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InvestigAide B&E
Break and Enter Expert System

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TECHNICAL REPORT
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Submitted by
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EXECUTIVE SUMMARY

This goal of this project was to develop a knowledge-based system that will assist the police in the investigation of residential break and enter incidents and that will illustrate the potential for other applications in support of police investigations. With the assistance of CPRC, a prototype system was developed as a cooperative project between the National Research Council and the Ottawa-Carleton Regional Police Service.

This prototype was transferred to Canadian industry as the base product of newly formed, InvestigAide Software of Ottawa. The software "InvestigAide B&E" has been in use at Ottawa-Carleton Regional Police Service since June 1996. Project leader Staff Sergeant L. Valcour reports, "in 1996 the Ottawa-Carleton Regional Police Service realized a 13% reduction in break and enters which translates into 1,400 less victims and $ 2½ million in property that was never stolen. InvestigAide B&E is one of the critical components in helping us focus on the small number of offenders who commit the vast majority of break-ins."

InvestigAide Software have charter customers in several Canadian police organizations including Ottawa-Carleton Regional Police Service, Thunder Bay Police, Metropolitan Toronto Police and the Royal Canadian Mounted Police (Burnaby and Coquitlam, British Columbia and Cole Harbour, Nova Scotia).

A new product "InvestigAide Commercial B&E" is scheduled for market in 1998.

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SOMMAIRE

L'objectif vise par ce projet est d'élaborer un systeme base sur les connaissances qui aidera la police à enquêter sur des introductions par effraction dans des residences, et qui illustrera le potentiel d'autres applications pouvant venir en aide aux enquêtes policieres. Avec l'aide du CCRP, un systeme prototype a été élaboré conjointement par le Conseil national de recherches et le Service de police regional d'Ottawa-Carleton.

Le prototype, transféré à l'industrie canadienne, constitue le produit de base d'une société nouvellement formée d'Ottawa, InvestigAide Software. Le logiciel InvestigAide B&E est utilisé par le Service de police regional d'Ottawa-Carleton depuis juin 1996. Le sergent d'État-major L. Valcour, chef de projet, indique qu'en 1996, le Service de police regional d'Ottawa-Carleton a constaté une diminution de 13 % des introductions par effraction, ce qui signifie 1 400 victimes de moins et 2,5 millions de dollars en biens qui n'ont pas été voles. Il ajoute qu'InvestigAide B&E est l'une des composantes cruciales qui aident les services du maintien de l'ordre à se concentrer sur le nombre restreint de contrevenants qui commettent la grande majorité des introductions par effraction.

InvestigAide compte des clients privilégiés dans plusieurs organisations de police du Canada, y compris le Service de police regional d'Ottawa-Carleton, la police de Thunder Bay, la police de la communaute urbaine de Toronto et la Gendarmerie royale du Canada – à Burnaby et à Coquitlam (Colombie-Britannique) ainsi qu'à Cole Harbour (Nouvelle-Écosse).

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INVESTIGAIDE   RESIDENTIAL B&E: A BREAK AND ENTER EXPERT SYSTEM

"The greatest strength of the Ottawa-Carleton Regional Police Service is its outstanding employees. By understanding the need to use new technology to assist these employees and by entering into strategic partnerships with local businesses and government agencies, the police service is continuing to effectively respond to the needs of the communities it serves. "

Background

Residential break and enters have long been one of the most intrusive and disturbing types of crime in our communities. Frequency of occurrence, high cost of investigation coupled with low solvability and an enormous impact on individuals and neighborhoods are just a few of the factors that police services must consider when looking for new and innovative ways in combating this serious problem.

Pressure to respond to short-term problems and issues, budgetary constraints and an increasingly complex and volatile environment make it all the more necessary to plan for the future and to take a proactive approach to policing. In part, this entails taking stock of internal strengths and weaknesses and then responding, not reacting to change.

In an assessment of the investigative process, the Ottawa-Carleton Regional Police Service (then called the Ottawa Police Service) recognized the need to improve their response to approximately 4,100 residential break and enters resulting in over $4,300,000 (1987) worth of stolen property. The organization realized that new technology may play a key role in the solution to this problem.   Effective utilization of the information the community provides police agencies is often the key to the successful completion of investigations. In attempting to solve this problem, the police service commenced research into various database and graphics display techniques to assist existing efforts.

In 1987, two well respected public research organizations (Canada's National Research Council and the Canadian Police Research Center, which is a partnership between the Canadian Association of Chiefs of Police, the Royal Canadian Mounted Police and the Research Council) approached the police service with a proposal. They sought a partnership to conduct research into the feasibility of using knowledge-based technology to assist the police in the investigation of residential break and enter incidents and to illustrate the potential for other applications in support of police investigations. This partnership resulted in the creation of an exciting and innovative new tool for criminal investigators and crime analysts.

