded maps would eventually be required for each major town in a country. These have both the grid coordinates and the NODE-LINK-CELL system superimposed. An extract from such a map commissioned by the TRRL for Islamabad is shown in Figure 9.

For the major inter-city highways, accident locations are defined by kilometre distance from the beginning of the road. This almost inevitably requires Kilometre Posts to have been installed on the highways concerned. These already exist in a number of developing countries. Kilometre Posts are invaluable for both highway maintenance and accident recording on major highways, in addition to their obvious benefits to the motorist in helping locate turn-offs, buildings etc. The office investigating accidents may find it useful to develop a series of strip maps for the major highways of the country. In addition to locating towns and villages, these strip maps will locate bridges and other prominent features or buildings by kilometrage. Wall maps are also useful in showing accident locations in major towns; rather than using pins, it is recommended that accidents be located with small coloured spots of adhesive paper on an acetate overlay that can be stored and replaced at the end of a year.

2.3 Future Developments

Programs now under development include:

- (i) a program that will enable the user to select from a range of 'stick' formats and allow him to modify these;
- (ii) a program that will enable the supervisor of the system to modify the accident record format himself without TRRL assistance.

The use of true 'graphics' to represent accident patterns and accident maps will be the next major stage of development.

2.4 Hardware requirements

Versions 2.0 and later of the Package will run on most of the current generation of 16- or 16/32-bit microcomputers. The earlier 8-bit version (1.0) is no longer fully supported. Versions 2 will run under Concurrent CP/M-86 or MS-DOS; however a small incompatibility between MS-DOS and PC-DOS necessitates the Package on the IBM-PC and compatibles to be run under Concurrent DOS. Either twin floppy or hard disk versions are available; a hard disk system would normally be recommended where more than 5000 accidents per year are recorded. A printer is required and an Uninterruptible Power Supply (UPS) is strongly recommended. Where good local agents are not available for maintenance support, it is recommended that two identical microcomputers and a spare disc drive unit be purchased. Allowance for good stocks of printer paper and floppy disks should also be made. The hardware costs are therefore in the range of £3000-£7000 (UK prices), dependent upon the configuration required.

3. ANALYSIS OF ACCIDENTS AT NATIONAL, REGIONAL AND LOCAL LEVELS

3.1 Introduction

Road accident investigation can be carried out at three levels: National, Regional and Local. The techniques of analysis at a National and Regional level are, in practice, broadly similar, relying heavily upon the use of cross-tabulations. These will be discussed in this section. However, the strategies and techniques of analysis at a local level are very different, and these will be discussed separately in Section 4. The differences between the two types of analysis are perhaps best illustrated by the fact that at a National or Regional level, it is only practical to analyse those details of accidents stored on computer; but at the Local level, the policeman's accident sketch and the witnesses' statements are frequently examined in trying to identify factors associated with the accidents.

3.2 The objectives

The general objectives of analysis of accidents at a national or region level are:

- (i) To give a general overview of the accident situation;
- (ii) To identify groups within the population most at risk eg. children or motor-cycle riders;
- (iii) To identify physical circumstances with high levels of accidents eg. nighttime or junctions;

- (iv) To monitor trends with time of the various accident types, particularly with a view to identifying as soon as possible a developing accident problem eg. an increase in motor cycle accidents;
- (v) To monitor the effectiveness of any national or regional road safety measure eg. introduction of seat-belts;
- (vi) To make national and international comparisons.

Having statistical analyses of accident records available enables the country or region to determine its road safety strategy on a rational, scientific basis. They will provide the foundation from which the cost-effectiveness of its programme of measures can be maximised.

3.3 Techniques of analysis

The cross-tabulation, such as that shown in Figure 3, is the most common technique of accident analysis used at a National or Regional level. These can be visually illustrated with the use of graphs, histograms or pie-charts. Most developed countries publish sets of such tables annually.

The interpretation of these tables is not always straightforward due to the need in some way to take account of exposure. Thus, it might be found that most accidents occur on Friday afternoon; but then that may prove to be when most vehicles are on the road. The most dangerous time to be on the road in terms of vehicle-miles driven might prove to be late Saturday night. Both findings - the most frequent and the most dangerous - are of significance in planning a road safety programme. It remains debateable where the best value for money lies, in tackling high accident frequencies or high accident rates. In many circumstances, this debate becomes academic since accurate vehicle-mileage data are not available - but the problem of exposure still needs to be taken into consideration in deciding priorities.

4. LOCAL AUTHORITY ACCIDENT INVESTIGATION

4.1 The objectives

Common experience suggests, and accident investigation confirms, that road accidents are not randomly scattered over the road network, but tend to cluster at certain locations. As a consequence of this, local authorities in a number of countries have established so-called 'Accident Blackspot' teams to tackle these problem sites. The United Kingdom has probably been the leading country in this particular field of Road Safety activity, and the results over the past ten years have shown that the techniques

developed have been highly cost-effective. For example, the Greater London Council's Accident Blackspot Team after well over 1000 schemes has achieved an overall First Year Rate of Return of 350%, including all overheads (Ridley, 1979).

During the development of the techniques, the objectives of the Accident Blackspot teams in the UK have broadened to the extent that there are now four distinct strategies adopted:

- (i) BLACKSPOT PLANS: Measures to tackle accidents at specific sites;
- (ii) ROUTE ACTION PLANS: Comprehensive treatment of routes or roads with high accident densities;
- (iii) AREA ACTION PLANS: Comprehensive treatment of small areas of a town or city with high accident densities;
- (iv) MASS ACTION PLANS: Mass application of established counter-measures eg. application of high skid resisting surfaces.

