Implementing and integrating crime mapping into a police intelligence environment

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ABSTRACT

Recent publications have highlighted the benefits to policing of an integrated intelligence environment, and the current move in both British policing and beyond is towards a level of information gathering and analysis that is focused at the local area command level. Local intelligence gathering is seen as both effective and economical, though much of the literature concerning the integration of local intelligence concentrates on the use of surveillance, informant handling and the development of intelligence databases. These documents concentrate on the gaining of information about criminal activity that is not known to the police and little is said about maximising the analysis of information already in the possession of the police. Digitalisation of both recorded crime records and calls for service provides a wealth of information about local crime activity that is readily retrievable from modern computer systems. The possibilities and potential benefits of mapping and analysing these types of data have been known for some time, though technical and other difficulties have often hindered the implementation of crime mapping systems. This paper acts as an introduction to crime mapping, presents a model of the required inputs and potential outputs of two types of crime mapping systems, and sets a framework for the integration and control of crime mapping in an intelligence environment. The result of a survey of every police force in the UK indicates that although some successes exist, many forces still have technical and human implementation hurdles to overcome.

INTRODUCTION

The integration of intelligence resource handling into a unifying structure has been regarded in a number of publications as one of the best methods of maximising the generation of crime intelligence at minimum cost (HMIC, 1997), and the Audit Commission in the UK has been one of the main advocates of this type of intelligence gathering (Audit Commission, 1993). This integration has coincided with a move towards the analysis

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and coordination of information handling at the level of the local area (or divisional) command (Amey *et al.*, 1996). The local intelligence officer has now become the linchpin of an information-gathering effort that seeks to integrate information about known crime and incidents, data from surveillance and intelligence from informants. This model of an intelligence-led local force has been adopted by a number of British police forces and is being considered by forces in other countries (Amey *et al.*, 1996; Barton and Evans, 1999; Seddon and Napper, 1999). A range of analytical techniques is available to a local intelligence officer (Read and Oldfield, 1995) though the use of mapping has not until now been widely available. Much of the literature surrounding the area of integrated intelligence concentrates on the organisation of surveillance, informant handling and the use of intelligence databases to maximise the circulation of intelligence data (Audit Commission, 1993; Meehan, 1993; Cooper and Murphy, 1997), though little has been said about the integration of data from sources of known criminal activity.

For a number of years police forces in the UK and beyond have been recording details of crimes reported to the police on computers and this repository of data has been complemented more recently by the introduction of command and control systems that catalogue incidents (known outside the UK as calls for service). The use of calls for service and recorded crime data for analytical purposes has been enhanced by the introduction of geographical information systems (GIS) to enable the mapping and geographical analysis of these data sources. In the past the use of mapping in crime analysis has been viewed as a considerable effort with little worthwhile return (Ekblom, 1988), though recently improvements in computer processing and data storage have increased data-handling capabilities, and the Police Research Group have been active in the promotion of crime mapping (Read, 1999). The ability to map and analyse crime in a spatial context is now a reality, though early attempts to introduce a GIS into a northern police force in England were unsuccessful (Openshaw *et al.*, 1990). Reasons for failure included organisational resistance to change, unrealistic expectations of the system, and technical difficulties. As will be shown in this paper, some of these problems still exist.

This paper aims to examine the technical issues in the transference of information on crime locations to a mappable format and then will examine an input/output model for two applications of crime mapping within the police service. The realisation issues are discussed with relation to the broader field of literature concerning implementation of a GIS, and the results of a UK nationwide survey indicate that although there have been some recent successes it will be some time before crime mapping systems are prevalent within the UK.

TECHNICAL ISSUES

There are two technical issues that should be considered at this point, as they can determine 'ownership' of a crime mapping system. A map of crime distribution requires a substantial quantity of crime data to be effective and the data tend to be retrieved from a police crime recording system in some fashion. The data will often require processing before becoming acceptable to a GIS or other information system, and texts exist that can act as a salutary warning not to underestimate this task (Anderson *et al.*, 1995). Similar problems exist in other areas of research such as the implementation of information technology (IT) into public health systems (Tim, 1995), though these obstacles are not insurmountable.

