PRELIMINARY DESIGN
OF A BOOKING INFORMATION SYSTEM
FOR THE CITY OF COLUMBIA, SOUTH CAROLINA

by

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in
Systems Engineering

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Committee Chairman: Benjamin S. Blanchard
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(ABSTRACT)

A need has been identified for a booking information system (BIS) for the City of Columbia, South Carolina to automate the arrestee booking process, collect booking information and images, and transfer information to a records management system.

This project presents problems to be solved by a BIS, a conceptual design, requirements generated for a BIS, then subsequently a life-cycle cost analysis and a preliminary design. The design utilizes commercial-off-the-shelf hardware and software components to promote compliance to industry standards, ease-of-use, reliability, and flexibility. Market surveys and maintenance provisions are included.

Benefits of a BIS include enabling law enforcement personnel to make better decisions through access to complete information; streamlining the information process; and making booking more efficient allowing officers to spend more time preserving public safety.
This project is dedicated to my husband, Mark.

His unending dedication and support were a source of constant motivation.
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1.0 INTRODUCTION

1.1 Purpose

This is a systems engineering project. That means I have applied the classic ‘engineering process’ to plan and design a system to solve a problem, in this case lack of efficiency and data integrity in the arrest booking process in the City of Columbia, South Carolina. What is the engineering process? According to Dr. Harold A. Kurstedt, Jr. of Virginia Polytechnic Institute and State University:

“Guided by fundamentals and governing natural laws, the engineering process aims to convert matter and energy into beneficial orientations within the application system to serve a user by supporting, joining with, and assuming the nature of the application system.”

The engineering process comprises functions, rules guiding the functions, and a mentality oriented toward the mission of the process. The engineering process functions include: analysis, design, follow-through, implementation, and follow-up. This can apply to anything that is ‘engineered.’ Rules are specific to the engineering discipline(s) employed to design the system as well as natural, physical, and scientific laws. The follow-up and follow-through functions imply a continuous, closed-loop process employing feedback. In other words, involving the user and ensuring that whatever is designed does what it is supposed to do. When discrepancies are identified, a change is introduced to correct the discrepancy (follow-through), and the end result is assessed (follow-up).

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When we apply the engineering process to a system and its life-cycle, we are in effect employing the system engineering process. The system engineering process aim is to meet a specific set of requirements. Every time the system engineering process is applied to a different system, it must be customized in terms of level of engineering effort to meet the system users’ needs in the end. The system engineering process is parallel to the classic engineering process and begins with recognizing a need that can be met through a system. From there, requirements analyses are conducted and the stages of design are employed. System design is employed in three phases:

1. Conceptual Design (Identification of Need)

2. Preliminary Design (Functional Analysis, Design Criteria, Optimization, Definition)


Preliminary design and detail design are somewhat closed process loops in that they both employ feedback to ensure all design phases meet user requirements. This project will primarily cover conceptual design and preliminary design. The need will be identified, requirements will be defined, the design will be conceptualized, and components will be selected based on system optimization. The goal is to lay the groundwork (through conceptual and preliminary design) for ultimately solving a problem (after detail design and implementation). From this project, final detail design activities can be performed, and prototyping activities can be started.
1.2 Current Situation

The city of Columbia, South Carolina has problems relative to their booking information. The City arrests approximately 300 subjects per month and captures all related information manually. Arrest processing takes place in the County Jail. Information is captured again and stored at City Hall.

After recording arrestee information, taking mugshot pictures, and rolling fingerprints, arresting officers subsequently misplace approximately 6% of the materials (arrest reports, mugshot pictures, and fingerprint cards). While this percentage seems relatively low, consider that the lost material represents arrestees who may become repeat offenders. If arrest materials from the first arrest are lost and never considered, the arrestee will not be treated with the severity of a repeat offender, and may be released prematurely. The City needs a means of permanently archiving arrestee information for 100% data retention as opposed to 94% data retention.