In the UK, there has been a heavy emphasis on using low-cost counter-measures, so that major road works are only considered as an option as a last resort. The counter-measures frequently involve low-cost traffic engineering measures but when appropriate, Publicity, Education and Training at a local level are all options considered, the RIDE BRIGHT campaign for motor-cyclists in London being a successful example (Lalani and Holden, 1978).

4.2 The Accident Investigation Process at a Local level

This section is intended to be a brief outline of the various procedures involved. More detailed accounts are available, such as the Accident Investigation Manual issued by the UK's Department of the Environment (1974).

The overall process is summarised in Figure 10. In the schematic diagram, the process is divided into activities at the accident site and those in the Accident Investigation office. After an accident has occurred, a police report is filled-in and after a certain elapsed time, data from this report will be added to the computer accident database. As discussed in Section 2.2, being able to identify the accident's location from the computer record is a basic necessity of any accident investigation system operating at the Local Authority level. Ideally, it should be possible to identify the accident location to within 100m or better. Whilst this should be achievable in a town or city, it is more difficult on inter-city roads where distances are defined

using kilometre posts. In this case, locating accidents to within 1 Km may be a more achievable goal; in some circumstances, however, 1 Km can be a long distance in which to pinpoint a problem in the road during a site study. The 'Accident Location Sketch' (Figure 11) introduced in revised police report forms being tested in a number of developing countries will hopefully minimise this problem.

The Graphics option 'Accidents on a Route' (ACCRROUTE) and 'Accident Map' (ACCMAP) are the two programs in the Microcomputer Package used for identifying locations with high accident rates. (See Section 2.1.7).

As Figure 10 indicates, the worst of the accident sites are then selected for more detailed analysis in the accident investigation office:

- (i) Cross-tabulations can be produced (using program options 6 and 7 in the Microcomputer Package) with limitations defined to restrict the analyses to just those accidents occurring at an accident site under investigation. These can be useful at an accident site under investigation. These can be useful in establishing the overall nature of accidents at the site.
- (ii) A Stick Diagram Analysis, or similar Factor Analysis, can be carried out (using option 8 in the Microcomputer Package) to try and establish patterns in the accidents.
- (iii) The serial numbers of the accidents occurring at the site can be listed from the computer (using option 5 in the Package) and the original police reports then retrieved from the police files. It is then valuable to read the statements of those involved in the accidents and the statements of any witnesses. These sometimes reveal new factors that should be included in the earlier Stick Diagram or Factor Analysis eg. a high percentage of those involved may have been strangers to the area.
- (iv) Another valuable source of information in the police report is the policeman's collision sketch. For a junction site, it is often useful to plot the location of each accident on a plan of the junction in an Accident Plot (see Figure 12); more useful still is to represent diagrammatically the movements of all the vehicles in each accident in a Collision Diagram for the junction (see Figure 13).

The next phase of the procedure is to make a site study, armed with the analyses made at the office. A photographic record of the site can be most useful for future reference back at the office. The first task is to record the key physical characteristics of the site eg. road width, shoulder width, existence of street lighting etc. A checklist is available in the UK Accident Investigation Manual; such checklists

may not always be relevant to the types of site being investigated, in which case the development of a locally applicable checklist should be considered. It is frequently useful to make preliminary surveys of traffic and pedestrian flows. A short survey of traffic approach speeds on different arms of a junction can sometimes be revealing; one simple method to do this is to use one person with a stopwatch stationed 50m from the junction and a second stationed 150m from the junction flagging when a vehicle passes him. A study of Vehicle Conflicts eg. ranked on a scale of 1 to 5 as illustrated in Figure 14, can often reveal hidden problems at the site. Observations of drivers' head turning movements or observing that drivers have to stretch to see approaching vehicles can sometimes lead to identifying a visibility problem. Note any other problems of visibility, eg. shallow hillcrests or vegetation blocking the view of approaching vehicles. Talking to local residents can also be helpful, although opinions about causes should always be treated with a good deal of caution. If there is a clustering of accidents at a particular time of day or a particular period of the week, then the site study should be made at these times. Again, the UK Accident Investigation Manual offers extensive checklists of possible factors to look for.

Having identified the probable causes of the accidents, the possible counter-measures should then be listed and ranked according to cost. Normally, the lowest cost solution would be adopted unless there is good reason to believe that it would be unsuccessful.

In implementing the counter-measure, due consideration should be given to whether or not advanced warning to the public is necessary, either in pre-publicity or in advance of the site with signs such as 'Experimental Junction Layout Ahead' (white-on-red). The first days of operation of a scheme should be carefully watched in case an unexpected problem has been incorporated into the design.

After a suitable elapsed period of time, the long term benefits of the scheme should be evaluated with before-and-after studies. For details of this, manuals such as the UK's Accident Investigation Manual should be referred to. It is most important to use 'control data' in such an analysis, comparing the before-and-after accident levels at the test site, either with those at similar but unchanged sites in the locality or with some regional data. Comparing the before-and-after accidents at the test site with those at the control sites eliminates 'global' factors that may occur in the after period, such as a particularly good or bad period of weather period, a change in oil price affecting vehicle speeds or a change in traffic law. If this evaluation indicates that the scheme has been unsuccessful then further analyses and site studies may be necessary before an alternative scheme is tried. The Chi-squared statistical test with Yates' correction is the most common statistical test used in evaluating Before-and-After studies.

5. CONCLUSIONS

The most encouraging finding of this research to-date is that developing country staff with no previous experience of computers are entirely capable of running the Microcomputer Accident Analysis Package. This has already led to a far greater insight into the accident problems of the study areas in which the system has been tested.

One of the central purposes of the system is to evaluate the cost-effectiveness of counter-measures introduced as a result of these accident analyses and this is the main thrust of the current phase of the research programme. Progress in this has to some extent been hampered by the need for 'institution building': in getting adequate staff, funds and facilities allocated to the work and in forging close links between the Traffic Police, Highway Engineers and other departments concerned with road safety. This has been the most significant problem encountered.