As data-processing capabilities have improved so have the mapping possibilities, and the range of crime-orientated analytical procedures and techniques has grown. Crime mapping relies on the accurate geocoding of incident locations that are then mapped within a GIS. Geocoding — the process of applying a geographical reference to an address or crime location — can often be difficult as police databases are rarely constructed with this process in mind. The pre-processing of police data prior to mapping often constitutes the most difficult and time-consuming stage in the mapping process. A number of forces choose, or are forced by technological limitations into, a post-recording geocode process that attempts to match a crime location (usually an address) from one or a number of fields in the crime record against a database of known locations. If a definite match is found then the corresponding geographical coordinates are attached to the crime record. In this manner crime records are mapped. Often the crime recording system can allow the same address to be entered in a number of different ways. The rate of success varies depending on the urban/rural nature of the force area and the rigidity of the address recording format, though success rates between 55 per cent and 85 per cent are common. Some forces such as Nottinghamshire Police (UK) can geocode every location at the point of data entry, though with varying degrees of accuracy (Ratcliffe and McCullagh, 1998). This process requires the crime recording system to be tied into a local gazetteer that 'knows' every location within the force area. Any attempt to enter an unknown location is rejected by the system. The gazetteer approach is generally more accurate and can achieve a notional 100 per cent accuracy, though costs are higher as the gazetteers require constant management and updating.

The ability to retrieve data from the crime recording system followed by accurate geocoding of incident locations is essential to the functionality of crime mapping. This emphasis on the technical aspect of the process can result in mapping systems being directed and marshalled by IT departments although, as will be discussed later in this paper, this is not necessarily an ideal situation.

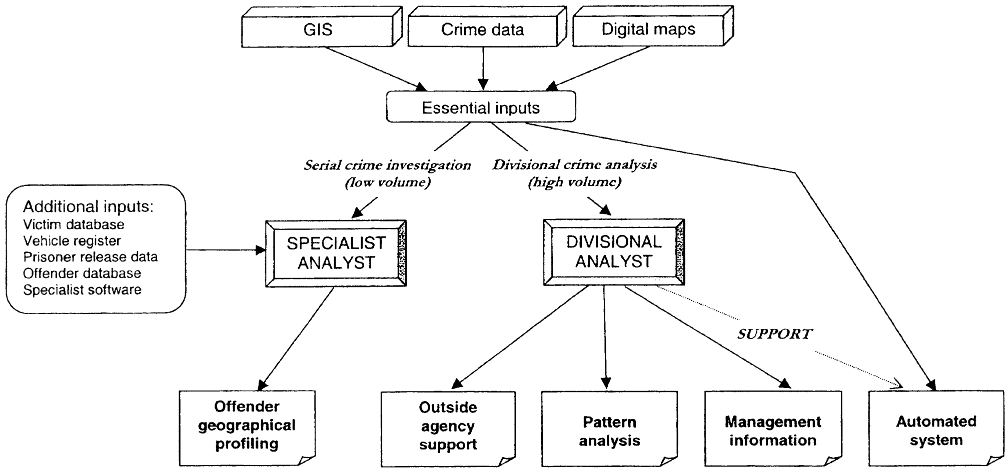
CRIME MAPPING MODEL

Once crime locations are geocoded and mapped within a GIS, there can be many possible applications and benefits of a crime mapping system to a police force, including tactical analysis, strategic planning and intelligence dissemination. Most of these applications require similar inputs and it is possible to construct a generalised crime mapping model that describes two of the most popular analytical paths: the geographical profiling of serial repeat offenders, and the mapping of high-volume crime. Figure 1 shows a theoretical model of the impact that spatial crime analysis can have in a police environment. The model shows that there are three essential inputs to any spatial crime analysis system: a GIS, crime data and digital maps. From this basis it is possible to follow one of two main paths: serial crime investigation (shown through the *specialist analyst* in Figure 1); and high-volume crime analysis (shown through the *divisional analyst* in Figure 1). The following section discusses the model in more depth.

Serial crime investigation (low volume)

Serial crime investigation (more commonly known as criminal profiling) can

Figure 1 High- and low-volume crime mapping model



be enhanced by attempting to determine the most likely area of residence of a serial criminal, based on the spatial pattern of their offences. Serial murderers and people who commit sexual offences against adults and children are rare in any society. The commission of this type of crime, however, generates an understandably high degree of public concern and subsequently considerable effort on the part of the police to catch the people responsible. Geographical offender profiling is one of many facilities available to the detective in charge of such a case, facilities that also include DNA matching, fingerprint evidence and surveillance of suspects. There are a number of texts that can serve as an introduction to this type of criminal profiling (Kocsis, 1997). An investigator aims to construct a criminal geographic targeting model or similar theory on the basis that offenders (like most people) have areas that they inhabit regularly through their routine activity (the home, work, recreation), areas in which they feel comfortable. The model assumes that offenders, while not operating too close to their home address, will commit most of their crime in this 'comfortable' area (Rossmo, 1995).

