PROCEEDINGS

1980 CARNAHAN CONFERENCE ON CRIME COUNTERMEASURES

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Dedication

This record of the Proceedings of the 1980 Carnahan Conference on Crime Countermeasures is dedicated to two men whose professional contributions have so greatly advanced the technology of crime countermeasures.

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COMPARING POLICE COMMUNICATIONS OF FIVE FORCES IN ASIA

by

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Introduction. This paper contains information about communication procedures in five police forces in Asia: Tokyo, Bangkok, Hong Kong, Singapore and Bombay. While the territories covered by the police vary, the population in the areas are fairly comparable. Because of the limited space only highlights of the communications, both human and hardware in nature, are discussed. The type of communication given top priority by each police force depends upon many factors: economy, culture, politics, tradition of the force, and education. Some of the factors are touched on briefly.

Tokyo

The National Police Agency in Japan places technology in a priority one status. Tokyo is in an enviable position in comparison to the large forces I observed in Asia: Bangkok, Hong Kong, Singapore, Bombay. Because of its economy, Japanese have developed legitimate services and formal systems of information, moving swiftly toward an information infrastructure based on interactive telecommunications and computer technologies. The police in Tokyo share the blessings bestowed by a technically-oriented and beneficent government. Officers have police radios in their cars, walkie-talkies on their persons. Police Communications Offices are equipped with emergency telephone complaint desks known as the Dial IIO desks, both radio and wire communication control desks, computerized patrol car locating systems, facsimile transmitters and receivers, and wire and wireless emergency alarm systems.

An emergency report can be made to the Communications Command Center through any telephone by dialing the number 110. Upon receiving such a report, the Center gives necessary instructions through radio desks to police stations, police boxes, patrol cars, patrol boats, helicopters and even foot patrol officers who carry tiny portable radio receivers. The Center is also linked by radio with adjacent prefectural police headquarters and the Control Center of the Tokyo Fire Department.

In addition, facsimile transmitters and receivers are in use for simultaneous communication between the Metropolitan Police Department and police stations in Tokyo as well as other prefectural police headquarters throughout Japan. During 1978 the Communications Command Center received 539,500 emergency reports. On the average it took a patrol car about 4 minutes 40 seconds to reach the spot after receiving an emergency report.

Tokyo also has a traffic surveillance system that gathers information automatically through vehicle detectors on streets and analyzes and displays it on the wall map display. Operators can monitor the traffic situation visually through CCTV cameras installed at important points. This system also gathers traffic information from helicopters, patrol cars and police boxes through telephone and wireless communication. Traffic information is relayed to citizens through radio broadcasts and variable information sign boards over the streets. Instructions on traffic control, regulation to police officers is relayed through telephone and wireless communication. Traffic signals are thus centrally controlled.

Interpersonal communication has continued throughout the years as centralization of technology and organizational policies grew. In Tokyo there are 95 police stations. Each station has an average of approximately 13 police boxes (Hashutsusho) or residential police boxes (Chuzaisho). The total number of the police boxes and residential police boxes in Tokyo is 1,239. In each police box, at least ten foot patrol officers who work in four shifts around the clock meet the public in face-to-face situations daily. The residential police boxes are located in the sparsely populated outskirts of the city and one police officer with his family is stationed there. An average of four patrol cars are provided for each police station.

Much has been printed about the reasons for Japan's low crime rate: a healthy economy, a homogenous society, strong family ties. Seminars conducted in the United States, reports from the Police Foundation and the city of Philadelphia praising the Japanese Police system are widely circulated by Tokyo police. Not all officers and citizens in Japan, however, share this unqualified optimism about the effectiveness of the police system or the advantages of superior technology.

A great deal of concern is being expressed

over the rising juvenile crime rate, the increasing number of crimes committed by women, and the fact that in the past few years fewer citizens report crimes to police or serve as informants. The Japanese National Police Agency conducted a study of 15,000 households revealing that unreported crime is 1.05 times that of reported crime. Rise in juvenile crime indicates juvenile crime equals one-half of adult offenses and four times the rate per 1,000 population. Officers interviewed correlate the rise in crimes committed by females to the changes in female behavior; the rise in juvenile crime to the diminishing authority of the father. A campaign urging fathers to Drop Your Thunder, using visuals of a heavy fist descending, is applauded by male officers. However, females interviewed complain of unequal labor laws; females cannot work after 10 p.m. and some employment practices discriminate against older females. In policing, the predominetely male administration's attitude toward women is still protective: the majority of women officers stand primly outside police boxes, serve at school crossings or at the desks answering 110 calls.