Once a subject is booked, their hand-written arrest report is sent to City Hall for data entry into an antiquated Unisys mainframe. The booking process is depicted in Figure 1-1. Five data entry clerks input various reports into the mainframe. Two clerks are dedicated full-time to entering and filing booking reports, and cataloging mugshots and fingerprint cards. The data entry clerks work 35 hours per week Monday through Friday and must each process 150 arrestees per month to keep up with the current arrest rate. This equates to a rate of approximately seven per day or one per hour. The City employs two data entry clerks full-time to capture data that has already been captured once before at the source.
Figure 1-1 Current Booking Process

There is no mechanism on the mainframe to check for a repeat offender until night-time processing takes place and past records are searched. Each arrestee gets processed as if they had no previous record. Data entry for repeat offenders is also repeated for each offense. There is no way to determine during the data entry process that the arrestee is already in the database, and then to extract the static arrestee data into the new record so as not to repeat entering it. There is no checking for errors; if an error is made, it may never get discovered. **There is no time-savings in processing repeat offenders; data for all arrestees is entered as if for the first time.**

The speed and accuracy of data entry is directly related to the legibility of the arrest reports. The arresting officers have a great deal of paperwork to complete when arresting someone, and try to accomplish it as quickly as possible. Often, portions of the arrest report are illegible and are misinterpreted by the data entry clerks. Additionally, because the arresting officers are in a hurry, at times the arrest reports are incomplete with vital fields of information missing. The mistakes and omissions amount to approximately 20% of all booking reports being either erroneous or incomplete. Errors are rarely if ever discovered later. While omissions may be discovered, it is
almost impossible to find the correct data and then back-fill it into the mainframe. Judges and
other justice personnel are making sentencing, incarceration, and parole decisions based on
inaccurate or incomplete information. That means arrestees could be incarcerated longer than
necessary, costing the City money for food and housing. Worse, they could be released earlier than
they merit, or when they in fact deserve a life sentence, now free to wreak havoc and possibly
threaten the lives of innocent citizens. The possibility exists of a seasoned repeat offender of
violent crimes treated with the leniency of a first-time, minor criminal who swears never to wrong
again. The life-time criminal who is set free could commit murder. This could be prevented
through 100% complete and correct information. The City needs a means of ensuring booking
reports are 100% legible and that all mandatory fields of information are completed so
justice personnel have accurate bases of information for decision-making.

300 arrestees are processed in Columbia per month. For each arrestee, one arrest report, two to
four mugshot pictures, and three fingerprint cards are mandatory. Of the three fingerprint cards,
one goes to the Federal Bureau of Investigation, one goes to the State, and one is kept in Columbia.
In addition, evidence and personal effects are often kept in an evidence room. Arrest reports
include demographic data about the arrestee (date of birth, hair color, eye color, height, weight,
etc.) and information about the arrest. Mugshots are taken with a Polaroid camera and include
front and side pictures, sometimes with and without glasses. Fingerprint cards include a variety of
fingerprints as well as demographic information about the subject (a subset of the arrest report
data).
The City requires arrestee information to be stored for five years before being taken into long-term storage. This means after five years the City will have 18,000 arrest reports, up to 72,000 mugshots, and 18,000 fingerprint cards. Once data entry has been complete, the paper arrest report is filed by arrestee number. The City's copy of the fingerprint card along with the mugshots are paper-clipped to the arrest report and stored by arrestee number, which is assigned chronologically. There is no cross-referencing. Once an arrest report has been filed, it can be extracted most efficiently by arrestee number. If the arrestee number is unknown but the approximate date of arrest is known, the arrest report can usually be found from a group of reports after some searching. This cumbersome, non-relational method of tracking and finding arrest reports allows no statistical analysis of data and discourages research that could aid crime-solving.