As the model in Figure 1 shows, it is probable that such an analysis would be performed by a specialist analyst for a number of reasons: the data relating to the offences are likely to be highly sensitive, there is (hopefully) not a frequent requirement for this type of analysis, and because there are additional benefits that can be accrued by integrating other data sources — sources that are usually from remote and often ill-fitting databases. Ingegration of diverse data sets is likely to require a greater degree of technical ability. Examples of possible additional inputs are shown in Figure 1 and can include previous victim databases, vehicle registration details, prisoner release data (for release addresses of known offenders) and the application of various spatial algorithms designed for this type of analysis. Specialist software packages to perform these analytical functions are available commercially, though often at high cost. It is also possible in some countries to buy in this type of assistance from consultants in the academic community. Although there is a clear requirement for the geographical profiling of offenders, the number of actual offences of this nature is low, and in most jurisdictions low enough not to warrant the training of a large number of analysts in this type of work. The model presented here therefore suggests that this type of analysis could be performed by a specialised analyst, possibly based at the force headquarters.

Divisional crime analysis (high volume)

The workload of a crime analyst at the local area command level can be driven by different demands. The model shown aims to identify some of the most common outputs from a crime mapping analyst, though it should be realised that this is not an exhaustive list but serves as an example of possible benefits of this type of spatial analysis.

Management information can aid senior and middle-ranking managers when allocating officers to divisions and subdivisional stations, and when deciding which areas will be the recipients of extra financial allocation for crime fighting. Often this type of mapping is restricted by the fixed boundaries that geographically orientated police forces work within: for example beats, neighbourhood watch areas, divisions and local authority areas. One of the great advantages of a GIS is the ability to perform crime analysis without any boundary constraints, and more enlightened police commanders are now realising that crime tends not to be confined by administrative regions.

Pattern analysis is often the main function of a crime analyst, involving the search for distinctive crime distributions. Hotspot analysis and the identification of repeat victimisation both come under this banner. The information gleaned can be disseminated within the force to improve operational strategy. The level of output is usually driven by a combination of the user (crime analyst), the client (individual making the mapping request), and the limitations of the GIS and the available data. Requirements of a supervising officer wishing to view a hotspot map of motor vehicle crimes for the previous month so that they can allocate manpower more effectively will differ from the needs of a crime prevention officer who wants to know if end-of-terrace houses are more prone to repeat victimisation. The needs of a community officer who would like to know if crime on a neighbourhood watch is decreasing will be different again. The list of possible areas of investigation is endless and the numerous successes of crime mapping systems (LaVigne and Wartell, 1998) often depend on the ability, knowledge of specialist techniques, imagination and enthusiasm of the crime analyst.

Outside agency support is a growing area emphasised in the UK by the recent Crime and Disorder Bill 1998 which requires the British police services to cooperate more closely with outside agencies such as local councils and health authorities in order that a coordinated effort can be made to combat crime (Home Office, 1998). This support can include liaison with neighbourhood watch coordinators and crime prevention agencies, and improving public understanding of crime patterns through the use of newspapers or Internet Web pages (for a UK example, see Brent Crime Mapping Project, 1998). This type of interagency cooperation is also growing in the USA, and crime mapping is an ideal medium for the sharing of information (Taxman and McEwen, 1998). Crime map Internet pages exist in the USA at a number of sites including Tempe, Arizona (http://www.tempe.gov/police) and New Orleans (http://www.acadiacom.net/nopd).

Interactive maps can be found at http://bcn.boulder.co.us/boulder/police.

An *automated system* is shown in the model in Figure 1 as a support function for a crime analyst, and is a possible direct output of a spatial crime analysis model from the essential inputs. With the ability to customise a modern GIS through programming languages such as Avenue (for ArcView) and MapBasic (for MapInfo) it is possible to create a robust and user-friendly interface to a crime system which would allow police officers with no GIS experience to pursue their own lines of enquiry. Simple dialogues and managed output options can allow officers to query the crime database and create their own maps of crime distribution. The support role of the crime analyst might be necessary to monitor usage and to give basic instruction. With skilful and sensible programming a robust 'officer-proof' system could be created. This has the advantage of providing a mapping system that is available to all officers 24 hours a day.