A white paper from the National Police Agency warns of problems of criminal gangs, stimulant drugs, juvenile delinquency, low clearance rates in crime situations, and terrorism activities. In most instances, the solutions listed in the white paper deal with stronger controls, more surveilence.

Growing concern about the changes affecting family life, such as a notable decline in attendance at religious ceremonies by young people, definite diet changes (there are warehouses of unwanted rice), the tendency for young married couples to live alone, alarm the police who are wedded more to traditional values than to the changing society. Several officers even voiced concern over the fact that young recruits do not "put the job first" as was the way with older officers.

"Are we sacrificing our spiritual well-being for our march towards mechanization?" asked a Japanese Inspector. Fortunately, the police still enjoy a good image with most of the citizens. But it will be interesting to observe the success the police have with "control" and "tightening procedures." The solutions aired involve: "arrest promptly...reinforce mobile investigation squads... improve mobile identification system...bear down on juveniles." Since the police are experiencing less contact with informants, posters, pamphlets and printed materials describing criminals are used in an effort to communicate with the people.

Hong Kong

Reaching the people is a more difficult task for the police in Hong Kong than it is in Tokyo, where police still have the public's respect. However, great strides have been made in this area since 1974. The ground swell of public response to several public relations programs is something new for Hong Kong, where traditionally most of the Chinese population ignore and avoid all contacts with police.

Technically, the biggest change in the Royal Hong Kong Police force is the completion of the personal beat radio scheme for the urban areas. The last phase of a seven year program, the Kowloon district system, was commissioned in June 1977 bringing a total of more than 600 beat patrol officers in direct contact with their respective command and control centers. A software program for the computerized information systems at control centers was also finalized in 1978. Police claim the radio system is "almost 100 percent, provided the patrol officer is near an outside wall." About 60 percent of all incidents is now attended by foot patrol officers as opposed to mobile patrol crews. Before the completion of the "set-on-the-man" program, only 38 percent was covered by foot patrol.

The system is supported by a highly efficient maintenance division which gives top priority to more than 3,800 fixed, portable and personal radios. When Vice-President Walter Mondale recently visited Hong Kong, the superintendent of maintenance called in all radios prior to his visit for complete checks.

In supporting the effort to reach the public, top priority is given to the Public Relations Division. A few years ago a Scotsman from the Daily Telegraph in London answered an advertisement placed there by the Royal Hong Kong Police and went to Hong Kong to improve citizen-police relations. He founded a program called Junior Police Call which now boasts a membership of over 200,000. In 1976 members of the public were responsible for effecting the arrest of more than 2,000 criminals. In that same period the public made 222,723 requests for police assistance, an 8.3 percent increase over 1975. Today over 200 persons are employed in the Police Public Relations Bureau covering News and Information, Publicity, TV and Films, Junior Police Call and "Off Beat," the force newspaper. The programs include 35 minutes of television and nearly three hours of radio programs every week, monitoring television and radio programs of interest to the force, arranging police presence on a wide range of current affairs, manning telephone "hotline," handling missing vehicle lists issued to the media twice daily, maintaining press cuttings reference system which is available to all formations, providing press control scenes of major crimes. Most decisions about media concerning high-ranking officers are made by Mrs. Wau, a civilian. "You are the only person who can lead the commissioner by the nose," she was told. She replied, "I am a civilian, and he cannot fire me."

The Public Relations program, one of the most extensive observed in Asia, coupled with the new thirty million command and control system has produced some results. Crime of violence trends, which reached a peak in 1974, have been on the decline, with slight increases during the past three years; of course, there are still problems with gangs, thefts and other crimes. The most heartening results of the efforts to reach the people, particularly the Chinese population, however, are evident in the number of citizens actually reporting crimes. The public still makes most of their reports directly to the police station. Last year over 9000 reports came to the stations, around 5700 reports through 999, and reports to substations and by telephone other than 999 both average around 2000. The force now boasts one officer to every 261 population. In Tokyo (as of 1975) there was one officer to every 290.