The City's manual methods of collecting information results in 6% of all arrestee materials to be lost; 20% of all arrestee materials to contain information that is erroneous or incomplete; decisions on 20% of all arrestees to be based on wrong or incomplete information; 0% statistical analysis; and two full-time data entry clerks to perform original data entry for all arrestee material. The requirement to maintain five years of data provides no benefit that a file cabinet doesn't. Collecting data manually at the source and then re-entering it perpetuates errors and omissions that result in some arrestees being incarcerated longer than required, and others being released when they should not be. The City has considered exploiting technology and automation to satisfy their booking information needs. Table 1-1 depicts Columbia's current booking-related problems and their associated impacts.
Table 1-1  Current Booking Process Problems and Impacts

<table>
<thead>
<tr>
<th>Problem</th>
<th>Impact</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arrest information is captured twice</td>
<td>Duplication of effort; labor cost</td>
</tr>
<tr>
<td>Six percent of arrest materials are lost</td>
<td>Lack of decision-making ability; premature release; civil liability</td>
</tr>
<tr>
<td>Twenty percent of arrest materials are incomplete or erroneous</td>
<td>Incorrect sentencing, incarceration, and parole decisions made; civil liability</td>
</tr>
<tr>
<td>Hand-written arrest reports are misinterpreted by data entry clerks</td>
<td>Data entered incorrectly at City Hall; incorrect decisions being made; civil liability</td>
</tr>
<tr>
<td>No search or analytical capability</td>
<td>Crime analyses not optimized; future crimes that could be solved or prevented aren’t</td>
</tr>
<tr>
<td>No permanent archive</td>
<td>Inability to form arrestee histories to aid in decision-making and prevent future crimes</td>
</tr>
<tr>
<td>The booking process requires unnecessary officer time</td>
<td>Officer patrol time decreased; public safety adversely affected.</td>
</tr>
</tbody>
</table>

The City’s problems could be mitigated through a system designed to retain ALL booking information, provide flexible access to information, eliminate hand-writing interpretation, and ensure mandatory arrest report fields are completed.

If the City elected to procure a system to automate their booking process and information archival, a system would need to fall within their budget constraints. From a life-cycle cost perspective, the City can allocate up to $700,000 for initial system design, development, and deployment. After that, they can budget up to $150,000 a year for the system’s first five years of operation and maintenance.

1.3 Recommended System Concept

The recommended system concept for the City of Columbia is to develop and deploy a system that automates the collection and management of arrestee information and transfers it directly into the court system. While the textual data is what is used to make decisions, a complete arrestee file
also includes mugshots, evidence, personal effects, and fingerprint cards. A system developed to collect booking information electronically should collect all information, and should also be aligned with the City’s strategic technology direction. Therefore, the solution recommended for Columbia is a Booking Information System (BIS) that includes the following capabilities:

- Automates the collection of arrestee information, mugshots, evidence, personal effects, and fingerprints
- Ensures all mandatory fields on the arrest report are completed prior to saving the report
- Transmits arrestee information (data and images) directly to the City’s court system (future RMS) to avoid hand-writing interpretation and data entry entirely
- Prints arrest reports, mugshot pictures, evidence/personal effects pictures, and fingerprint cards
- Archives arrestee information and images for historical and backup purposes, preventing arrest materials getting misplaced
- Supports Columbia’s strategic technological goals
- Is easy for arresting officers to use and for system personnel to maintain
- Falls within the City’s budget constraints.

To promote speed, efficiency, and future growth, the BIS should be designed using client/server architecture and open systems technology. Non-proprietary hardware and software should be used. Commercial-Off-The-Shelf (COTS) components should be employed wherever possible to ensure
compliance to industry standards and promote maintainability. The system should be designed to support and improve upon the City's current arrest booking processes.

1.4 Benefits

Expected benefits for a BIS are both immediate and long-term. Immediate benefits can be realized by police officers and other booking personnel. This system will automate the process of collecting personal history information, taking mugshots, recording personal effects, and collecting fingerprints. Instead of using more manual means, officers will be guided by a computer and offered electronic means of collecting information. This will be quicker and easier for booking personnel.