INTEGRATING CRIME MAPPING INTO AN INTELLIGENCE ENVIRONMENT

Crime problems that mapping has been applied to include: drug incidents (Olligschlaeger, 1998), crime and deprivation (Bowers and Hirschfield, 1999; Ratcliffe and McCullagh, 1999), gang violence (Kennedy *et al.*, 1998), serial rapist investigations (Hubbs, 1998) and burglary repeat victimisation (Johnson *et al.*, 1997). A number of innovations in this field are being coordinated by the Crime Mapping Research Center based in Washington DC. Their website provides an interesting guide to the benefits of crime mapping and is illustrated with maps from the USA and the UK (http://www.ojp.usdoj.gov/cmrc). Many of these applications use crime mapping as the sole intelligence asset, however in a truly integrated intelligence environment it should be possible to envisage areas where successful crime mapping can complement other intelligence resources. For example, surveillance of motor vehicle thieves can be enhanced by a greater understanding of the pattern of autocrime in the surrounding area. Similarly unspecific information on burglaries from informants can be cross-checked against a map of local burglaries to corroborate the informant's story, or a detective can interview a suspect armed with information about similar crimes in the local area that could be the work of the detainee.

Although there are policing benefits to the introduction and integration of a crime mapping system within the overall local crime reduction strategy of a police force, it does create implementation and control issues. As said earlier in this paper, due to the technical difficulties associated with the geocoding of crime locations, a number of IT departments are tasked with the introduction and running of crime mapping systems. This can lead to both a preoccupation with the geocoding issue and a focus on data security concerns. The separation of the operational arm of the service from the support structure introducing a GIS can remove the impetus and a number of UK police forces are still waiting for any form of crime mapping system. To examine the extent of this problem a telephone survey of every police service in the UK was conducted during April and May 1999.

Each UK force was contacted, first through the Force Intelligence Bureau (FIB) at the Force Headquarters and then contact was made with the IT department if necessary. A short semi-structured interview took place with FIB personnel to ascertain if crime mapping systems were available to individuals or analysts at a divisional (or area, depending on the force) level. If such systems existed, they were then asked what type of system was used, how the crime locations were geocoded and which department maintained overall control of the system. At a number of forces where crime mapping systems were running particularly successfully, follow-up interviews were conducted with key individuals. It must be stressed that the purpose of this survey was to ascertain only the situation regarding crime mapping at a divisional level. Some forces were evaluating or using a number of GIS products for different tasks, including contingency planning, offender profiling, and incident handling but this survey restricted itself to crime mapping systems that were operational at the time of the survey at a divisional level. The author recognises that a number of forces are in the process of implementing systems that may become operational during 1999.

The survey found that of the 52 geographical police forces in the UK, 29 (56 per cent) have no crime mapping facility at the (divisional) local area command level. A number of these forces said that they were evaluating a number of systems, including the PAFEC GIS from SER Systems, although they had not made any definite purchasing decisions. In many of these counties, the IT department was tasked with the testing, purchase and implementation. Of the remaining forces that had a crime mapping capability, the majority used MapInfo as the corporate GIS package (14 forces — 27 per cent of the total number of forces), a smaller number used Zeda Prophecy, and the remainder employed either in-house systems or other products. Most of these systems have only become operational within the two years prior to April 1999.

In the majority of successful crime mapping cases, the system was under the control of the crime analysts who were responsible in turn to the Crime/Operations department (terminology differs from force to force and a generalisation is made here for clarity). IT were often responsible for maintenance of the hardware and software in a support role, though the driving force in system operation came from the users in the Crime/Operations department who pushed through product improvements and innovation. In a number of forces that were contacted, analysts recognised the benefits of crime mapping systems but were hampered by the involvement of IT departments. Even in successful cases there was often a degree of frustration on the part of the users. An example of this is evident from the quote of one officer in a northern force:

> 'Our IT Branch do not really understand the user requirement in relation to crime mapping and it shows. Because of this any innovation or development of the system has to be led by the users even down to upgrades of the latest version of software.'

The experiences of the police service are corroborated by the body of literature that examines the implementation of a GIS in fields such as hydrological resources (Clark, 1996; 1998) and urban planning (Nedovic-Budic and Godschalk, 1996; Campbell and Masser, 1992; Robey and Sahay, 1996; Ventura, 1995). The latter case is especially interesting as parallels can be drawn between planning departments and the police service. Both are large government-run organisations where potential users tend to have little or no prior GIS experience. Heather Campbell, in a study of local authorities in the UK, identified four factors that appeared to improve the chances of success: the use of simple applications that generate outputs that are useful to the user, user involvement in the implementation, an awareness of the limits of available resources and the organisational ability to accept change (Campbell, 1994). Similar research tends to agree that the best method of introducing new technology of this nature is to avoid centralised control of implementation and move to a user-centred approach that is driven by user ability and requirements (Robey and Sahey, 1996; Ventura, 1995; Heywood *et al.*, 1998).

