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Social network analysis in an operational environment:

Defining the utility of a network approach for crime analysis using the Richmond City Police Department as a case study

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ABSTRACT

Increased awareness of network-based social action (Castells, 2009), including criminal action, necessitates the incorporation of network-based analyses in the work of the precinct crime analyst. Social network analysis is a social science methodology that can provide crime analysts with a set of quantitative metrics and robust visual displays, through which they can quickly discover, analyze and visualize network-based criminal action with the goal of developing rigorous interdiction strategies. Using 'real world' data provided by the Richmond City Police Department, a large urban metropolitan police department located in the United States in Richmond, Virginia, we show how social network analysis can provide a common language through which crime analysts and police detectives can effectively work to quickly develop interdiction strategies in response to criminal activities that afflict local law enforcement agencies. Through both a case study and use of SNA in actual criminal cases, we show how a network approach can assist police in understanding complex behavioral motivations of offenders, strategically hot-spotting people of interest and developing stronger inter-jurisdictional working relationships.

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Introduction

Humans are inherently social creatures therefore human behavior is inherently social. The choices, actions and options of individuals are rooted in a larger social context which informs their behavior. As such, among the most important questions in criminological research centers upon interpersonal associations and how peer networks function in criminal behavior (Haynie, 2001). Research consistently shows that social networks can both facilitate (Patacchini & Zenou, 2008) and inhibit (Haynie, 2001) delinquent behavior such as involvement in gangs and organized urban drug networks (Murji, 2007), can enable international terrorism (Krebs, 2002) and can support the distribution of pornographic material (Johnson, 2010). Furthermore, criminal networks are not isolated; they are nested within the community, drawing support from members of the community at large as well as extracting significant costs from host neighborhoods (Kadushin, 2005). As a policing matter, the existence of social networks necessarily means that police department strategies are heavily contingent upon the ability to grasp and respond to the social networks within which criminal behavior is embedded.

Although intelligence led crime analysis is not a novel idea, profound technological advancements in analytic tools such as social network analysis (SNA), geographic information systems mapping (GIS), and data warehousing have played critical roles in opening up possibilities for advanced crime analysis that were simply unavailable to previous generations of police departments (Taylor et al., 2007; Cope, 2004). In fact, technological advances have coincided with a burgeoning civilian crime analysis vocation within police departments (Cope, 2004; Manning, 2001). Some research has discovered, however, that despite the numerous developments, the crime analyst’s ability to incorporate an assessment of the underlying intelligence on criminal behavior into their analytical products has not necessarily improved (Nichols & O'Shea, 2003).

Research on the role of crime analysts in police departments reveals an operational gap between the analyst and the police officer with crime analysts focusing more on counting or mapping occurrences of criminal activity rather than a more effective 'on the ground' approach to understanding crime (Cope, 2004; Taylor et al., 2004; Belledin & Paletta, 2008). This gap has led to some discord between analysts and officers, the end result being an under-utilization of intelligence-based policing benefits (Cope, 2004). Viewed in this way, the crime analyst needs to be positioned between the data and the street (Bruce, 2008), employing tools which permit the analyst to 'see' the data as it functions in theater.

This growing need for network-based crime analysis that provides a comprehensive 'on the ground' understanding of the social context of persons of interest can be met by incorporating Social Network Analysis (SNA) into precinct level crime analysis processes. Through (SNA) the analyst and officer can develop a more supportive and proactive relationship, a key component in solving criminal cases. Social network analysis is a social science methodology consisting of quantitative metrics and robust visual displays, through which analysts can quickly discover, investigate and visualize network-based criminal action. These metrics and visual images can easily be shared with officers on the street providing them a near real-time social map of the network of a targeted group or individual which the officer can use to interrogate, monitor or apprehend persons of interest. In other words, the analyst can quickly map and measure the social landscape which the officer can effectively use to navigate and interdict the 'on the ground' reality.