Some minor hardware maintenance problems have occurred, but with the rapid influx of micros into virtually all developing countries, local maintenance expertise is growing and these problems should eventually become insignificant.

Data gathered using the Package will be discussed in detail in a future paper. The data so far collected have shown, as in developed countries, that accident locations are not randomly scattered but tend to cluster at 'hazardous locations', and that the nature of the accidents differs markedly from site to site. Rural accidents have been found to be considerably more severe than urban accidents, most probably due to the combination of higher speeds and problems of medical recovery. Analyses of the accidents at hazardous locations identified with the Package combined with site studies have suggested a wide range of problems, including speeding, close following, poor lane discipline, poor planning (especially direct frontal access from commercial buildings onto major highways and excessive use of crossroads), poor or non-existent junction design, the need for climbing lanes, steep side slopes resulting in rollovers, narrow shoulders and recovery zones, poor skid-resistance, poor delineation of curves, poor pedestrian behaviour, lack of footpaths, the special problems of animal-drawn vehicles, lack of facilities for local traders selling to passing traffic, lack of lay-bys for stopping or resting, lack of bus stop bays, faulty and misused vehicle lighting, poor tyre condition, etc. Correcting some of these problems is clearly a long term process, but some low-cost counter-measures have been implemented and are being evaluated.

The high severity of rural accidents combined with the clustering effect indicate that a high priority should be given to establishing a system of kilometre posts on major rural highways where these do not exist. The need for theft-proof road signs and kilometre posts has become apparent during the studies.

Local Authority Accident Investigation has been found to be highly cost-effective in the UK (see Section 4.1), partly as a result of the heavy emphasis put on low-cost counter-measures. The Overseas Unit of TRRL considers that this approach to Accident Investigation has considerable potential for Developing Countries and it believes that the Microcomputer Accident Analysis Package now makes the establishment of effective local Accident Investigation Units an achievable goal.

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ACKNOWLEDGEMENTS

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***** ACCIDENT RECORD *****

**** ISLAMABAD(1)/85/00205 ****

* 1 YEAR	85	* 20 AM/PM	2
* 2 CASE NUMBER	00205	* 21 ACCIDENT SEVERITY	F
* 3 POLICE DISTRICT	01	* 22 WEATHER	1
* 4 CITY	01	* 23 LIGHT CONDITIONS	1
* 5 POLICE STATION NO:	02	* 24 ROAD GEOMETRY	2
* 6 F.I.R. Number	0069	* 25 ONE- OR TWO-WAY	2
* 7 TOTAL NO OF VEHICLES	01	* 26 MEDIAN	Y
* 8 NO.VEHICLES DAMAGED	01	* 27 ROAD SURFACE TYPE	2
* 9 NO.DRIVERS/RIDERS KILLED	00	* 28 RIDING QUALITY	1
* 10 NO.DRIVERS/RIDERS INJD	00	* 29 ROAD WIDTH	10
* 11 NO.PASSENGERS KILLED	00	* 30 SHOULDER WIDTH	2
* 12 NO.PASSENGERS INJURED	01	* 31 SHOULDER TYPE	1
* 13 NO.PEDESTRIANS KILLED	01	* 32 SURFACE CONDITION	2
* 14 NO.PEDESTRIANS INJURED	00	* 33 JUNCTION TYPE	4
* 15 MONTH	02	* 34 JUNCTION CONTROL	2
* 16 DATE IN MONTH	23	* 35 HIT & RUN	1
* 17 DAY OF WEEK	4	* 36 COLLISION TYPE	5
* 18 HOUR	02	* 37 ROADWORKS	1
* 19 MINUTES	30		

**** VEHICLE 1 ****

* 38 VEHICLE MAKE	061	* 46 TYRE BURST	1
* 39 VEHICLE YEAR	78	* 47 VEHICLE LIGHTING	2
* 40 REGISTRATION TYPE	1	* 48 LENGTH SKID MARKS	05
* 41 VEHICLE TYPE	03	* 49 DRIVER SEX	M
* 42 VEHICLE MANOEUVRE	01	* 50 DRIVER/RIDER AGE	24
* 43 VEHICLE DAMAGE	1	* 51 DRIVER/RIDER INJURY	U
* 44 NOSE-TO-TAIL	1	* 52 LICENCE NUMBER	K3042
* 45 VEHICLE LOADING	1		

**** PASSENGER 1 ****

* 53 PASSENGER VEHICLE CODE	01	* 56 PASSENGER: INJURY	H
* 54 PASSENGER SEX(M/F)	F	* 57 POSITION IN VEHICLE	1
* 55 PASSENGER: AGE	05		