Also, automating the process of completing arrest reports can add the ability to mandate that certain fields are filled to allow complete decision-making by judges and prison personnel.

By collecting arrest information electronically at the source, it can be entered at the court system exactly as it was entered by the arresting officer. This eliminates the need for data entry personnel to interpret illegible hand-writing and possibly enter incorrect data in the court's system. This also eliminates the requirement for the two dedicated data entry positions, allowing the City to re-deploy those personnel to currently unfilled administrative positions. This will save the City approximately $125,000 per year on salaries, benefits, and training.

The current cost to the City in terms of releasing criminals prematurely and other outcomes of insufficient data for decision-making currently cannot be quantified. For budgetary purposes, however, a life-cycle cost analysis will be performed to help the City of Columbia decide how to proceed with a BIS.
Currently multiple copies of fingerprint cards are required for an arrest. An officer must physically take a subject’s fingerprints for each copy needed. This is time-consuming, messy, and inconvenient. If fingerprints could be taken electronically, without ink, officers could immediately re-do individual fingers instead of the entire card if one mistake is made. They could also print multiple copies from one fingerprinting session. This would be cleaner, easier, and much more efficient than the current manual method.

300 arrestees are processed per month in Columbia, each requiring approximately 40 minutes to process, detaining at least one officer for that amount of time. Based on the author’s experience during a one-year pilot of an automated booking system for the Drug Enforcement Agency (DEA), several field offices were able to cut their booking time by an average of 50% in going from a manual method to an electronic method.² The DEA booking agents captured the same general information as the Columbia officers do. Using this experience, it is anticipated that Columbia could save half the time they currently spend processing arrestees, and return officers to the street sooner. 100 hours per month could be saved, allowing officers to devote more time to public safety.

Long-term benefits encompass the information storage and retrieval aspects of the system. If copies of arrest reports, mugshots, or fingerprint cards are ever needed, they can be searched for on the system and printed. More important, if past information on a criminal is required for sentencing decisions, it is easily attainable. Also, criminal information can be maintained and tracked as the criminal progresses through the justice system. Decisions on release and incarceration can be made with confidence; saving money when a prisoner can be released with

² Based on actual time study in three DEA field offices.
certainty and no longer a liability to the City, and preserving public safety by continuing to hold a prisoner who is assessed as still being a menace to society. This information can also be shared with other systems and agencies as necessary.

1.5 Project Methodology

The methodology for this project was determined by considering several factors:

- First and foremost was the System Life Cycle Process as detailed by Benjamin S. Blanchard and Wolter J. Fabrycky in their book Systems Engineering and Analysis (Figure 2.4, page 22).

- One goal was to employ techniques and procedures I had employed successfully at work to develop and integrate systems for clients. Coming from a consulting/systems integration background, I tried to work in a manner I felt was realistic based on past and present client expectations. I took into account priorities that were perhaps less academic and more customer-oriented.

- A study of available technology was done to determine which system components could be COTS and which needed to be custom-developed.

My project is a preliminary design. According to Systems Engineering and Analysis, preliminary design encompasses the following:

1. Conceptual Design (must be accomplished before the preliminary design can begin)

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4 Background includes work for Booz, Allen & Hamilton Inc., GTE, and Unisys Corp.
• Feasibility Study (Needs Analysis, System Operational Requirements, System Maintenance Concept)

• Advance Product Planning

2. System Functional Analysis

• Functional Requirements

• System Operational Functions

• System Maintenance Functions

3. Preliminary Synthesis and Allocation of Design Criteria

• Allocation of Performance Factors, Design Factors, and Effectiveness Requirements

• Allocation of System Support Requirements

4. System Optimization

• System and Subsystem Trade-offs and Evaluation of Alternatives

• System and Subsystem Analyses

5. System Synthesis and Definition

• Preliminary Design

• Detail Specifications

In simplest terms, I have identified a need, formed requirements, conceptualized a system design, allocated the requirements to components, performed trade-off analyses, and
combined the components into a preliminary design. The following paragraphs my project methodology.