Singapore

There is one law enforcement officer for every

36 people in Singapore, according to the police monthly magazine. Actually, there are only 7,000 uniformed officers, but there are 53,000 persons in the combined special constabulary, the vigilante corps and the national service. In the special constabulary nearly 9,300 are national servicemen, the remaining 700 are volunteers. In the vigilante corps, which is made up of national servicemen, there are 40,000 youths discharging their duty to the nation. The special constabulary serves to augment the strength of the regular force in eight land divisions, in radio, marine, traffic divisions. The full-time police national service youths work right alongside police regulars involved in team policing, routine station duties or other patrol systems.

There are 1,200 portable radio sets in the force, control stations in five different locations, and fixed stations number 100.

Last year the crime rate dropped to well below 800 crimes per 100,000, the lowest ever recorded in twenty years. Police describe themselves as disciplined and controlled. The citizen interviews conducted for this study revealed a high degree of faith in the honesty of the police. However, a recent study by the police, while claiming that police enjoy a good relationship with the public, nonetheless reported the following figures: 38% of the respondents agreed with the proposition that police are never around when you need them; 28% held the view that police beat up people in police stations; 14% that they use unfair methods to get information; some 50% stated they had never read or carefully considered any police leaflets or posters; 90% had never attended a lecture of any kind given by the police; 52% had never been to a police exhibition, and 75% had never been to an open house at a police station.

All stations are surrounded by iron gates and carefully guarded by officers who insist on identification. The media comes to press conferences that are highly structured by the police public relations personnel who seldom allow questions and select items carefully for press dissemination.

A reporter told his researcher he would not print anything which threw "brickabracks" or questioned the procedure and reflected badly upon the government. He said he liked the discipline. Benefits derived from the saturation of law enforcement personnel are exceptionally clean streets; disciplined pedestrian behavior. In spite of the effort to make Singapore the vacation spot of Asia, however, the streets do get bloodied at times. During my visit, two officers, two national service men, a corporal and a vigilante traveling in one patrol car saw three men behaving suspiciously. The officer driving the patrol car stopped and ordered the men to stop. The three men ran toward a hotel, one man stopped and snatched a baton from one officer, the other two men had daggers. Two of the officers drew guns, one blew a whistle. One officer caught up with one of the men who turned and stabbed the officer. The other two men grabbed a gardener and took him into the hotel bar. The police ordered the men to release the gardener, but the men took him out to a car lot where they stabbed him. As the gardener slumped to the ground, the police opened fire, killing one man and injuring the other two.

Singapore police rely heavily on numbers more than on technology. Singapore has twenty 999 cars, Volkswagons, which aid the radio division. There are 150 other cars. The communication center is not modern. A PABX switchboard operated by "Hello Girls" (a name given affectionately by public relations personnel) relays calls to police headquarters. Dial 999 has twenty trunk lines and averages 400-500 calls per day. Records are kept manually. The control room is small, with a circular table where the female telephone operators answer calls that are then relayed to the dispatchers. A male supervisor is positioned in the hollow center of the table, elevated about the operators. No pictures were allowed to be taken and the public relations officer requested I not talk to the news media about my visit.

A superintendent claims that "discipline" is an accepted word in Singapore and does not have negative connotations. In fact, he claims most people defend the word and are proud of it. The well educated like the police more than the less educated. However, 50% of the population is under 31 and the superintendent acknowledges that "in the future we must be flexible." The gates, he explained are not there because the police are afraid of "people attacks" but of "communist attacks." He explained that Singapore is dangerously close to communist countries or countries threatened by communist countries.

Thailand

The gates to police stations in Thailand are always open. People are constantly cooking, eating, talking in the compound where the officers and their families are housed, which is always situated near the district police station and booking area. In the early morning hours before roll call, relatives wait with food to give to those in the lock-up.

Seven years ago political riots resulted in the police communication building housing modern equipment being burned. Because of the country's economic problems, little money is available for much new equipment. The communication division is, therefore, ill equipped and small. A squad of cars is assigned to Dispatch. Calls come into the 919 lines and officers dispatch the 919 cars. The patrol district cars listen to the calls and sometimes respond faster than the 919 cars. The supervisor in the control center said "I wish I really knew where the cars are;" he does not always believe the officers' responses to location. Sixty calls per day are handled by the communication center. Most of the communication between officer and citizen is a result of citizens walking to the local stations. People come to report crimes, to complain about the police, and the lack of investigation into their problems. Every station has complaint officers who fill out reports. Because of inadequate availability of financing for the police, extremely low telephone density and computer penetration, limited education skills and a relatively low literacy level, Bangkok remains on the first rung of the ladder leading to an information producing society. It is difficult to obtain national statistics. There is no time to collect them nor the technology to aid in the collection.