In 1995, there was a 21% increase in break and enters in Ottawa-Carleton, with 11,422 break-ins occurring in the region. In 1996, by focusing our efforts on the small number of offenders who commit the large majority of break-ins, the Break and Enter Squad was successful in reducing break-ins by 11.5%. This represents a 32% reversal in B&E's in one year. What this means in real terms is about 1,300 less victims of break and enter and about $2.7 million in property that was never stolen or damaged. While these statistics are impressive, it must be clearly stated that the InvestigAide system is only a small portion of the many factors that have influenced these improvements. Targeting high risk break and enter offenders is the primary tool, but this can only be successful if investigations are focused, using all the tools at our disposal, such as informants, Crime Stoppers, case solvability, case management and crime analysis.

The potential of this leading edge technology is just now being realized. As a result of a highly competitive tendering process and with the assistance of the Canadian Government, the system was licensed to InvestigAide Software, a Canadian company specializing in crime investigation software for further development and industrialization. The system, sold under the name "InvestigAide Residential B&E," has now been installed in sites from coast to coast. A software package designed to analysis commercial break and enters is now being developed, again in partnership with InvestigAide Software (named by the Financial Post in March 1997 as one of the "top 25 up and coming" software companies in Canada), and is expected to be alpha tested in Ottawa-Carleton by the end of the summer.

Project Selection

> *"Applying information technology to business reengineering demands inductive thinking -the ability to first recognize a powerful solution and then seek the problems it might solve, problems the company does not even know that it has."*

Nature of the Project

In 1987, the Ottawa Police Service (now the Ottawa-Carleton Regional Police Service), the National Research Council (NRC) and the Canadian Police Research Center (CPRC) entered into a partnership to conduct research on how knowledge-based technology might assist in solving crime and in the deployment of resources to combat crimes. The initial goal was to determine where knowledge-based technology could make a significant contribution in the investigation of criminal

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[1]   Michael Hammer and James Champy, <u>Reengineering the Corporation,</u> (Harper Collins Publishing, New York, 1993), p. 84-85.

activity. As the above quote suggests, the application of a knowledge-based solution required inductive problem solving and an iterative, or evolutionary, approach.

While the genesis of this project was technology driven, the emphasis later shifted to being user-oriented. It was agreed that the key to the eventual success or failure of the project would be a broad base of "ownership" within the organization. Members from across the police service were regularly called upon for input into the project. Key team members were identified from all three organizations and their roles were clearly established at the outset.

The crime of residential break and enter was the focus of the project. This decision was based on clearly articulated community needs, volume of cases, low rate of solvency and recidivism of suspects. It was clear that residential break and enters would be an excellent starting point to introduce knowledge-based technology and to illustrate its potential for other applications.

The system is primarily designed to assist investigators and provides them with a tool to aid in investigations. While the system was designed with investigators in mind, it is powerful enough to allow crime analysts unprecedented access to a wealth of information and yet simple enough for front line officers to conduct their own analysis at a street level. While the application is currently geared for residential break and enters, the Ottawa-Carleton Regional Police Service is currently working with InvestigAide Software on a commercial break and enter application, and foresees similar applications for other types of incidents including auto thefts, robberies, arson, etc.

Community/Department Need

Through community meetings, the local media and feedback from its front line officers and investigators, the Ottawa Carleton Regional Police Service has clearly received the message that residential break and enters are one of the most intrusive and disturbing types of crime affecting the community. The problem is difficult to deal with for various reasons: frequency of occurrence; enormous emotional and financial impact both on individuals and the community; high cost of investigation coupled with low solvability; and, a tradition of losing expertise due to transfer, promotion and retirement of senior investigators. Four community surveys, conducted by the police service, revealed that between 83% and 92% of local residents were concerned with the problem of break and enters. This was, by far, the greatest concern identified in all four surveys.

Investigators expressed a great deal of frustration at their inability to effectively manage their investigations due to the large number of cases and limited resources available. One study showed that each detective was being assigned approximately 27 cases to investigate every month. Local crime statistics, while not the only measure of effectiveness, were also telling a disturbing story: in 1987 there were 4,160 residential break and enters in the city of Ottawa.

Although there had been successes in the past, the police service understood that it needed to be flexible and relentless in its search for new and innovative methods of combating this serious community problem. Therefore, it commenced research on the use of geographic information systems, database technology and graphics display techniques in the hopes of using technology to assist in solving this problem. As part of this research, it had available a large data set of residential break and enter incident data. What it lacked was expertise working with this data with a view to improving its internal methods of investigating criminal activity.