1.5.1 Conceptual Design

Conceptual system design is performed prior to in-depth requirements identification. It entails identifying a need, performing a feasibility analysis, defining operational requirements, and detailing a system maintenance concept. In this project, a need for a BIS will be described, as much as possible in terms of quantitative factors. It is anticipated that if the City of Columbia elected to develop a BIS, they would go forward with a complete needs analysis and further define quantitative system factors.

The system operational requirements describe how the system must meet Columbia’s needs, and what conditions the system will be operated under. Environmental conditions have been described. The system maintenance concept in this project will drive system maintenance requirements. In this concept, the various component manufacturers must be included for optimum availability results. Columbia personnel cannot expect to be able to repair all potential failures as well as the manufacturer can. The down-side of using components that Columbia has not developed themselves is that they are not equipped to handle all failure scenarios that can arise. Given the operational requirements of a BIS, a ‘spare then repair’ strategy is included in the maintenance concept. The maintenance concept presents anticipated levels of maintenance support, who is responsible for support, repair policies and/or constraints, and the maintenance environment.
1.5.2 System Functional Analysis

System functional analysis bridges the gap between the need and the preliminary design. It brings the operational requirements a step further by describing what functions the system must perform to meet the users' needs. The systems life cycle process says that *not one piece of equipment should be defined or acquired without first justifying its need through the functional requirements definition process*. This refers to both COTS and custom-developed components. Through my methodology I have tried to use COTS components wherever possible after ensuring the individual COTS components can be justified, are highly reliable, are of good quality, and meet the City's requirements. If through functional requirements definition there is no COTS component available, then the decision must be made whether to develop that component from scratch, or to use a combination of COTS and custom components. In the case of a BIS, I have elected to employ a baseline COTS software product for the user application and then customize it to meet Columbia's booking needs since no COTS component does today.

In this project, all functional requirements were defined in terms of several categories including: system level, technology, data entry, image capture, storage, user interface, security, reporting, display, etc.

1.5.3 Preliminary Synthesis and Allocation of Design Criteria

This involves allocating the requirements specified previously to actual subsystems and components. It means ensuring that system components can meet the functional requirements so that design can be conducted responsibly. Using COTS products, all functional requirements were allocated to hardware and software components, with the exception of requirements that will be filled by a custom-developed software application using COTS software tools.
1.5.4 System Optimization

Requirements establish constraints that system components must lie within. For each component type, two or three alternatives were identified as a result of a market survey. Requirements allocation was performed along with component trade-offs. In some cases, one component met the stated requirements more effectively than another. In other cases, all parameters being equal, cost was the deciding factor. In still others, all components of a category met the stated requirements, but one went further in additional capabilities and thereby proved to be the better value.

1.5.5 System Synthesis and Definition

Once the system components have been evaluated and selected, system synthesis can ensue. This entails combining and structuring the separate components in such a manner as to form a functioning system. In this project, a system architecture was first defined and separate servers and workstations were specified. The components that made up the servers and workstations were defined. Each component was treated as a system, with inputs, outputs, and processes. The combination of the various hardware and software components made up the preliminary design.

The software application needed to tie all functionality and peripherals together was not available as a ready-to-use COTS product. A suitable application development tool was identified, but the functionality of the resultant application needed to be defined. A software specification was created so that the requirements of the custom-developed application were defined. A life-cycle cost analysis was performed to ensure the City's budgetary requirements were met, both for initial research and development and investment, as well as yearly operations and maintenance.
1.6 The Commercial-Off-The-Shelf System Alternative

I have approached this project as I would approach any major system project in all of the three major companies I have worked for. A large part of my approach relies upon Commercial-Off-The-Shelf (COTS) components, which most systems integrators today rely upon, after justifying their use. There are several reasons for this, among them:

- **The advancement of technology.** Technology has proliferated such that an abundance of COTS components are available for practically any function needed by organizations today. This obviates the need to design and build unique, single-use components. It is often beneficial to capitalize on the labor of a manufacturer who specializes in components required by an organization. Chances are, that manufacturer has already invested a great amount of research and development money, and if they specialize, they are considered experts on that particular technology.