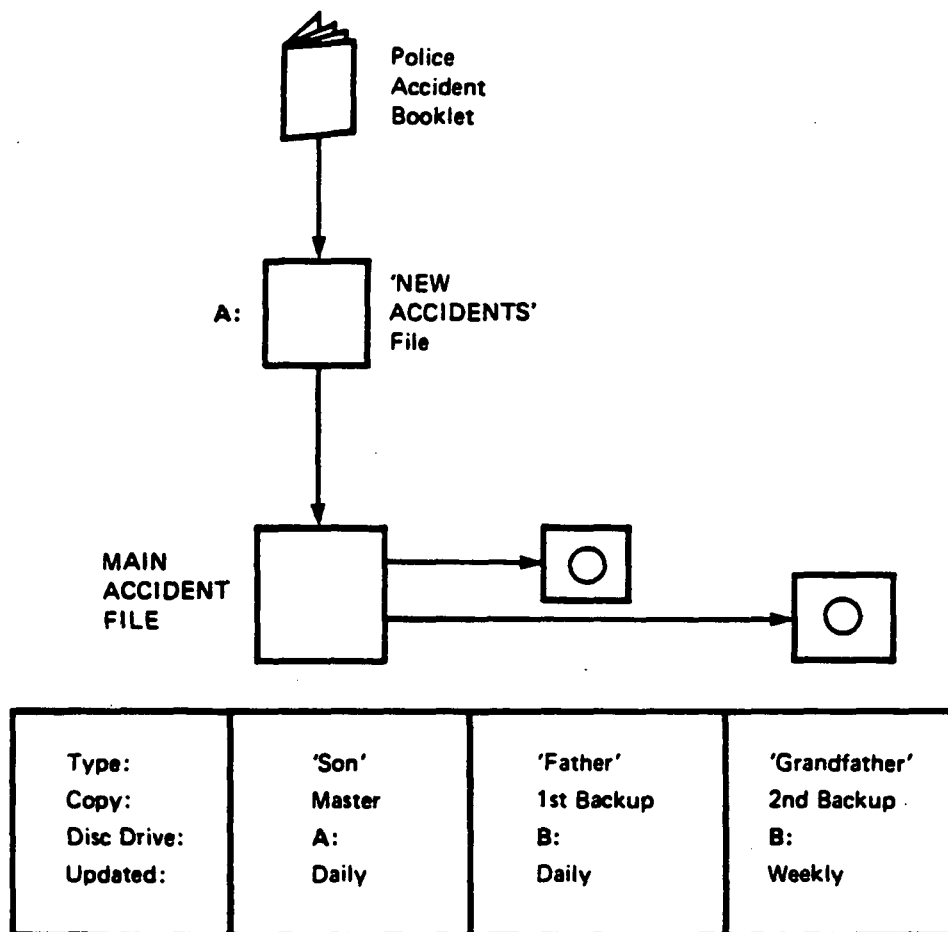
**** PEDESTRIAN 1 ****

* 58 PEDESTRIAN SEX	M	* 61 PEDESTRIAN MANOEUVRE	2
* 59 PEDESTRIAN AGE	67	* 62 PEDESTRIAN LOCATION	1
* 60 PEDESTRIAN INJURY	F	* 63 SCHOOL	1

**** ACCIDENT LOCATION ****

* 64 URBAN/RURAL	1
* 65 TOWN/VILLAGE CODE	0001
* 66 KILOMETRE POST	0000
* 67 100 METRES	00
* 68 MAP SERIES	01
* 69 MAP CODE	6
* 70 X CO-ORDINATE	220
* 71 Y CO-ORDINATE	065
* 72 MAJOR ROAD CODE	0
* 73 MINOR ROAD CODE	0
* 74 NODE 1	-207
* 75 NODE 2	000
* 76 SECTOR	F1
* 77 SUB-SECTOR	2
* 78 DIRECTION OF TRAVEL	N
* 79 CAUSE OF ACCIDENT	23

Fig.1 Example of an accident record printout from the Micro Accident Analysis Package. The record format varies considerably in the different countries in which the Package is being evaluated (Fictitious data)



File system used in the Accident Analysis Package
 The main accident file can be given any name up to 8 characters long (beginning with an alphabetic character; the full stop character is not permitted)
 Disc drives are for the Apricot hard disc microcomputer

Figure 2

STANDARD ACCIDENT TABLE 8
 =====

TYPE A: ALL ACCIDENTS
 =====

ACCIDENT RECORD FILES:

CONDITIONS SET:

NONE

HOUR	DAY OF WEEK							*Total *
	* Sun *	* Mon *	* Tue *	* Wed *	* Thu *	* Fri *	* Sat *	
00/01	43	52	54	59	52	63	66	* 389*
02/03	40	10	8	4	14	21	60	* 157*
04/05	25	4	9	9	9	20	58	* 134*
06/07	30	45	61	39	54	56	89	* 374*
08/09	45	70	76	90	70	83	118	* 552*
10/11	28	50	48	38	44	58	49	* 315*
12/13	26	42	42	41	51	64	43	* 309*
14/15	56	111	96	113	112	161	113	* 762*
16/17	73	99	120	107	120	169	128	* 816*
18/19	53	45	52	53	56	102	168	* 529*
20/21	33	33	24	34	43	94	99	* 360*
22/23	25	31	33	40	67	86	81	* 363*
Total	477	592	623	627	692	977	1072	* 5060*

(Total Number of Accidents on File = 5422)

Fig.3 Example of a Standard Accident Cross-tabulation

ACCIDENTS ON A ROUTE
******* ** * *******

ACCIDENT FILE:

CONDITIONS SET: LOCATION CODE 1 = HHY

KILOMETRES	ACCIDENTS	
280	0	
281	0	
282	0	
283	0	
284	1	x
285	0	
286	0	
287	0	
288	0	
289	2	xx
290	0	
291	0	
292	0	
293	0	
294	0	
295	5	xxxxx
296	0	
297	0	
298	0	
299	2	xx
300	0	
301	1	x
302	0	
303	0	
304	0	
305	0	
306	14	xxxxxxxxxxxxxxxx
307	0	
308	0	
309	0	
310	0	
311	1	x
312	0	
313	13	xxxxxxxxxxxxxxxx
314	0	
315	0	
316	4	xxxx
317	0	
318	0	
319	0	
320	0	