The police face a monumental drug problem. Attempts have been made as recently as 1978 to crack down on opium dealers and to seize caravans.

Since 1922 one fifth of all Siamese revenue came from opium. In 1959 opium was made illegal but the supply was not reduced according to a recent study by a professor in Singapore. The profits, he claims, were divided between influential individuals in the army, police force and the insurgent armies on the borders of the mountain area known as a golden triangle: Thailand, Laos and Burma.

Production of opium has increased to 1,100 times in 1978. The present policy, the professor claims, is a compromise between international pressure to eradicate it and local pressures to cultivate it. The Prime Minister can execute heroin dealers without trial and has done so. However, he claims horse caravans still carry raw opium to 20 or so refineries along the Thai border, then the drug moves to Chaing Mai, Bangkok and from Bangkok to the west.

Besides the drug problem, Bangkok officers face serious traffic problems. Fatalities are increasing.

People respond differently to officers than to constables. In a military atmosphere the officers are like commissioned personnel in the army, while the constables are like non-commissioned personnel. People interviewed expressed the opinions that the non-commissioned personnel, because of low salaries, are open to bribery. While they do not trust the officers, neither do they seem to fear them. In the hotel an officer came in and brandished his gun much to the delight of the cook who brandished his knife amidst much laughter.

Most of the communication is handled in face-to-face situations. The commissioned officers are on duty twenty-four hours a day. If they start a case they must remain with it. But for all their problems, they generally face a homogenous people who believe in smiling.

India

The people in Bombay are not smiling, nor are they listening very closely to the police. Millions of people fill the streets, working, begging, hawking their wares. There are 600,000 vehicles and over 6 million people. "We have a pedestrian problem," says the commissioner. A concentrated effort to teach school children pedestrian safety is underway. The results have reduced traffic fatalities in children "substantially" claim the officers. Adults pay no attention to the rules. "Undisciplined," report the officers.

The general structure of the Greater Bombay Police force includes a commissioner of police, two additional commissioners of police, fifteen deputy commissioners of police, excluding the Deputy Commissioner of Police, Special Branch II who is borne on the cadre of the Subsidiary Intelligence Bureau, Government of India, and other subordinate staff consisting of Assistant Commissioners of Police, Inspectors, Assistant Inspectors, Sub-Inspectors, Constabulary and the ministerial staff. They total, according to their own report, 4,953 personnel...tremendously undermanned.

The officers work long hours, seldom take vacations and communicate mainly in face-to-face situations. As in Thailand, telephone density is low.

The Deputy Commission of Police in charge of Prohibition Branch is also in charge of the Wireless Section. The wireless section in Greater Bombay, is responsible for providing wireless communication to and from the wireless patrolling mobiles in the city as well as to the Districts in the State. There are three branches (a) Mobile Section (b) Radio Telephone Broadcast and (c) H.F. Section working on Morse Code. The Mobile Section provides wireless mobiles for city patrol, C.I.D. patrol, Prohibition and traffic duties and also maintains the R.T. communication in the city. The R.T. Broadcast is used for sending look-out messages four times daily to all Police Stations in the city at scheduled times. For emergency and urgent measures, it can also be operated at any time. The H.F. Section handles wireless messages addressed to and originated from the District, Taluka and specially created stations in the State. All messages are sent in Morse Code. This section also includes the control room which is situated in the Police Commissioner's Office Building.

The Control Room is connected with Mobile Section and R.T. Broadcast Section of the Wireless Section. It is mainly divided into two sections: Information Section and Wireless Control Section. The Control Room collects and disseminates information from and to the patrolling mobiles and Police Stations through different channels on the wireless. There are seventeen wireless Mobiles which patrol various localities in the city. Each wireless mobile is manned by thirteen personnel, in a vehicle resembling a paddy wagon. When a call is received and a vehicle dispatched, the sheer numbers control the situation. The seven constables in the vehicles are not armed.

The Indian officers are inquisitive. They like to discuss an issue at length. Political pressures and enormous amounts of forms frustrate the officer. "The people do not understand freedom or the responsibility it brings. Freedom to them is freedom to do anything," is a sentiment echoed by many of the officers. Much time and effort is devoted to the "law and order division," which controls political rallies and daily gatherings to protest some aspect of the government.