Established Goals

Based on the research conducted and the needs identified by the Ottawa Carleton Regional Police Service and the NRC, the project goal was defined as:

> *To develop a knowledge-based sysfem that will assist the police in the investigation of residential break and enter incidents and that will illustrate the potential for other applications in support of police investigations.*

Initial system functionality objectives were established as follows:
- Provide support for gathering and recording case data;
- Generate suspect characteristics from case parameters; and
- Provide investigators and analysts with easy access to the following information:
  case parameters; other incidents in the vicinity; similar cases; patrol officer report narrative; witness information; sighting reports; investigator's notes; identify the modus operandi of suspects from cleared cases; generate a list of possible suspects; generate reports as appropriate; and provide a graphics display capability.

Five main criteria were identified as crucial to the success of the project. First, the system had to be robust. Failures should not occur more frequently than once per month and any system failure should not require re-entry of more than one case. Second, the system had to achieve user acceptance, i.e. the system had to be perceived by the users as permitting them to carry out their tasks more effectively. Furthermore, users should have a sense of ownership in the system through

contributing to its development and continuing evolution. Third, the system had to be acceptable throughout the organization.   It must be seen to have tangible benefits to the organization in the form of productivity increase for those investigators using it. Fourth, the system must demonstrate future potential. It should be perceived by the users to be applicable to other areas of investigation and to offer a means of maintaining or increasing service in a period of limited resources. Finally, the system should be suitable to commercial deployment. The results of the alpha and beta testing should demonstrate a significant commercial opportunity for the private sector.

Agency and Community Input

This project was based almost entirely on input from the policing community. In order to properly benchmark the project's goals and objectives, the decision was made to visit several sites where knowledge-based systems were being applied to criminal investigations.

In January of 1992, team members visited the Federal Bureau of Investigation Academy at Quantico, the United States Treasury Department and the Jefferson Institute for Justice Studies in Washington and the Baltimore County Police Department. Interviews were conducted with key participants in the various organizations. It became clear that, of the sites visited, only the Baltimore County Police Department had an active knowledge-based system. This system was developed by the University of Delaware and the Jefferson Institute in conjunction with several municipal police services in the United States, including Baltimore County. Within that police service, there appeared to be general agreement that the system could become an extremely useful tool if some problems, such as a lack of resources, limited database and an incomplete validation of the rule base, were overcome.

This research proved to be an extremely valuable contribution to the project. It confirmed that the area of residential break and enter was one that offers good potential for demonstrable success.   It also alerted the project team to some problems that would have to be overcome to achieve technical success and organizational acceptance. Of particular importance was the identification of the need to involve in the development all users of the system, suppliers of data to the system, and those involved with the system in other ways, such as its integration into the general information processing environment.

Analysis Techniques

The need to develop organization-wide ownership in the system strongly suggested an approach based on specification through an evolving prototype. This would permit users to contribute to the system and quickly see their influence on the design.

Knowledge Acquisition

To produce an effective system, it had to be determined from the available experts what information about a break and enter incident was significant and what this information meant to the investigators. The process started with a brainstorming session in which a team of approximately 30 experienced detectives, consisting of present and past members of the Break and Enter Squad, Identification Section and Crime Analysis Section, were brought together. The goal was to identify all of the parameters that might be significant in describing a residential break and enter. A form being used by the Tucson Police (one of the cities involved in the Jefferson Institute project) was used as a reference guide.

The session yielded approximately 260 parameters that could describe a residential break and enter, such as: glass cut; glass broken; searched concealed compartment; and victim at home at time of incident. Subsequently, each of the investigators was given a book containing a subset of 50 parameters and were asked to identify, for each one, what they would conclude about the physical and/or behavioral characteristics of the suspect. They were also asked to indicate the degree of confidence that they had in their conclusion (i.e. If glass was cut to gain entry, *then_____*. On a scale of 1 to 10, how confident are you?) This culminated in the development of sound weighting criteria for future analysis.

These conclusions, based on the experience, knowledge and perceptions of the team members, were charted on a simple spreadsheet. If there was no link identified between the break and enter parameter and a suspect characteristic by any of the experts, that parameter was eliminated. The result was a set of matrices of confidence factors (weighting criteria) relating almost 180 break and enter parameters with suspect characteristics. Once the results of this process had been analyzed, the project team was reassembled to come to a final consensus on the relation between the break and enter parameters, the suspect characteristics and the associated confidence factors.

This detailed process provided two key results: first, a core set of rules representing the investigators combined knowledge; and second, a data gathering form that was to be used in reporting all residential break and enter incidents. For the first time a form in use by the police service would be based entirely upon the needs of

furthering criminal investigations and not just administrative requirements. This new method of analyzing needs and creating a process that was needs oriented was and is seen as an exciting and powerful technique for future use.