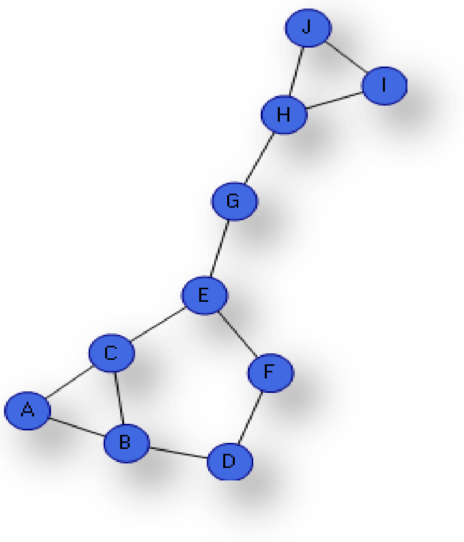
Using data provided by Richmond City Police Department, a large urban metropolitan police department in the United States in Richmond, Virginia, this paper seeks to illustrate the effectiveness of incorporating social network analysis into the precinct-level crime analysis process. Data were collected via a snowball sample of the departmental crime database gathering any connections to 24 persons of interest (POI) as identified by a gang unit detective as well as any connections between those connected to original POI's four steps out. Through a description of the analytical process as well as how the results were used by the police, this paper will outline the myriad of ways in which SNA can facilitate a mutually beneficial relationship between the office and analyst and how it can prove helpful to the crime analysis and response process. For Richmond City Police, SNA has already been used to solve a homicide and a large string of robberies occurring across jurisdictional lines.

Social Network Analysis: Theory and Method

Social network analysis is both theory and method. Theoretically, the approach takes seriously the sociological axiom that all social actors, including both humans and organizations, are positioned in and influenced by larger social structures (Laumann & Knoke, 1986). Methodologically, SNA provides a precise, quantitative process through which social structures and constituent relationship patterns can be operationalized, mapped and measured (Wasserman & Faust, 1994). Because the fundamental element of a social structure is relational, social network analysis requires three points of data—actor A, actor B and the tie or link between them. These three pieces of data comprise the basic SNA unit of analysis. Actors, called 'nodes' in the SNA lexicon, can be people, organizations, computers, or any entity that can process or exchange information or resources. For the purposes of this paper, all nodes refer to individuals. Relationships between nodes are called 'ties', 'connections' or 'edges' and can represent any type of exchange such as drug transactions and phone calls or any type of positive or negative contact such as family relations or victim/offender contact. Unlike link analysis where the focus is on displaying large amounts of diverse data about particular individuals, SNA focuses exclusively on analyzing relationships between a set of individual actors.

SNA produces two forms of output, one is visual and the other is mathematical. The visual output is a map or rendering of the network called a social network diagram which displays the nodes and the links between the nodes. Figure 1 is an example of the visual output of SNA. The diagram works well to visually conceptualize how the network functions and to quickly answer questions about who is connected to whom in the network. For example, Figure 1 provides quick information about the central role of nodes E, G & H thus providing immediate input regarding the nodes position relative to all others in the network. One look at the visual rendering and it is clear the pivotal role that E and G play in controlling the flow and access of the network. However, in larger networks key nodes are more difficult to visually identify thus the analysis turns to the quantitative output of SNA.

Figure 1:



The social network diagram is accompanied by a set of quantitative SNA metrics, most often comprised of centrality measures. The centrality of a node, such as an offender, is a metric identifying the prominence or importance of that individual to the overall functioning of the network. How important is that person to the criminal network? Does he play a large or small role? Is he most active? Or is he well-positioned to control the flow of information? These questions can be answered using basic centrality metrics, including degree, betweenness and closeness.[1] In brief, degree measures how many connections a particular nodes possesses, betweenness measures how important a node is to the flow of the network and closeness measures how quickly a node can access information from the network. Nodes are rank ordered according to their centrality with those at the

[1] See Wasserman and Faust. 1994. *Social Network Analysis: Methods and Applications* for a review of these centrality measures.

top of the ranking playing the most prominent role in the network. The value of each of these metrics is determined by the analytical question at hand.