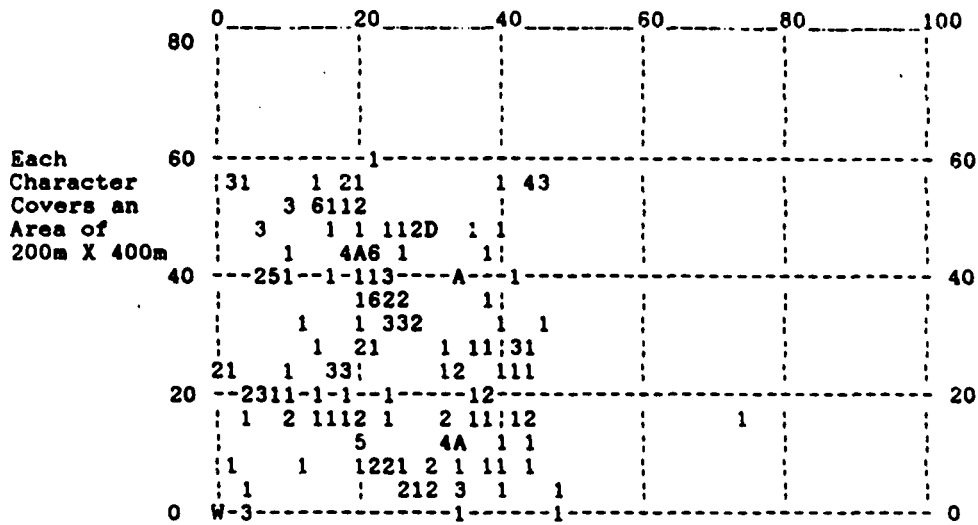
Total= 43

* Fatal x Injury or Damage

Fig.4 Example of Section of a 1 Km interval histogram for a major inter-urban highway, generated by the program ACCROUTE

ACCIDENT MAP
***** **

ACCIDENT FILE:
MAP SERIES 12
MAP CODE 013
CONDITIONS SET: NONE



```

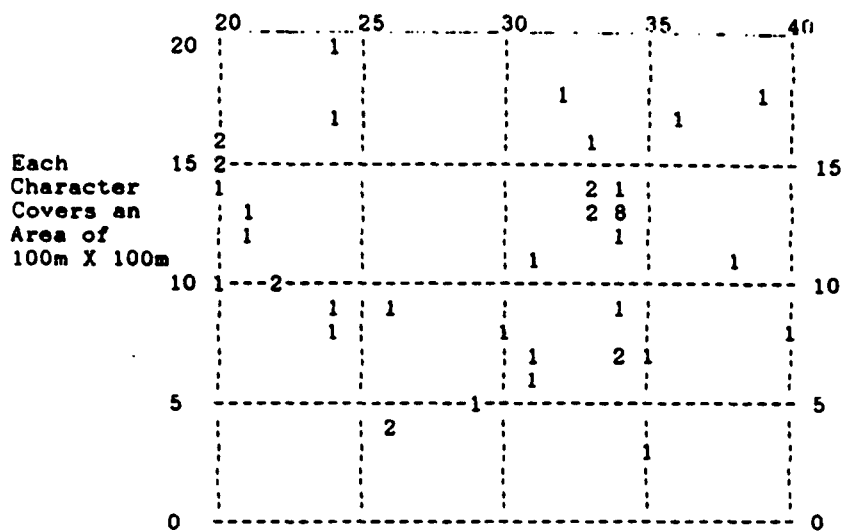
=====
Characters used to Code Accident Numbers :-
1=1 2=2 3=3 4=4 5=5 6=6 7=7 8=8 9=9 A=10 B=11 C=12 D=13
E=14 F=15 G=16 H=17 I=18 J=19 K=20 L=21 M=22 N=23 O=24 P=25 Q=26
R=27 S=28 T=29 U=30 V=31 W=32 X=33 Y=34 Z=35 >35=*
=====

```

Fig.5 Example of an Accident Map generated by the program ACCMAP (see text)

ACCIDENT MAP
***** **

ACCIDENT FILE:
MAP SERIES 12
MAP CODE 013
CONDITIONS SET: NONE



```

=====
Characters used to Code Accident Numbers :-
1=1 2=2 3=3 4=4 5=5 6=6 7=7 8=8 9=9 A=10 B=11 C=12 D=13
E=14 F=15 G=16 H=17 I=18 J=19 K=20 L=21 M=22 N=23 O=24 P=25 Q=26
R=27 S=28 T=29 U=30 V=31 W=32 X=33 Y=34 Z=35 >35=*
=====

```

Fig.6 An enlarged section of the map in Figure 5, generated by the program ACCMAP

LISTING WORST ACCIDENT SITES

ACCIDENT FILE:
 MAP SERIES 12
 MAP CODE 013
 CONDITIONS SET: NONE

1	.....	X= 31	Y= 49	12	Accidents
2	.....	X= 34	Y= 13	8	Accidents
3	.....	X= 35	Y= 41	8	Accidents
4	.....	X= 20	Y= 44	8	Accidents
5	.....	X= 14	Y= 55	6	Accidents
6	.....	X= 23	Y= 38	5	Accidents
7	.....	X= 23	Y= 45	5	Accidents
8	.....	X= 9	Y= 40	4	Accidents
9	.....	X= 18	Y= 26	3	Accidents
10	.....	X= 27	Y= 33	3	Accidents
11	.....	X= 25	Y= 34	3	Accidents
12	.....	X= 19	Y= 44	3	Accidents
13	.....	X= 10	Y= 53	3	Accidents
14	.....	X= 2	Y= 58	3	Accidents
15	.....	X= 45	Y= 59	3	Accidents
16	.....	X= 4	Y= 2	2	Accidents
17	.....	X= 26	Y= 4	2	Accidents
18	.....	X= 34	Y= 7	2	Accidents
19	.....	X= 22	Y= 10	2	Accidents
20	.....	X= 33	Y= 13	2	Accidents
21	.....	X= 33	Y= 14	2	Accidents
22	.....	X= 20	Y= 15	2	Accidents
23	.....	X= 20	Y= 16	2	Accidents
24	.....	X= 10	Y= 18	2	Accidents
25	.....	X= 6	Y= 22	2	Accidents