Data Acquisition

From the beginning, it was understood that members of the Patrol Division would be critical to the project's eventual success. They were asked to complete an entirely new type of report form that needed to be filled out with a high degree of accuracy for the system to be of any value.

With this in mind, a group of 20 patrol officers were selected to complete a trial on the training and implementation of the data reporting form. The trial took place for a period of three months. A direct result of this effort was the high degree of acceptance of this new method of gathering data. Officers indicated that the form was easy to complete and added only a few minutes to their investigation.

Training of all patrol officers commenced through the fall of 1992 and by the end of the year all residential B&E incidents were reported using the new form. Feedback resulted in significant and continual improvements to the form.

Iterative Design

By using an iterative or evolutionary approach to developing this aid to investigation it was possible to avoid threatening pitfalls. Since the steps taken were small and successful, based upon regular evaluation and feedback, the gradual move from concept to reality allowed the project to achieve all of its objectives and goals with little need for developing radical alternatives.

In addition, the composition of the team (the Ottawa Carleton Regional Police Service, NRC and CPRC) allowed for expertise to be added when and as required for any minor mid-course correction in scope or approach. This use of expertise went hand in hand with the evolutionary approach and ensured that the team never lost sight of the original reason for this effort.

A detailed analysis was conducted using Geographic Information Systems technology for the purpose of determining if geographic location was a factor in residential break and enters. The results of this analysis was utilized to further the goals of the project.

The actual project plan, as described in section 3.3, set out the following stages in line with the evolutionary approach to this effort:

requirements analysis; review of prototype functionality; implementation of prototype; field test; review and extend scope of prototype; and testing and evaluation.

Exploration of Alternatives

The initial solutions investigated attempted to identify patterns in the data that would provide information for use in solving crime and in the deployment of resources. The earliest attempt involved the investigation of Geographical Information Systems (GIS) as a solution. A lack of maturity in the field and insufficient data quality forced other alternatives to be considered.

Attempts to gather the proper types of information and perform complex analysis then led to the use of spreadsheet applications which gave both a calculation and a graphical view of the data. This was a somewhat rudimentary approach (by today's standards) but was an effective step.

At the same time that the police service was investigating the use of more traditional database and graphics display techniques, the NRC was investigating, as part of its research and development activities, the use of Artificial Intelligence and machine learning techniques. Their goal was to determine the potential for using machine learning in applications for real-world problems. When the two projects were brought together by the CPRC it was determined that the fit was a mutually beneficial application of technology to solve a real-world problem. From that point forward it became not a matter of alternatives but the right approach and application of the chosen technology.

Solution Based Remedies

The research into the GIS solution led to conclusions which both reenforced the need for this type of system and provided leads to follow. The approach of utilizing spreadsheet technologies proved to be quite effective in gathering and storing information. However, there was still great effort required in achieving meaningful results and deriving information from the raw data. Given the original project objectives and goals and the need to develop a tool to assist investigation teams, the approach of working with the NRC came together. By using expert system technology along with the new methods of data collection it was clear that the project was on the right course.

The solution was not designed to solve the crime directly but to place another tool at the disposal of the investigative team. By bringing together the approach and the

technology this was achieved and will be of even more benefit as the product matures.

Action Plan

The initial project plan encompassed the activities which were required to produce a system for use within the police service itself. This was a plan to prove the concept and demonstrate that the next step, building a tool expandable beyond Ottawa, could and should be taken. The steps within the plan included:

1. Establish project team: The project team included investigative and computing system expertise from the Ottawa Carleton Regional Police Service and Artificial Intelligence expertise from NRC.

2. Requirements analysis: NRC staff worked closely with an investigator on several cases to identify the information that was used and its sources to specify requirements for data gathering and processing.

3. Review of prototype functionality: The proposed prototype functionality was reviewed in respect to requirements, availability of data and implementation problems.

4. Implementation of prototype: NRC implemented a prototype suitable for field testing based on the agreed functionality goals. Ottawa-Carleton Regional Police Service implemented data gathering procedures defined by the functionality goals.

5. Field test: The field test prototype was installed by NRC and the Ottawa Carleton Regional Police Service computing services for a six month field test.

6. Review and extend scope of prototype: During the field test, evaluation results were used to extend and adapt the prototype to better respond to operational requirements.

7. Test and evaluate: An evaluation plan addressed system benefits, deployment considerations, need for future development and industrial participation.

The second phase of this project involves a partnership with industry in bringing the application to its full potential. It was deployed to the Ottawa-Carleton Regional Police Service by InvestigAide Software, after being awarded the licence by the NRC, and has now been adapted for use by other police services in Canada and abroad. The successful development and launching of a new software product is

a complex project involving hundreds of tasks and dozens of skills. The approach, in this phase, is rapid and incremental and puts "small" product (based upon evaluation and feedback) in the hands of a small number of customers quickly. It then expands the base with an early first release and follows up with a comprehensive launch of a more robust product. This approach has been used successfully by many vertical and horizontal software firms.