As a set of descriptive metrics, these measures cannot tell a researcher what the network structure should be, but rather they can effectively inform the researcher as to what the structure actually is. These measures assess the position and prominence of a node relative to other nodes in that particular network. If the number of ties or the presence or absence of particular nodes changes in the data, the metrics and rankings will possibly change as well. This presents a significant challenge for data collection because the researcher must be able to clearly define the boundary of the population to be sampled; who is in the network and who is not? Network boundaries can expand from ego-networks or networks centered around a single node whereby the ego nominates those who should be considered members of the network structure (Laumann & Pappi, 1976), to complete networks of an identifiable group (Knoke, 1983), to diffuse network that span an entire nation (Levine, 1972). Solutions to the boundary problem can include: 1) a position-based approach where those actors who occupy a particular position in a social structure, such as an organization, would be included and all others would be excluded; 2) an event-based approach identifies boundaries using a particular event, time period or region (this is the sampling method used in this study); or 3) a relation-based approach whereby those actors who are in a select type of relationships—co-workers, family, friendship—inside a particular social arena—school, business, neighborhood—would be included (See Laumann, Marsden & Prensky, 1983 or Marin & Wellman, 2010 for a complete discussion). Sampling procedures can include asking the group members to identify who is in or out, using rosters or membership lists, snowballing where members nominate subsequent members or random sampling (Frank, 1977, 1981; Scott, 2004). Decisions on how to solve the boundary specification problem must be made early in the analytical process and should be driven by the theoretical and methodological questions at hand (Scott, 2000).

Social Network Analysis in Action

In January 2008, a collaborative pilot project was launched to explore the viability of incorporating social network analysis into the precinct-level crime analysis methodologies of a Richmond City Police, a large urban metropolitan police department. Members of the pilot project included the chief of police, a sociologist from a local university (first author), a software designer, the head of the crime analysis unit, a gang unit detective and the project manager from the police department. The goal was for the research team, comprised of the sociologist and the software designer, to use Richmond crime data to assess how constructive SNA would be in solving the types of crime that were most prevalent in the area as well as the feasibility of training the precinct level analysts in conducting SNA effectively.

The question posed to the researchers was what set off a rash of violence between two groups of previously friendly males? Several persons of interest to the police, who at one time were on good terms with each other, had begun to 'beef' and assault one another. The source of the violence was not clear to the police and they were looking for ways to effectively respond. They wanted to know if SNA could help them understand the genesis of the violence and what interdiction strategies could be developed using a network approach. The research team was provided access to the in-house database—PISTOL—which houses information on criminal occurrences, convictions, criminal associates, demographics, and victim/offender relationships in the city of Richmond. The police provided no other background information on the individuals nor did the research team meet or discuss the ongoing investigation with the detectives. The analysis was done off-site and the only recurring contact was with the police database manager to extract the data in relational form.

Using 24 persons of interest identified by a gang unit detective as seeds, a snowball sample of PISTOL extracted all connections occurring in the year 2007 through October 2008 four steps out from the seeds, as well as any interconnections among any and all nodes in each step. The connections between the nodes in the database are officially categorized by incident type—common incident participation, victim/offender, gang memberships, field contacts, involved others and common locations—as well as sign—positive or negative. Positive ties described a cooperative relationship between individuals such as two individuals robbing a store together, hanging out together and family relationships. Negative ties described a hostile relationship such as a victim/offender relationship or recorded hostility between individuals. Individuals can have multiple connections between other nodes of varying signs. The current analysis uses the official police defined categories and flavors as outputted from the database. Four networks resulted from the snowball sampling, one for each step out from the seeds. For the purposes of this article, we will focus on the network that produced the most robust analysis—the two-step network.

The two-step network which includes the seeds, the connections among the seeds, those who are directly connected to the seeds and those who are directly connected to associates of the seeds, totaled 434 individuals and 1711 ties. Figure 2 is the social network diagram of the two-step network. The visual rendering shows an elongated structure with hubs of activity. The network has several weak spots where a single node connects regions of the network as well as very dense areas of heavy interconnectivity. Using SNA software, an analyst can produce one of these visuals, including names, within minutes which can be used by the detective to quickly assess the structure of the group that is she/he is investigating or to quickly reference to whom a POI under interrogation is connected. The software used in this analysis is Blue Spider, SNA software specializing in law enforcement analysis.