Many of these factors will be familiar to police practitioners who have attempted to bring about change and innovation to the service in the past. The non-police GIS implementation issues are particularly applicable in a law enforcement scenario where few crime mapping systems have been operational in the UK (and beyond) for more than two years. With few systems operating in other forces, senior management who are resistant to change or unconvinced of the benefits of a GIS can look for support to a lack of innovation elsewhere. The technical issues that were mentioned earlier can often be used as an argument for centralised implementation and development, but the benefits of centralised implementation are disputed by the survey in this paper and the corroborative research detailed above. In a number of UK forces, users have found a workable solution to the problem of acquiring crime data from the crime recording system that is not the ideal automated online system advocated by many IT departments, but that works. Although a daily download of the crime recording system is not a perfect solution to all parties, in many police services it is functioning as an excellent interim solution enabling the crime analysts to benefit from access to the data. Once crime mapping systems are actually up and running, they can then be used to demonstrate the benefits described earlier and more long-term arrangements for data transfer and automated geocoding can be considered.

THE FUTURE

It now seems certain that crime mapping is here to stay. The ability to portray user-specified graphical images of crime distribution provides such a level of functionality for a modern police service that a backwards step is unimaginable. Whether this function is provided by a GIS interrogating a remote database, or the future possibility of a virtual-reality-type interface with a live database, is yet to be seen. As the technology advances the fundamental process of a GIS — extraction of meaningful information from a spatial system — will remain the basis of the operation.

What is likely is that the design of databases for the storage of crime-related information will be geared more towards the needs of crime mapping systems with a greater emphasis on 'place' as one of the central identifying keys to a record. The closer integration of a GIS and databases will enhance the ability of crime analysis systems to understand the spatial relationship between crime and incident locations. It is to be hoped that the users will benefit from quicker databases that respond more intuitively to their needs. They will also benefit from the growing realisation that customisation of a GIS will improve productivity by automating difficult and repetitive tasks. The Crime Mapping Research Center in Washington DC is working currently in collaboration with a major GIS supplier (ESRI) in the development of a crime mapping extension to the ArcView GIS package, and MapInfo, the other large supplier of GIS to the law enforcement community, already advertises a crime-specific customisation for MapInfo on their website.

The spread of crime mapping systems as an information dissemination and analysis tool is already producing in some forces a greater corporate understanding of the benefits and limitations of crime mapping. The New South Wales Police Service in Australia has begun to use crime mapping as a central tenet of the Commissioner's Operations and Crime Reviews (OCRs), a forum designed to improve accountability among local commanders derived from the original New York CompStat process. The maps are used to analyse, inform and illustrate, alongside an appreciation that crime mapping is just one of many tools at the disposal of the police in attaining their objective of crime reduction.

CONCLUSION

The drive to a localised, intelligence-led police service has changed the way that many forces operate and resulted in organisational and cultural changes (Barton and Evans 1999). The benefits of proactive analysis of crime-related information already in the possession of police has now been recognised and the slow spread of crime mapping systems suggests that this technology will be an essential ingredient of future crime pattern analysis processes and intelligence-handling strategies. The flexible nature of the technology allows a crime pattern to be explored at a variety of scales, and crime mapping systems now have the potential to become one of the most effective weapons in the crime analyst's armoury. Crime mapping systems allow intelligence to be developed from information that the police already possess and as such are a relatively inexpensive and ethically sound source of intelligence. As Stan Openshaw has argued, if a benefit can be obtained from the analysis of geographical information then there is a duty to utilise that resource, and indeed it would be a crime not to profit from the application of GIS (Openshaw, 1993). As there are often technical obstacles to be overcome, it would be tempting to allow the information technology department of a force to coordinate the implementation and development of a GIS, but the research regarding the implementation of GIS into other areas of public organisations, and the practical expereiences of UK police forces who have systems up and running suggests otherwise. The most successful schemes appear to be user-driven, controlled by the departments that house the analysts who benefit from the system, with IT technical support. The users (analysts) appreciate the needs of the community they serve. It would appear that a more successful implementation of crime mapping can be achieved if the users are closely involved in the development process.

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