Fig.7 A listing of the worst 25 accidents sites for the map in Figure 5 for 100m x 100m areas

STICK DIAGRAM ANALYSIS

ACCIDENT FILE:
 CONDITIONS SET: NODE 1 = 237
 NODE 2 = 0

```

=====
STICK:1 | 8 | 11 | 5 | 10 | 7 | 3 | 4 | 2 | 6 | 9 | 13 | 12 | 0 | 0 | 0 | 0 | 0 |
=====
MM | 01 | 02 | 02 | 02 | 02 | 02 | 02 | 01 | 02 | 02 | 03 | 03 |   |   |   |   |   |
DD | 1 | 2 | 6 | 1 | 3 | 6 | 2 | 5 | 4 | 3 | 2 | 6 | 2 |   |   |   |   |   |
HH | 05 | 06 | 06 | 07 | 10 | 11 | 13 | 13 | 14 | 15 | 15 | 16 | 17 |   |   |   |   |   |
SEV | D | N | N | D | D | D | H | D | N | D | D | D | D |   |   |   |   |   |
PED |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
=====
<-\ |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
/-> |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
U |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
O/T |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
>> |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
=====
+ | + | + | + | + | + | + | + | + | + | + | + | + |   |   |   |   |   |
*N* |   | *N* |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
DIR | 4 | 4 | 4 | 3 | 4 | 3 | 1 | 3 | 1 | 4 | 2 | 4 | 1 |   |   |   |   |   |
=====
MM =Month    DD =Day    HH =Hour    SEV=Severity    PED=Pedestrian
<-\ =Left turn    /-> =Right turn    U =U-turn    O/T=Overtake
>> =Nose-to-Tail    + =Junction    *N*=Night    DIR=Direction of travel
ACCIDENT SEVERITY:    F =Fatal    H =Hospital    N =Not-H    D =Damage
=====
Stick Number = Accident Code Number:-
1 =00023    2 =00076    3 =00118    4 =00167    5 =00196    6 =00224    7 =00259    8 =00303
9 =00311    10=00323    11=00427    12=00507    13=00542
=====
    
```

Fig.8 Example of a Stick Diagram Analysis generated by the program STICK. Each 'stick' contains some key details of information about an accident. The accidents have been sorted by HH (Hour of day). It can be seen that the left-turn accidents all occur between 13.00 and 16.00 hours at this junction

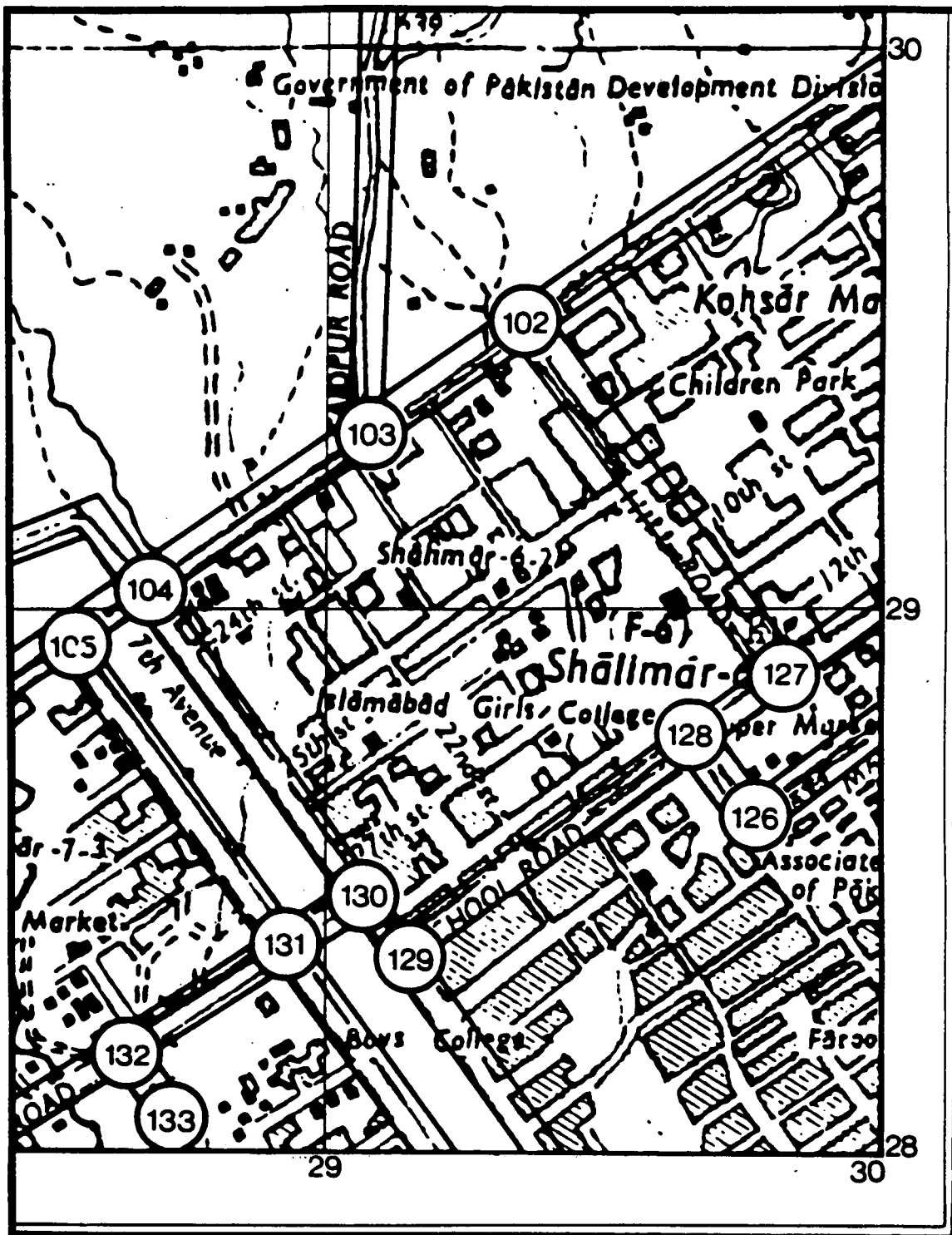
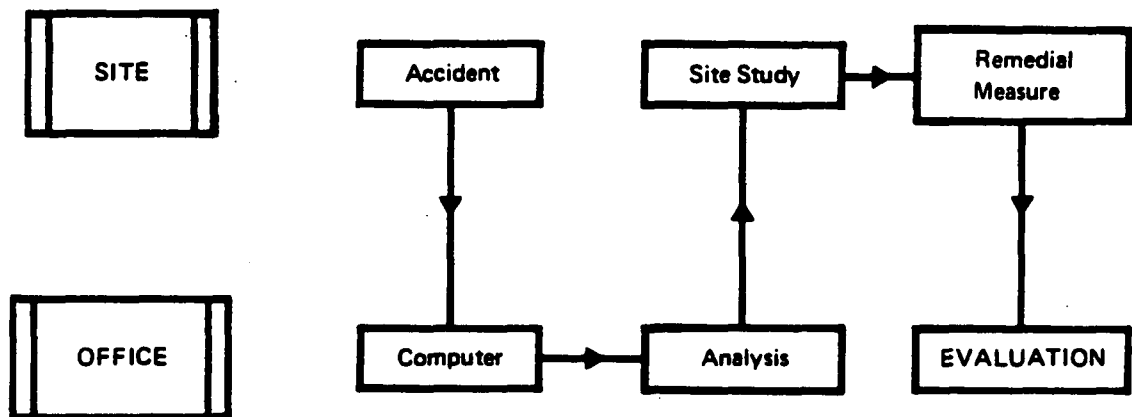