Descriptive data can also be layered onto the visual to produce a nuanced analysis of the network. Nodes and ties can be colored, shaped and sized to reflect demographic and descriptive information. For example, in Figure 2, female nodes are colored pink and males are colored green. It was through visual analysis of Figure 2 along with the metric of betweenness (see Table 1) that the question of the source of the 'beef' was answered. The metric of betweenness was able to point to critical junctures in the network that revealed interpersonal tensions among males revolving around their relationships with females (see boxes in Figure 2 and Figure 3 for close-up of box A). There were several tensions spots in the network characterized by a high number of overlapping positive and negative ties surrounding triads. In SNA, triads are considered to be one of the most important and powerful relationship configurations because of the pivotal role they play in alliances (Knoke, 1990), the spread of disease (Bearman, Moody & Stoval, 2004), juvenile delinquency (Haynie, 2001) and social power (Burt, 1995). The influence of triads in a network relates to structural balance. Triads that are balanced produce stability and calm in a network whereas triads that are unbalanced are points of tension and unrest (Heider, 1979). A balanced triad it one in which all ties are either of the same sign, that is all positive or all negative, or if two are negative and one is positive. The research team found unbalanced triads involving females were at the core of tensions inside the network.

Figure 2: Two-step network

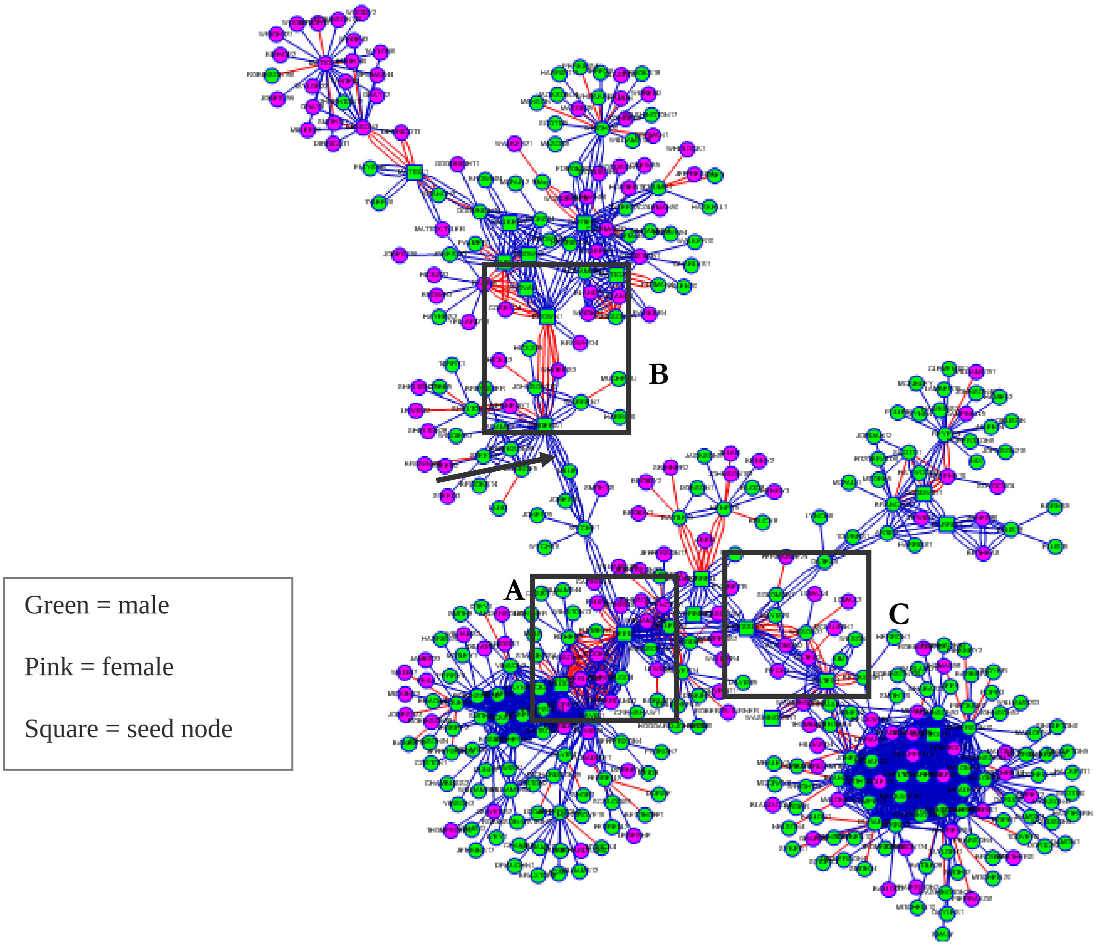
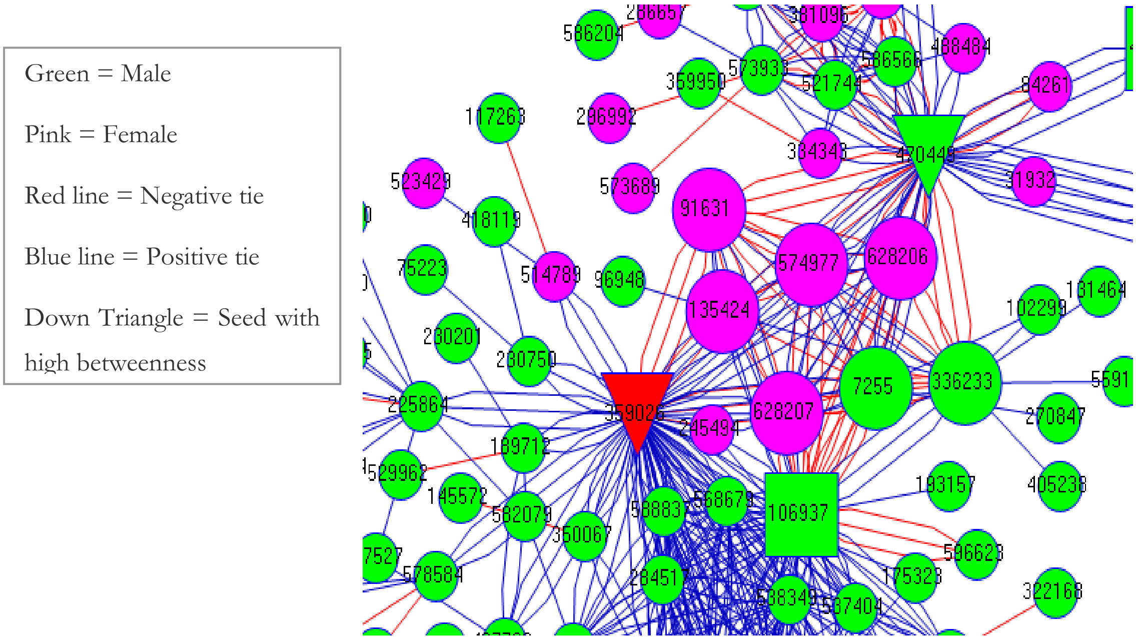