The media meets with public relations officers daily in a relaxed atmosphere. A thirty year veteran of police reporting says officers work too hard, too long but that isn't a story his editors would want. He spoke of Bombay's major problem: organized crime. Prohibition laws, say the officers, are mainly responsible for organized crime and the lack of respect for the law.

The police have recently acquired a computer. The philosophy of the Indian officer differs greatly from that of the Japanese. The Japanese officer accepts the technology without question, the Indian officer spends hours discussing its advantages and disadvantages, why it is being used, how it should be handled, etc. Because of limited manpower and machines, both resources in India need and get careful attention.

Conclusion

"How do our communications compare?" is a question that was constantly asked by officers

in every country I visited. In a limited view where only the hardware is considered, Japan simply has acquired more and the officers are comfortable with the equipment! Hong Kong has a good radio system and maintains it well. Where telephone density is low, naturally the system is limited and dependence upon human interaction is more important. In a broader view of communication, considering both the humans and the hardware, comparisons are more difficult. Politics, culture, the level of education, the economy, and traditions all enter the picture, which is not clear under brief scrutiny but must be studied in depth for important elements to come into sharp focus. Police communication is greatly affected by the element of discipline and control exercised by the government. Countries visited ranged from highly controlled communication (Singapore) to free (and, according to police, "undisciplined") expression (India). Japan and Hong Kong, with different cultures, used equipment as a tool to reach the people and operate under moderate government control. In human communication trust, which was always equated with the amount of perceived corruption, was an important factor but trust could be built by a good publicity campaign. Each country was in a different stage of what could be defined as an information-producing society, ranging from primitive to advanced.

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SYSTEM ENGINEERING LAID BARE

by

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Abstract. The preponderance of literature available on the subject of system engineering is self-defeating. Our law enforcement community needs a clear and concise description of what system engineering is, what it can do to assist in developing a system, and how to use the theories embodied within system engineering. The paper points out the exorbitant amount of literature currently available on the subject, very little of which is used by individuals developing law enforcement systems. This lack of use is due to insufficient awareness, on the part of law enforcement personnel, of what is available and the esoteric nature of a bulk of the material that is available. The basic techniques of system engineering can, and should, be used by individuals designing law enforcement systems, such as forensic laboratories, communication systems, building utilization plans, etc. These basic techniques are identified and explained with specific illustrative examples of their application to the development of law enforcement communication systems.

Introduction

Over 300 books have been published in the last four years in the United States on the subject of system engineering. If a conscientious law enforcement planner wished to investigate the usefulness of system engineering for his designing efforts, and picked up one of these books at random, the chances are the few words that he would recognize as he flipped through the book would be the conjunctives, articles and prepositions. He would have to search through many titles (or abstracts) to find sound and thorough reference material that would be directly applicable to his problems.

System engineering, if properly applied, can provide a logical method to design, implement and utilize a law enforcement system. This method consists of progressing through a series of steps in sequence. These steps are listed and explained in this paper with a description of their application to developing a law enforcement communication system.

Many treatises on system engineering attempt to cover too broad an area to be of specific use to a law enforcement planner, or designer. The purpose of this paper is to assist individuals who are responsible for designing, or implementing a communication system to be used by a law enforcement agency. Suggestions, and references, are furnished at the end of the paper for those wishing to extrapolate the methods presented here for other applications.

Definitions

One of the confusing aspects of system engineering is the laxness with which words and definitions are bandied about. Only the following definitions will be used for the listed terms:

System engineering –– the logical process used by managers and technical personnel to identify problems; establish objectives, requirements and constraints; synthesize solutions of the problems that meet the objectives and requirements without violating the constraints; analyze the solutions to select the best solution, then implement and use the best solution.

Synthesize –– the application of inductive thinking to evolve the plan, design, organizational structure, etc., necessary to solve a problem or satisfy a set of requirements.

Analyze –– the application of deductive thinking to select the best plan, design, organizational structure, to solve a problem or to satisfy a set of requirements.

Project –– the amalgamated ad hoc effort of a group of individuals with a common (supposedly) goal –– in this paper, a system engineering effort.

Optimize –– improve a document, list, design, specification, program or other artifact on the basis of pre-established objectives, requirements and constraints.

Short range –– that which will be experienced, or commenced, during the forthcoming budget period.

Medium range –– that which will be experienced, or commenced, during the forseeable future.

Long range –– that which can be established only as goals.