Fig.9 Extract from coded map commissioned for Islamabad by TRRL Overseas Unit
Both the grid coordinate and Node-Link-Cell systems are used



1. Identify accident locations to within 100m
2. Identify locations with high accident rates
3. Select the worst for detailed analysis
4. Make site study
5. Identify probable causes
6. Identify possible counter-measures
7. Implement lowest-cost counter-measure
8. EVALUATE with before-and-after studies

Fig.10 The process of accident blackspot investigation

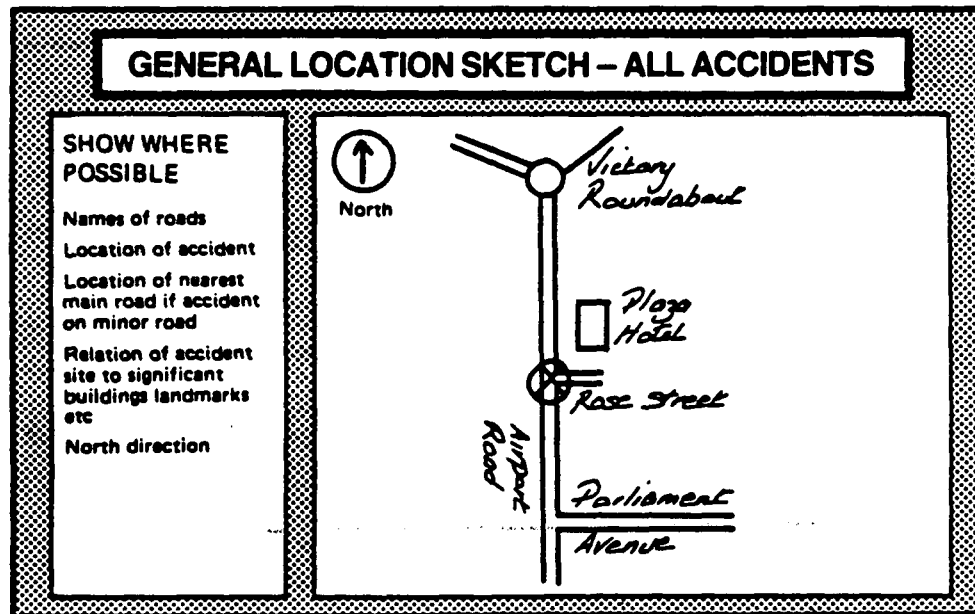
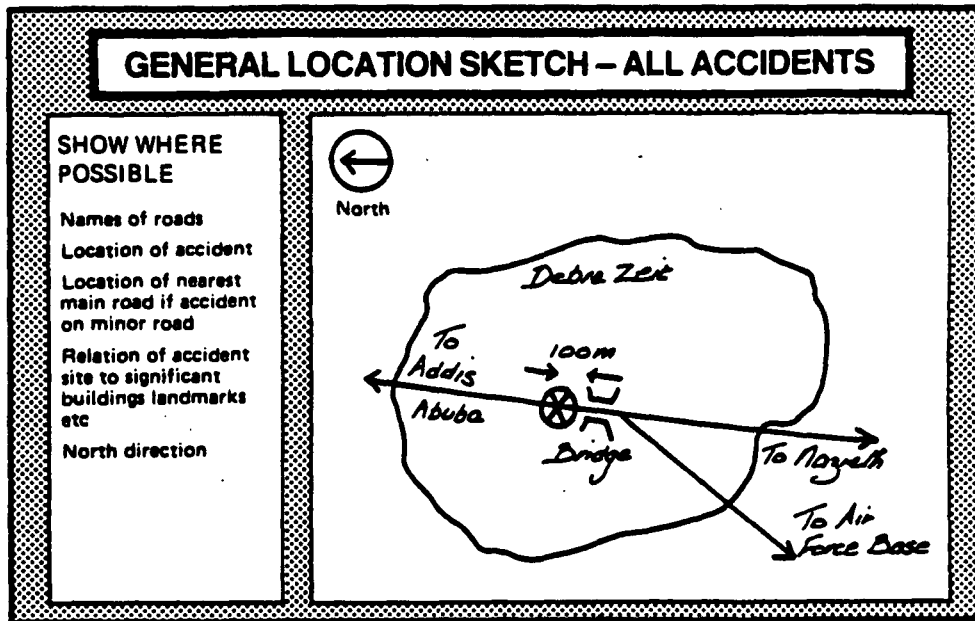