Figure 3: Close-up of male-female tension spot (Box A)



For example, the tension in Box A (see Figure 3 for close up) reflects aggravated assault stemming from the development of an unbalanced triad. Two powerful male nodes—#106937 and #359026—are gang members were reported to have a positive relationship in October of 2007. However, in April 2008, one powerful male—#106937—victimized a female friend—#628206—of his fellow gang member—#359026. During the same incident, the powerful male #359026 also victimized a female friend—#91631—of male #106937. In other words, the two powerful males who at one time had a positive relationship victimized a female friend of each other thus creating unbalanced triad consisting of two positive ties (one between each male and a one between one male and a female) and one negative tie (one between a male and a female). Again, during the same incident, powerful male #470449, who has a positive association with male #359026 and a positive association with female #628206, victimized the female friend—#91631—of #106397, the now adversary of #359026. Box B and C show the same pattern involving an incident where a powerful male either assaults or engages with a female associate of another powerful male. In other words, the boys were fighting over girls.

The quantitative metrics also provided additional information regarding who the powerful players were in this network (Table 1). By rank ordering the individuals according to their centrality measures, the analysis not only confirmed that the squad had their eyes on the right people and were therefore using their community resources effectively but the metrics also helped them further parse out the importance of the seed nodes. Many of the seeds nodes being targeted by the squad ranked as powerful in the network based on a SNA metric score two standard deviations above the mean while other seeds did not populate the higher rankings indicating they were less vital to the network. Furthermore, the quantitative metrics also pointed to six other vital players of which the police were unaware. One of those newly identified nodes (ID# 321765) was a critical player in flow of the network (see arrow in Figure 2) of which the squad was completely unaware.