Induction –– creation of a set of general ideas, concepts, or principles upon the basis of specific knowledge, requirements, events or actions.

Deduction –– establishing conclusions by inference on the basis of a set of established propositions which may be principles, tenets, ideas or concepts. The process of deduction is infallible if the original proposition(s) is/are true.

General

The system engineering process consists of proceeding through the following stages with the realization that the stages are not independent and that thought processes and actions performed in one stage may create the need to regress and "fine tune" the work performed in the previous stage(s).

Problem Statement —— identification of, and definition of the perturbation that caused the project to be originated.

Objectives —— the basic desire of the individual, i.e., solve the problem, remove the problem, exacerbate the problem, learn to live with the problem, etc.

Requirements —— the accomplishments that are necessary before the objectives can be attained, i.e., system performance, personnel training, real estate acquisition, equipment purchase, etc.

Constraints —— the inviolate limitations (usually resource limitations) upon methods by which the objective can be attained.

Solutions —— the different methods by which the objectives can be realized, one of which is best.

Within each of the stages, one must reiteratively perform the following processes, with a realization that emphasis on each process changes from stage to stage, and that process techniques change from stage to stage:

Synthesize —— see above definitions

Analyze —— see above definitions

Optimize —— see above definitions

Document —— post, or publish, results for scrutiny and later use.

Execute —— perform the indicated action.

For example, the process of synthesis during the problem statement phase will consist of deciding what is wrong, what people are dissatisfied, why they are dissatisfied and what equipment is not performing as required; and the process of synthesis during the solution phase will consist of developing system designs and equipment design requirements. Another example: the process of execution during the objective phase will consist of using the results of the objective phase to direct the work that is to be performed during the subsequent system requirements phase; and the process of execution during the solution phase will consist of employing a solution to alleviate the original problem.

The expansion of this iterative combination of the stages and processes listed above can be portrayed, in another framework, as a sequence of 24 steps that are interrelated and overlap in calendar time. These steps are listed below and are detailed as The System Engineering Process in the next section:

1. Problem Recognition
2. Problem Definition
3. Objectives
4. System Requirements
5. Constraints
6. System Requirements Analysis
7. System Synthesis
8. System Analysis
9. Design Optimization
10. Equipment Description
11. Equipment Analysis
12. Implementation Planning & Cost Estimate
13. System Optimization
14. System & Equipment Specifications
15. Cost Revision
16. Bidding
17. Vendor/Contractor Selection
18. Implementation
19. Operator (and/or User) Training
20. Maintenance Training
21. System Support Services
22. Operation, Improvements, Maintenance
23. Funding
24. Documentation

The System Engineering Process

Designs will be implemented only if they are technologically feasible and if they are considered, by those in command, to be economically justifiable. After they are implemented, they will remain in use only if they perform their function(s) in a manner that is satisfactory to those in command. The sequential process described below is based upon the work of Arthur D. Hall (Ref. 1) and has been polished by the author during twenty years of application on numerous systems.

Problem Recognition:

The very first step in the system engineering process is to recognize that a problem exists and to identify the problem. Many system engineering projects are doomed to failure from the beginning as a solution is sought for the wrong problem. If one is assigned the responsibility to design a new communication system he should be very certain of the reason for the assignment. Is a new communication system really the answer, or is an update of the present system desired? Is the present system really inadequate? Or was the assignment made because there were some extra funds to be expended? Or, was the assignment made because the individual assigned happened to be available? Or, or, or —— answer the question honestly and correctly before proceeding.

Problem Definition:

The problem recognition process leads into the problem definition process. Problem definition is slighted frequently with the result that personnel working on the project, or working in the organization, have a fuzzy concept of the problem and are not all working toward the same goal —— or are attempting to solve the wrong problem. Information that is required to complete the problem definition includes the following:

What is wrong with the present communication system —— people problems or equipment problems?

What communication system links are required that cannot be provided by the present system? How many of these links cannot be provided with landline facilities?

What are the sources of interference that the present system is experiencing?

How is interference affecting the present system?

Could it be, for example, that proper use of all of the features and capabilities of the present system would alleviate the problem?

Objectives:

What is your objective? Do you want to fix the present system and eliminate the problems, do you want to implement a new system to replace the present system, are you really striving for a promotion —— what is your honest objective? This question must be answered honestly and fairly. If the objectives are not recognized and agreed upon by all those working on the project, the team effort will be compromised.