Innovation

This project has been extremely innovative in two areas; the use of advanced computer technology to assist in the investigation of the B&E incidents and a unique approach to readying the product for 'market' both demonstrate novel approaches.

By utilizing expert system technology, the project has taken a truly innovative approach.   Expert systems have evolved over the years from the ongoing research into artificial intelligence. Essentially, expert systems use a unique way of programming that makes it possible to encode basic rules of reasoning for a given situation. An expert system is designed to automatically use these rules in attempting to solve a problem such as a break and enter.   This system accomplishes innovation by generating a profile of the person responsible for a given break-in. It then looks for similar profiles or 'behavioral fingerprints' from its suspect data base and attempts to match them. Another advanced feature is the use of weighted queries in the system's crime pattern analysis.

In examining opportunities to take the application beyond the current capabilities, the high technology industry was approached to submit bids for the further development and 'industrialization' of the B&E system. In the selection process, the Ottawa Carleton Regional Police Service was able to ensure that the goals of the project were maintained, keeping alive the potential to extend this new and innovative approach to police services around the world. The successful firm, InvestigAide Software, is using a new approach to system development called Rapid Application Development (RAD). This encompasses building the system in small, manageable stages thus gaining greater user acceptance and staying closer to the original course.

Results - Measurable improvements

Based upon the original project objective, the functional objectives and the five criteria for success, it is felt that this project has far exceeded project goals. Due to the nature of this project, that of changes in an operational and highly speculative area, the results are of a qualitative nature and are difficult to quantify. Where

possible, statistics have been provided but the goals of the project strongly lean towards increasing efficiencies in the longer term.

A prime indicator pointing towards the effectiveness of the system is the vastly improved data gathering processes designed during this project, otherwise known as "best practices." All of the police services now using the system report marked improvement in the quality of the data now available to their organization. A second indicator is the broad base of user acceptance. Front line officers, who have traditionally been frustrated at their role of report taker now have access to timely crime analysis, without having to wait for weekly or monthly reports. They also report an increased sense of self worth, as they have a structured report to follow that improves their preliminary investigation and helps them provide a quality level of service to break and enter victims. The final, and possibly most telling indicator is the dramatic 11.5% drop in total break and enters in 1996, from 11,422 to 10,109. In real terms, this means 1,313 less victims of break and enter and about $2.7 million less in property theft and damage.

While this drop is primarily attributed to the creation of a high risk break and enter offender targeting team (discussed below), they can not be successful unless they focus their attentions of the right offenders!

Functional   Criteria

- *Provide   support   for   gathering   and   recording* case *data*

A significant improvement in identifying what data to collect has been achieved. By reviewing each piece of data and asking what this tells about the suspect, investigators are now collecting information that it truly is useful to the investigation of   crime.

By changing the method of collecting data and changing the way this data is used, the organization now has access to much more of the information that was traditionally captured in narrative form and only available if the report was read. This new process, using the data gathering form created as part of this project, also provides the investigators with easy access to the case parameters based on crime scene observations by front line officers. These officers now have a simple yet comprehensive check list to follow when conducting their preliminary, on scene, investigation.

The quality of the data gathering process now in place at the Ottawa Carleton Regional Police Service for residential break and enters has been reviewed by police agencies and private businesses from Canada, the United States, the United Kingdom and Japan. Based on these reviews, the Ottawa Carleton Regional Police Service is confident that this data, and the process used to discern what data to report, is 'world-class'. After reviewing the system, Ron Myer, President of Versaterm Systems, one of Canada's leading police software companies stated: "the process used to create the data gathering form is at least one, if not two, generations beyond anything currently in the market."

- *Generate suspect characteristics from case parameters*

Once the data has been entered into the system, a process that takes seconds, it is then capable of generating a detailed list of suspect characteristics. These suspect characteristics, such as *sophisticated, lives nearby, uses a vehicle,* are essentially the behavioral fingerprint of the suspect. By analyzing a number of cases using the system, investigators are capable of discerning case and suspect similarities that were previously unavailable or were lost in the mass of information contained in thousands of narrative report forms.

These suspect characteristics are the replication of some of the knowledge of the collective experience of the 30 experienced investigators used in the creation of the system. Some of the power of this synergistic collective has been retained in the Break and Enter Section, not just in the individual memories of officers that are no longer working there.