Table 1: Ranking based on a SNA metric 2 Std. Dev. above mean

Individual	Betweenness	Individual	Degree	Individual	Closeness
470449*	1	554123**	44	470449*	1
476757*	0.753	178752**	41	476757*	0.948
514546*	0.6467	57466	38	321765**	0.9134
321765**	0.6296	327937	37	466561*	0.8795
239566*	0.5446	602549	37	567812*	0.8733
243892*	0.5288	563071	37	359026*	0.8698
359026*	0.3275	589661	36	106937*	0.8571
514949**	0.3186	607556	36	239566*	0.8533
550394**	0.2293	583970	35	336233	0.8394
464771*	0.2269	514949**	34	7255	0.8386
440112**	0.1993	342579	32	135424	0.8382
		607555	32	91631	0.8378
		359026*	31	574977	0.8378
		436404	31	628206	0.8378
		441304	31	628207	0.8378
		523518	31	514546*	0.8362
		592634	31		
		591822*	30		
		106937*	26		
		470449*	23		
		117556	21		
		501815	21		
		242194	21		

*** Denotes seed nodes; **Denotes node recommended for targeting**

Using the metrics, we were also able to make recommendations of interdiction strategies for specific nodes. Because the network is a hub network, the betweenness score is a key indicator of importance as it points out those nodes that connect the hubs. Hub networks are characterized by a network's dependence upon a limited number of powerful nodes (Barabasi, 2003). As such, nodes with betweenness score would be good targets for removal if the operational goal was to fracture the network. If the goal is to gather intelligence, nodes with high degree would be ideal targets as they can produce a high volume of valuable information on the network. Nodes with a high closeness score would be ideal picks for launching disinformation campaigns or as entry points into the network for covert actions. It is vital to note the value of these metrics and how they inform interdiction strategies is an iterative process involving a dialogue between all subject matter experts including both the crime analysts and the officer on the street. Social network analysis should not be treated as a standalone tool; rather, it should be integrated into an analytical process that includes both subjective and objective assessments. Furthermore, interdiction strategies need to account for the on-the-ground dynamic reality of networks—networks are organic systems which can change, respond and reconstitute themselves in response to interdictions. Developing interdiction strategies using longitudinal data would strengthen the ability of SNA to accurately and effectively target networks (van de Hulst, 2008).

While bureaucratic processes elongated the timeline of the pilot project making these results and recommendations too late to be actionable (the police had already solved the conflict), the 'on the ground' knowledge of the detectives, of which the research team was *not* privy, validated the results. Detectives confirmed the answer the research team had discerned from the data—boys fighting over girls—was in fact the genesis of the 'beefing'. Furthermore, the detectives acknowledged that the case would have been solved more quickly and easily had they had this analysis to guide some of their interdiction strategies. The detective's feedback validated the worth of the project as well as the usefulness of SNA to the law enforcement strategies of the police and moved the project into the next phase where precinct level crime analysts were trained in social network analysis. Training took place in the summer of 2009 through a 36-hour in house training seminar. Through lecture and hands-on training, 11 crime analysts from both the police and federal agencies used data from their own projects to learn to incorporate SNA into their unique crime analysis needs.

Within two weeks of completing the training, the analysts used SNA to solve several cases including a murder and solve a large series of convenience store robberies that occurred across jurisdictions. These instances reveal ways in which SNA can be used to facilitate a productive working relationship between analysts and officers. In the homicide case, the analyst worked very closely with the lead detective to produce a working social map of the larger network that hosted a person of interest wanted as a witness in a homicide. The analyst and the detective work together to corral the POI by using the social map to hot-spot his social resources leaving him nowhere to seek refuge and eventually he turned himself in as a last resort. The SNA diagram provided to the detective by the analyst allowed him to effectively and efficiently move his personnel resources to strategically navigate the suspect into the hands of the police. Rather than saturating the entire network of the person of interest, the analyst and the officer on the street used the to the diagram to identify where in the network he had the most options and strategically moved personnel around the network to push the suspect into a corner. Once in police custody, the suspect provided the police with the vital information needed to solve the homicide.