Fig.11 Examples of 'Accident Location Sketches' used for training purposes

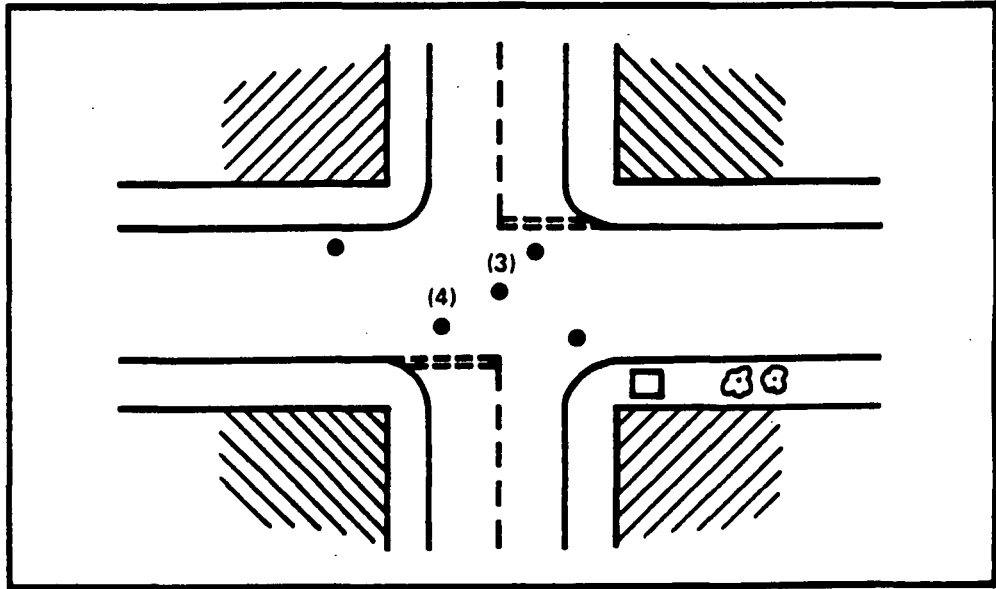


Fig.12 Example of an Accident Plot (from DoE, 1974)

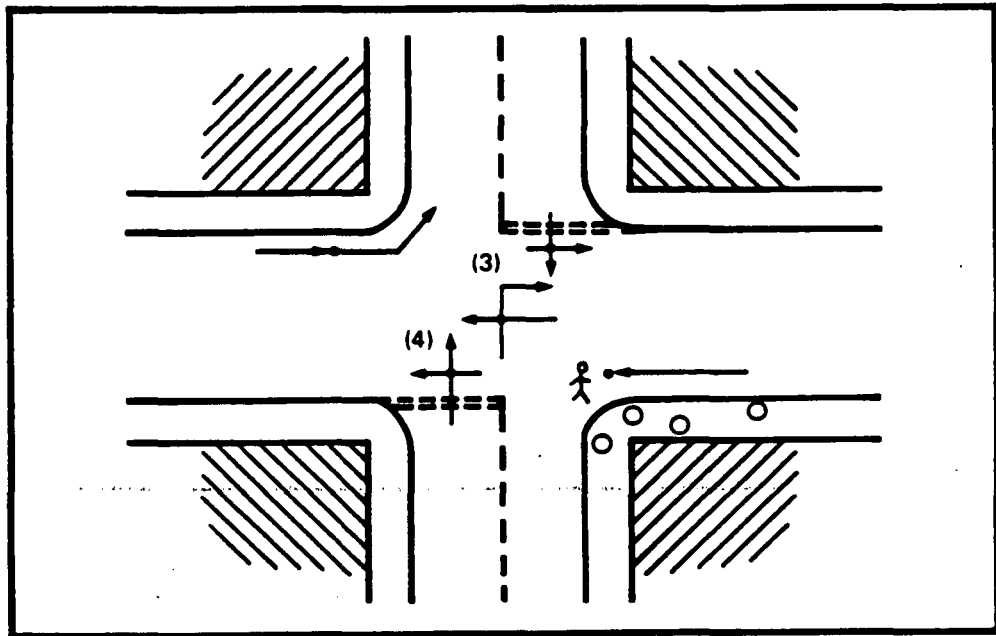


Fig.13 Example of a Collision Diagram (from DoE, 1974)

CONFLICT REPORT SHEET

DATE:—

Diagram of occurrence		Conflict severity	
	1	Precautionary conflict (i.e. braking for vehicle waiting to emerge, precautionary lane change, or anticipatory braking)	
	2	Controlled braking or lane change to avoid collision but with ample time for the manoeuvre	
	3	Rapid deceleration, lane change or stopping to avoid collision, resulting in a near miss situation. No time for steady controlled manoeuvre	
	4	Emergency braking or violent swerve to avoid collision resulting in very near miss situation, or occurrence of a minor collision	
	5	Emergency action, followed by collision	
Time	Note on diagram direction, colour, vehicle type and evasive action taken		

Example of conflict report sheet for one section of junction

Fig.14 Conflict study rating scale adopted by the TRRL
(from Spicer, 1972)