- *Provide investigators and analysts with easy access to information*

The Ottawa Carleton Regional Police Service investigative process has traditionally relied heavily on information from victims of break and enter cases. This information, as reported to the patrol officer, provided most of the data to be investigated by detectives. Other sources of information, such as potential witnesses, informants, or even data already captured and stored in police data banks played less significant roles in the investigative process. Further, not only was some information unavailable, some was never even collected, such as what property was available but *not* stolen. As a result, there was little or no evidence upon which to base an investigation into a residential break and enter. By using a structured process to acquire knowledge from expert investigators, a great deal was learned about what information to obtain at the scene of a residential B&E.

By linking the new proven techniques of data gathering to the effective storage and retrieval capabilities of computer systems, information can be accessed quickly and is presented in a format that users can understand, because it was designed by investigators with no computer training. In this way powerful, useful information is put at the fingertips of investigators and analysts.

Main Criteria for Success

- *the system had to be robust*

The goal of the team was to provide a solid system and then go about working towards the lowest possible MTBF (Mean Time Between Failures). By adopting computer industry proven approaches to system development it was felt that the original goals would be met. The application now in use has proven to be extremely robust, as measured by the almost total lack of system failures registered to date.

- *the system had to achieve user acceptance*

While there are no quantitative measures of the projects success in this area, feedback received from investigators, front line officers and various other members of the organization, indicates that the project was extremely successful in gaining user acceptance.

From the outset, this acceptance was one of the highest priorities in the creation of this system. The technology was designed by investigators for investigators (not known for their prowess on computers) to be easy to use and to provide information that is immediately useful to the investigator.

In an example of acceptance by the primary user group, during the Alpha test stage an investigator from the Break and Enter Section asked if he could use the system in an attempt to identify break and enters that may have been committed by a group he was investigating. When he was finished he was asked two questions. First, did he find the system difficult to use? He stated that once he had used it for a few minutes it was very easy to maneuver around and get the information he was looking for. Second, and more importantly, did the system help his investigation? His answer was an unequivocal yes. Before using the system he was sure that this particular group was responsible for three break and enters.

Based on the responses he received on the computer he now had a list of six break-ins that he was confident had been committed by this one group of suspects. He now had access to information that had previously been hidden, somewhere in a mass of reports and computer files. The investigator later cleared all six of these cases to the suspects in question.   Shortly after this occurred, numerous other investigators began requesting information from the system, indicating growing user acceptance.

- *the system had to be acceptable throughout the organization*

The key to the eventual success of this project was not any one individual or organization. The key was the effort of numerous people in all three contributing agencies. Efforts as diverse as pulling files, writing code, snapping reports, testing a new data gathering form or participating in brain storming meetings all led to individuals taking ownership in the system.

Throughout the evolution of the project, the importance of organization wide ownership of the system was stressed. This ownership was especially vital due to project-driven changes in organization wide procedures, investigative techniques and paper flow systems. In attempting to solve these problems and the same time increase exposure of the system to the service, the project team focused on front line workers. As in any organization, it is usually these people that have the solutions, as they are the people who are tasked with the day to day work. Thus, in a substantial break from policing tradition, the hierarchical chains of command were regularly bypassed. The input of the "rank and file" was sought in problem solving and procedural change situations.

Obviously this type of non-traditional problem solving would not have been successful without senior management embracing the concept of empowering the team members. This decision, to allow team members to work outside the boundaries of Sections and Divisions was one of the major reasons for the projects success.

Over 100 members of the Ottawa Carleton Regional Police Service, police officers and civilians, assisted in some way in the success of this project. Every one of these members were invited to attend a demonstration of the system at a briefing held on May 24, 1994. Approximately 70 members were able to attended. The feedback from this briefing was outstanding and pleasure was expressed at having been involved with such as successful endeavor.

- *the system must demonstrate future potential*

When viewing this system a senior investigator from the Scientific Intelligence Unit at New Scotland Yard, who is tasked with analyzing tens of thousands of sexual assaults every year, immediately recognized the implications of the system's weighted queries, and the underlying intelligence that went into creating them. He indicated that in looking at the masses of data he currently analyzes there is no way of prioritizing his searches. He stated that by using a system such as this his ability to focus in on similar cases would be immensely enhanced.

While suspects in cases of residential break and enter often confine themselves to a relatively small districts, some criminals travel much larger distances to conduct their activities. Data could be collected across large geographical areas, such as regions, counties, provinces or states, nationally and internationally. In crimes such as commercial break and enter, suspects often travel hundreds of miles to their targets. Bank robbers regularly travel across countries. Art thieves cross international borders to ply their trade. By standardizing data across these geographical boundaries and providing quick and easy access to current useful data, the effectiveness and efficiency of all police and/or security agencies would be vastly improved.