System Requirements:

At this point in the project, it must be decided what the new system must be capable of doing. The greatest difficulty in this step is to avoid stating "how" the system must perform or "how" the system must be constructed. Instead, it must be decided "what" the system must be capable of doing —— the following are typical requirement statements:

How many individuals will need to be supplied with communication facilities (telephone, mobile radio and portable radio) initially and in the future as the system grows?

Will the individuals that require radio facilities need to talk to each other, a central dispatcher, several dispatchers, other agencies, originate telephone calls from their radio, receive telephone calls with their radio, and so on? In other words, who needs to talk to whom?

What capabilities, features and installations are required for the telephone system that are not already provided? Are these capabilities, facilities and equipment items available?

Is only voice communication required, or will voice and data be required? What special provisions are necessary for the data?

Is automatic identification of originator of each radio call necessary?

Will automatic location of automobiles, or individuals, be a necessary system requirement when technology and/or funds enable such a capability?

Is paging required? Public address, tone-and-voice radio or tone-only radio? What area of coverage is required?

What growth in these requirements is expected in the future?

This list can go on and on, but as it is expanded it will tend to become more and more detailed. It is apparent that the generation of this list must be accomplished with a knowledge of what technology has to offer in the way of capabilities and how much money can be spent on the system —— i.e., the constraints.

Constraints:

The constraints upon implementation of the ideal "dream" system must be recognized. Constraints consist of funding limitations, legal restrictions, hardware capability limitations and human frailties. It should be realized that more systems are destroyed (or never implemented in the first place) because of people than for any other reason. Some ways in which people negate system engineering are personal animosities, personal self-centered goals, lack of operator training, lack of maintenance training and lack of management understanding. All of these deficiencies and impediments must be recognized and taken into account or removed by training, cajoling or briefing.

System Requirements Analysis:

The five steps listed above require an intimate knowledge of the law enforcement operation that is to be served, but require only a modicum of technical expertise. When system requirements analysis must be performed, a detailed knowledge of existing technology is required. Decisions such as use of portable radios versus use of mobile radios, use of telephone lines versus use of microwave links, use of selective calling techniques, use of trunking and other macroscopic trade-offs must be made. The basic question that must be answered is "What do the requirements mean in the way of macroscopic system design?" This step leads into detailed system design, known as system synthesis.

System Synthesis:

The successful consummation of this step requires technical expertise which, usually, is beyond the resources available within an average law enforcement agency (Ref. 2). If the individual responsible for the project has not obtained outside help for the previous steps, he will probably need to bring in outside assistance at this point. System synthesis requires the application of inductive logic to investigate all possible solutions to the problem, which will enable reaching the objectives and to satisfy the requirements without violating the established constraints. Imagination must be used during the synthesis step to avoid stereotyped thinking and the omission of viable solutions. The mark of a good system engineer is the ability to develop numerous practical solutions to a problem without becoming stuck on any one of them until the next step —— system analysis.

System Analysis:

The system analysis step is the point in the project where the method, or system, that will be used to achieve the objective is selected. This requires evaluating each synthesized solution by deductive logic and, perhaps use of modeling (Ref. 3) and/or other mathematical tools (Ref. 4). The experienced system engineering practitioner will perform some optimization (Ref. 5) of each synthesized solution to determine the relative potential of each solution.

Examples of the application of this step to law enforcement communication would be:

Compare the use of mobile units versus the use of portable units.

Compare use of UHF frequencies versus VHF High Band or 800 MHz frequencies.

Trade-offs between the use of wire-line, cable, fiber optic and microwave point-to-point facilities.

Trade-off between the use of the services provided by a franchised communication company and the use of leased or purchased equipment.

Identify the programmable features to be available for implementation in the telephone system.

Design Optimization:

The solution, i.e., the system, selected in the system analysis step is examined carefully and improved to maximize its capabilities while minimizing its cost. Design optimization of communication systems includes decisions typified by the following:

Transmitter tower height versus antenna gain versus transmitter power output versus range.

Location of antennas on mobile units (roof, trunk, etc.) versus range and transmitter power output.

Final selection of features available for each telephone instrument in the system.

Final selection of computer hardware and software requirements.

Equipment Description:

Describe the equipment that is to be used to implement the solution to the problem. The trap that many people fall into at this point is the tendency to attempt to design the equipment

needed for implementation without sufficient regard to what is available already, i.e., they attempt to "reinvent the wheel."