The second case where SNA proved helpful was a string of 16 inter-jurisdictional convenience store robberies. Working off of a SNA map of another case, the analyst noticed a connection between a person of interest in the robberies in one jurisdiction and one of the members of the network that she was investigating. Using the two names as seeds, she extracted another network to discover an inter-jurisdictional network that was previously unknown to either her or her colleague in the second jurisdiction. She presented the social network diagrams to the detective in charge of the case, illustrating the sequence of network connectivity which he then took to a detective in the other jurisdiction. Through this cooperative work, mediated by a SNA social diagram, the analyst and detectives were able to piece together 16 convenience store robberies that were not previously thought to be connected. Once again, the diagram presented a medium through which the analysts could quickly, easily and effectively share their analytical observations with the police in a way useful in theater.

Employing the social network diagram was novel for the RPD and was quite effective in facilitating communication between the crime analyst and the officer on the street. Prior to the SNA training, analysts conceptualized a network perspective as a series of ego-networks. To understand the ‘network’, the analyst would bring up the immediate connections of a person of interest. If the analyst wanted to know to whom one of the alters of the original ego was connected, a second ego-network was constructed. In the end, the analyst was faced with a series of ego-networks, leaving out the interconnections among them. Through the training, analysts began to conceptualize the effectiveness of the larger network environment as represented in the diagram. They then used the diagram as a social map through which they could both orient themselves and the officer to the larger network environment. In the homicide case, the officers had a copy of the diagram with them on the street and were in communication with the analyst in the precinct to strategically corral the person of interest. In the case of the convenience store robberies, the diagram provided the vital clue that allowed the analyst to ‘see’ the connections between incidents that were previously not even considered related. Had SNA been an available tool the analyst in the other jurisdiction, such a connection might have been discovered earlier.

It should be mentioned that the SNA diagrams used in solving both these crimes, as well as the metrics used in the demonstration project described earlier, are baseline SNA capabilities. While there is much more advanced work in the academic literature on using social network analysis to understand criminal networks (for example, see Chattoe and Hamill, 2005 or Natarajan, 2000), analysts at the precinct-level in the U.S. are working in an operational environment involving multiple persons with varying analytical skills and understanding. Analysis must be able to be completed quickly and must be intelligible to diverse audiences with little explanation. For example, the analysts at the RPD often times have to produce useful information on the spot, with an officer looking over their shoulder or must be able to succinctly present a comprehensive picture of the problem in a public forum of higher ranking officials. They must be confident in their abilities to explain their analysis and be able to demonstrate the effectiveness and necessity of their skills. As a young but quickly developing profession, crime analysts are honing their basic analytical skills while at the same time incorporating innovative new tools into their procedures (Osbourne & Wernicke, 2003). With regards to integrating SNA into the operational environment of the precinct-level crime analyst, we found it is most productive to start with basic tools. As both the profession of crime analysts grow as well as the skill level of the precinct-level analyst, more robust capabilities, including dynamic modeling, can be incorporated.

Conclusion: The Value of Social Network Analysis

The above three cases illustrate the actual ways in which SNA has been successfully employed in developing law enforcement strategies and interdiction techniques as well as a medium through which analysts and officers can effectively communicate. First, the pilot project illustrates how SNA can assist in answering sophisticated questions about the underlying motivations of crime, an area that research has shown to be underdeveloped in police crime analysis processes (Nichols & O'Shea, 2003). The research team was asked to figure out why violence was occurring among groups who were previously amicable. Without any subject matter knowledge, SNA was able to reveal behavioral motivations rooted in complex interpersonal relationships using visual analysis alone. The pilot project was also able to provide confirmation of the current resource allocation of the squad as well as indicate new avenues of policing with the potential to produce a high return on investment.

Secondly, the two cases in which SNA was used to produce actionable results illustrate how SNA can be used to facilitate a productive working relationship between analyst and officer. Research shows that one of the biggest hurdles in establishing effective communication between the two roles is being able find a common language between the analytics of numbers and the pressures of reality on the ground (Cope, 2004; Belledin & Paletta, 2008). Each of the cases described above exemplify how SNA and in particular the social network diagram can function as a common ground where the rubber meets the road and the data meets the streets. In each case the analyst was able to use the diagram to visually depict her analysis which resonated with the detective because it approximated his understanding of the reality of the street; yet she was still able to tell the detective 'something new' that aided his investigation.