The system demonstrates tremendous potential for future migration to other crime types. It is readily adaptable to commercial break and enters, auto theft, robberies, sexual assaults, arsons, frauds, bias or hate motivated crimes, etc.

By using a structured process to acquire the collective knowledge of experts in any investigative field, the reporting process is improved dramatically. Once an organization has access to excellent data, it can be used in a myriad of applications including knowledge-based systems such as this. However, it must be recognized that while new technologies are not the answer but, they are definitely part of it.

- *the system should be suitable to commercial deployment*

The product has proven to be a perfect candidate for commercial deployment. Since announcing InvestigAide   Residential B&E and the Canadian Association of Chiefs of Police conference in Ottawa in August last year, the system has been purchased by the Royal Canadian Mounted Police, the Metropolitan Toronto Police Service and Thunderbay Police Service.   One critical element for commercial viability is to be 'first to market'.

Through research and word of mouth it appears that there are no competitive products either on the market or in development. This makes the potential for InvestigAide Software extremely attractive. All sites currently using the application have expressed great interest in receiving the commercial B&E software, due to be delivered later this summer.

Additional Positive Effects

By analyzing how experts think and then capturing their thought processes in the form of rules, a knowledge base has been created for future investigators to utilize in the investigation of crime. A police service will never be able to replace expert investigators, but if a service can capture and preserve even a small portion of their expertise, efficiency and effectiveness will improve. In a study quoted by the FBI [2] it was estimated that when anyone leaves an organization, up to 90% of their knowledge goes with them.

The expert system assists managers in efficiently training new investigators by allowing them access to historical case profiles. Investigators can quickly understand offender behavior due to the collective knowledge of seasoned detectives that is stored in the rule base.

The system may be of greatest benefit when repeat offenders are released from jail. By quickly linking current behavior patterns to previously identified offenders, the system will help investigators focus on the prime suspects.

Externally, communities served will witness a positive change in the way police deal with them at the scene of a crime. Instead of simply filling out a form and leaving, investigators are now asking detailed questions and collecting precise data, thus sending the message they care and want to help.

Finally, it is believed that improving the investigative process in the Ottawa-Carleton Regional Police Service will have qualifiable results. Some of these include: improved patrol officer/detective relationships via better communications; an increase in detective's productivity resulting from a lightened caseload; and, better management of the entire investigative effort by police administrators.

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[2] Roland Reboussin, Ph. D., <u>Develooment of a Rule-Based Exoert Svstem for Profiling Murderers.</u> March 18, 1987. Quoting Texas Instruments (1986) Knowledge Based Systems, An Overview. Part II. Video Tape. Texas Instruments, Dallas, Texas.

Documentation of Effects

International research indicates that approximately 4% of suspects can commit as many as 80% of all break-ins. In an effort to quantify this statement, occurrences entered into the prototype system between January 1, 1993, and August 15, 1994, were analyzed.

During that period 836 cases were solved, with 318 individual persons identified as being responsible for at least one break and enter. Of that number 67 (21%) were responsible for more than one break-in and only 12 (4%) were responsible for five or more cases.

The 4% of suspects who committed five or more break and enters were responsible for 505 (60%) of the 836 solved cases.   Thus, if police agencies are to be more efficient in their efforts to arrest these suspects they need to concentrate on the small number of suspects who do the large percentage of solvable cases. The expert system can easily be used as a resource allocation tool by managers in deciding how best to assign investigations or directed patrols.

This theory has been tested during the past eighteen months by the creation of the Regional Break and Enter Response Team (BERT).   In brief, BERT, in conjunction with the various other measures taken by the regional Break and Enter Squads, has been immensely successful in dramatically reducing the number of break and enters in Ottawa-Carleton. Prior to BERT's start in October of 1995 there had been a 35% increase in break and enters to that point in the year.   Immediately upon the team commencing the targeting of active offenders the trend reversed. By the end of 1995 the increase in break-ins had been reduced to 21%, hardly a positive number, but much better than had been projected just a few months earlier. By the end of 1996, the B&E's in Ottawa-Carleton were down 11.5%. This represents a **46% reversal in B&E's since the formation of BERT.** It was also the first time in five years that break-ins were reduced in Ottawa-Carleton. It must be clearly stated that crime analysis is only one component in the investigative process and InvestigAide   Residential B&E is only one component of that crime analysis. In a 1993 research paper, as part of the work being completed on this project, the Break and Enter Squad identified ten primary components to successful break and enter investigations.