Equipment Analysis:

Review the equipment described in the above step and determine if it is the best way to implement the solution. Are there alternate equipment complements that will do the job? Is some R&D necessary to modify existing equipment or develop new equipment, or can equipment already available do the job? How much of the equipment on hand can be used?

Implementation Planning and Cost Estimation:

Determine how the system of equipment items will be implemented. How will it work, how much will it cost, how much will it cost to install it, how much will it cost to maintain it, how much will it cost to operate it, what is its total system life cost?

System Optimization:

Review the work performed in all of the above steps and determine if the correct approach is being employed. Are there other ways to solve the problem that are more efficient? Here is the opportunity to correct mistakes and to perfect the work performed on the project before large sums of money are committed.

System & Equipment Specification:

Specify the equipment that will be required to implement the solution. Do not over-specify and do not under-specify, specify only what is required. Potential vendors should be invited to review the specifications to check if the specifications contain requirements that are biased or prejudicial and to determine if they can bid the specifications without taking exceptions.

Cost Revisions:

Refine the original cost estimates on the basis of the work performed during the system optimization and the specification steps. Information necessary for this step can be collected from the vendors as they review the specifications. The vendors should not be asked for their expected bid costs, but they can be asked for list prices and normal installation costs of the equipment specified. Experience and discussions with others can provide expected discounts based upon volume and a system bid.

Bidding:

Obtain three honest and compliant bids to implement the system, or justify directed procurement.

Vendor/Contractor Selection:

Select and justify the best vendor (or contractor) to do the job.

Implementation:

Ensure that the equipment and system implemented is the one that you specified. The final system should be tested thoroughly to determine if it meets all of the specified requirements. The specifications must state how and when the system is to be tested.

Operator (and/or User) Training:

Trained operators must be available to operate the system, or else why build it in the first place? The users of the system must be trained to operate it or the system will be employed at less than full efficiency, and may not be accepted or used at all.

Maintenance Training:

The system must be maintained or it will gradually disintegrate, or become inoperative.

System Support Services:

The system must be supported by supplying operating personnel, maintenance personnel, spare parts and operating spares.

Operation, Improvements and Maintenance:

After the system is installed, operating and accepted, it must be kept in operation, it must be technologically up-to-date, it must be expanded as requirements expand and it must be continuously maintained. If this step is not executed properly the original problem for which the system was developed to eliminate will reoccur.

Funding:

If the personnel who control the purse strings aren't satisfied with the solution, the original problem will not have been solved.

Documentation:

The work performed during each of the above steps should be documented for the benefit of you and your successors.

Extrapolation

The application of system engineering to the development of a law enforcement system is an extremely specialized (but worthwhile) use of this powerful tool. System engineering can be useful in all projects which involve finding solutions to problems involving people, or people and equipment. Exemplary applications include city planning, designing of industrial operation and control systems, resource management, investment planning, designing of business management systems, transportation system design, land use planning, health care planning, communication system development and development of training programs. Each of these applications of system engineering employs the sequentially and iterative application of the five stages (problem statement, objective, requirements, constraints and solutions) which must be operated upon by the five processes (synthesis, analysis, optimization, documentation and execution). References 6 through 8 describe the use of system engineering in these, and other, areas. Reference 6 is one of a series of eighteen books on system engineering and analysis published by John Wiley & Sons. Reference 4 presents mathematical tools for the extremely rigorous application of system engineering techniques to a variety of problems. The periodical "The Journal of System Engineering" published by the University of Lancaster, Department of Systems; Lancaster, England is constantly presenting new material in this area.

An individual interested in other uses of system engineering should peruse these references and, if desirous of a further depth of information, look at subject cards on "System Engineering," "Operations Research" and "Information Theory" in any large technical library.

Caveat

The need for system engineering was recognized over sixty-five years ago by William Durand (Ref. 9). Catastrophes such as the Mulholland's St. Francis Dam failure in 1928 (Ref. 10), and World War II necessities illustrated by the allied bombing aircraft losses and accuracy problems, spurred the development of operations research. Subsequent to the war the industrial community seized upon operations research, modified it to the discipline we now call system engineering (and also systems engineering) and used it to save time and money, and to aid projects used to develop such systems as Loran, Television, TD–2 Microwave System, weather satellites, automatic process control system and a host of others (Ref. 1).

In the 1950's the terms "system engineering" and "system engineers" became glamorous, and abounded in the popular