The visual and quantitative outputs of SNA can assist in solving institutional memory issues associated with analyst longevity, attrition and new hires. First, by producing a current overview of the network, SNA can help alleviate institutional memory problems associated with personnel mobility by allowing for either new analysts or analysts new to the case to come up to speed very quickly regarding the current status of the network. Second, SNA can assist an experienced analyst in maintaining a clear bead on the changes in a network by chronicling the growth and development of a network as members and connections appear and disappear. Law enforcement agencies, such as the RPD, benefit from having access to data which is structured, relational and temporal all of which creates an ideal data environment for SNA. Analysts can reliably map the changes in the network using an automated extraction process. Through this dynamic process, the experienced analyst is less likely to develop blind-spots in their data analysis or get stuck in an analytical rut.

Access to an expansive, structured relational database also helps minimize the issue of missing data, one of the most significant methodological challenges to conducting SNA (Stork & Richards, 1992). Since the basic unit of analysis in SNA requires three points of data—actor A, actor B and the relationship between them—missing data on any one of these three points can effect not only that unit but potentially the entire network as each unit is measured against all others in the network. A structure database where all three points of data are requested data entry fields, such as the RPD PISTOL database, significantly enhances the ease and reliability of conducting SNA. However, like all analysis, SNA faces the data limitation of reflecting back only information which has come to the attention of the police. In this way, the network is not 'authentic' rather it is a reflection of police activity. Still, while SNA may not offer up any new piece of information not previously accessible to the analyst, it does facilitate a more holistic and quicker way to process and visualize available data which as shown in the three cases presented here, can provide valuable clues to solving cases and facilitating effective communication between analysts and officers.

The expanding role that data analysis plays in solving crimes coupled with the rise of dedicated crime analysts in most large police departments have not only increased the demand for technological tools to aid in the fight against crime, but actually offer unlimited opportunities to craft new interdiction strategies previously unavailable. These tools, however, are most effective when analysts and officers work together to achieve a level of understanding about how to integrate them into the department. As the above examples demonstrate, SNA has already achieved such a standard, revealing its importance in the identification of criminal networks and in the crime fighting mission. It can be a particularly indispensible tool for those police departments that have persistent problems with gang violence, organized crime syndicates, and drug enterprises, all of which have a particular reliance on networks of individuals working in some coordination to execute their crimes. For example, prior research suggests that positive reductive effects on crime depend not only on addressing individual offenders but also the offender's status in the group (Reiss Jr., 1986, Reitzel, 2006). In other words, from a crime reduction standpoint, police practices that focus on a juvenile's network of friends and accomplices are of particular importance because adolescents are much more likely to offend together than are adults (Reiss, 1986). As demonstrated in the case examples, SNA can deliver results for many types of crime because it makes it possible for police officers and crime analysts to have such timely and accurate information readily available for those operations that occur rapidly or unexpectedly, and useful for long range strategic planning.

To be sure, this case study has some limitations. First, we were unable to provide more in-depth analysis of the underlying social network. This was due, in part, to the nature of SNA data available to us. The strength of the RPD data was that it was in a structured form making extraction of relational data relatively easy. It was also a reflection of policing practices; the data spoke to what the police knew about crime. Since the goal of the study was to assess the goodness of fit between SNA and police data, a structured database containing most of what the police knew about offenders was ideal. However, the data *only* reflected what the police knew and did not speak to how the network functions in its natural environment. As such, the networks under analysis were comprised of relationships constructed by police action rather than purely through the agency of the individual. Future research should focus on evaluating how close a match police relational data is to that of actual, organic networks. Understanding the gaps and alignments between the two can better inform policing strategies. Secondly, we were unable to address the relationship between police officers and crime analysts in a more systematic way. The three cases we observed reveal the potential of new technologies and methodologies for improving communication between analysts and officers. A more systematic study is needed to confirm these observations.

In sum, we have come a long way from the pin point mapping. Indeed, it is the technological advancements of the past decade that has given many policing personnel much more confidence in their ability to handle the complex crime problems that plague numerous departments around the country. With the support of robust technology, SNA is a rich tool that is reliable across time, data, analysts and networks and can produce actionable results quickly inside any policing operational environment. By incorporating SNA into departmental policing strategies, police can more effectively deliver results because SNA makes it possible for police officers and crime analysts to communicate effectively because they are simultaneously conducting 'on the ground' analysis that is useful for long range strategic planning as well for operations that occur rapidly or unexpectedly.

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