These were:

1. **TARGET ACTIVE CRIMINALS**
2. **UTILIZE DETECTIVES EFFECTIVELY**
3. **INCREASE USE OF INFORMANTS**
4. **ENHANCE PATROL OFFICER'S DUTIES**
5. **IMPROVE CRIME ANALYSIS**
6. **CANVASS NEIGHBOURS FOR WITNESSES**
7. **COMMENCE FORMAL CASE MANAGEMENT**
8. **UTILIZE FORMAL CASE SCREENING PROCESSES**
9. **CONTINUED AND INCREASED USE OF VOLUNTEERS**
10. **IMPLEMENT SCENES OF CRIME OFFICERS**

Note that only two of these components, improving crime analysis and enhancing patrol officer's duties relate to the new software. In other words, the system is just another tool in our too/ box. Police officers solve crimes, not computers.

While it is acknowledged that most of the benefits of the expert system may be categorized as 'soft,' or unquantifiable, there exists a number of documented cases in which the system proved to be an effective and rewarding aid in the investigation of residential B&E incidents.

Maintainable and Permanent Improvements

The impacts of the project are ones which can be readily sustained and improved upon over time. Not only is this a new approach to assisting police services in B&E occurrences, but it is a tool which will retain some of the collective knowledge of the officers and analysts that pass through the particular police service.

As a direct result of the project, there now exists a significantly improved method of gathering and accessing information in the Ottawa-Carleton Regional Police Service. This structured method of gathering information at a B&E scene will result in the collection of consistent information. This will accent the overall effectiveness of the information used in and across police systems. In addition, the ability for data to be collected and shared across police service boundaries now exists. This is extremely relevant given the amalgamation of existing area regional police services into Ottawa-Carleton Regional Police Service. Sharing of information will ensure timely and relevant information for the investigation teams working on B&E occurrences.

Adaptable   Solutions

The system is readily adaptable to other agencies and organizations due to four key factors. Each of these will be undertaken to ensure that other police services around the world are able to install and use the system with minimal effort. This section will describe each of these and outline their importance to the project.

Conversion of Original Application

The original application, as it was originally built by the NRC, used technology with a character based (DOS) interface. One of the first steps taken by InvestigAide Software was to convert the system to operate in a Microsoft Windows environment. The 'Windows' application gives it an improved look and feel and dramatically increases its ease of use. In addition, the system is in line with current trends within the industry to develop applications to run under MS-Windows, Windows 95 and Windows NT.

Development of a Portable Architecture

A critical element for widespread adaptability is that it must integrate with a variety of existing technical platforms employed by various police services. This application must also be able to access a variety of database technologies (Sybase, Oracle, Informix, SQL Server...). In addition, there are a variety of technical architectures which exist in the marketplace today.

User-Friendly Look and Feel

The original system was designed with a DOS or character based interface. The approach for adaptation placed emphasis on a graphical screen representation which will allow for a significantly more intuitive screen setup and layout. This makes the application simpler and more marketable to less technically sophisticated clients. In developing the interface, the approach keeps in mind certain questions including: who are the ultimate users of the system, what conditions will this be used in, and how computer literate are the users.

Adaptable Rules Base /Localization

Another key issue in making this product expandable beyond Ottawa was to ensure that the rule base is expandable to encompass a number of variants. This approach

will allow for maximum local effectiveness of the tool and at the same time retain the knowledge base acquired throughout its life.

Quality Process as Standard Operating Procedure

Policing can not remain a static profession. Change is a powerful opportunity for growth and improvement. Organizations must learn, adapt and adjust. The methodologies and approaches used throughout this project have created a template for future similar activities.

A quality process is about listening, being flexible and being focused not only on results but on the ultimate client - the community. By demonstrating the effectiveness of learning, teamwork, partnering and ownership, the organization has realized that things can and should be done differently. These lessons have been adopted by the organization as standard operating procedures.

The Ottawa-Carleton Regional Police Service expert system project was responsible for numerous new processes and procedures that have impacted across the organization. The acceptance of these procedures by all levels of the police service is testimony to the success of the project. This success will act as a guide for future innovative endeavors.

Conclusion

Policing can no longer remain a static profession. Change is a powerful opportunity for growth and improvement. Both the internal and external environments for police organizations have changed drastically in the past decade. Organizations must learn, adapt and adjust. As such, the police must consider changing their way of thinking and allow front line officers the authority and autonomy to act, ideally before community problems arise and incidents occur. These are the principles that problem oriented policing are founded on.

For this to work though, front line officers (in plain clothes or in uniform) need timely, accurate and relevant knowledge, not just masses of information.

While technology is not the answer, it is certainly part of the answer. The creation of an expert system for the analysis of residential break and enters has proven highly successful for the Ottawa-Carleton Regional Police Service. Now that the software has been commercialized and is in use across the country, we are seeing just how powerful partnerships can truly be. Our investigators are learning from

investigators across the country, our systems and processes are becoming more effective, and the quality and effectiveness of our service is improving.

Are these not, in the final analysis, our primary goals?