- **Compliance to standards.** There are several industry standards, such as Microsoft Windows, that manufacturers are eager to embrace. This benefits the integrator, and subsequently the user, tremendously. Historically, before some of the overwhelmingly popular standards of today emerged, it was commonplace to identify components for their functionality only to be burdened by a large integration challenge. Many mass-consumption components were designed and manufactured with little or no regard to interface commonality. Companies developed their own proprietary standards, and components would work together with only other components made by the same company. Organizations were limited by one company’s components; there was no “best of breed” selection criteria. Today, with many manufacturers developing to the same standard, organizations can buy with confidence, knowing that if they
adhere to a prolific standard for all their components, they will not have an interface problem. The integration challenge is lessened, and the accompanying risk is mitigated.

- **Quality.** The quality assurance testing has already been done. A large part of any component-development task, whether the component is hardware or software, is testing. Today's mainstream manufacturers cannot afford to inject a new product into the marketplace only to have a consumer discover bugs or failures. Manufacturers place large emphasis on testing to assure users they have purchased a quality component. They simply cannot afford to have their reputation be adversely affected by poor quality. A large manufacturer can afford to put forth a huge testing effort before mass-producing an item; certainly more than an organization can afford to do when developing a single component.

- **Time is of the essence.** With shrinking budgets, organizations cannot afford to wait years before something is developed uniquely for them. Also, planning cycles are shrinking; organizations identify a need today and often want to see that need filled in the near future. The ability to pick up the phone or look through a catalog to select appropriate components is invaluable. Also, new technology is emerging so quickly that by the time a unique component is designed, tested, and built, it is almost guaranteed that the capabilities of that component would already be eclipsed by newly-introduced products.

- **Cost.** It is almost unthinkable to consider designing, developing, testing, and manufacturing a unique component when similar-function COTS products are available at a fraction of the cost. The cost of technology is inversely proportionate to the advancement of technology. For example, a PC with a 66 Mhertz clock speed today costs approximately what a PC with a 33 Mhertz clock speed cost a year ago. What if there is no similar-function COTS product?
Often, it is more time- and cost-effective for an organization to start with a baseline COTS component and customize it themselves, pay an outside party to customize it, or pay the manufacturer to customize it than it would be to start from scratch. This assumes that a COTS component can be justified. If the component has an initial cost that is lower than custom developing but turns out to be a quality and reliability nightmare, chances are the organization spent more money and time than they had planned.
2.0 CONCEPTUAL SYSTEM DESIGN

The conceptual system design for the City of Columbia’s BIS includes the definition of need, feasibility analysis, system operational requirements, life-cycle cost goals, and a system maintenance concept.

2.1 Definition of Need

Currently, Columbia’s police officers hand-write arrest reports for subsequent entry into the current court system. This information is used by judges to make final disposition and sentencing decisions, as well as by jail or prison staff to understand the nature of the arrestee’s crimes and treat the arrestee accordingly. Approximately 20% of the arrest reports currently are misinterpreted by the court’s data entry personnel due to illegible hand-writing. That means the reports for 60 arrestees every month (based on 300 per month) are entered incorrectly into the court’s system. Judges and prison personnel are making decisions based on inaccurate data. Arrestees could be incarcerated for longer than necessary. This costs the City money to house and feed those arrestees. Conversely, arrestees could be paroled earlier than their crimes merit, or worse, they could be paroled when they actually do not merit release at all. This negatively impacts public safety.

Also, the City’s officers cannot keep up with current demands on their time. They are spending time on administrative duties, such as processing arrestees, that is detracting from time spent patrolling the City. Processing each arrestee requires approximately 40 minutes once at the station. For a booking system to be worth their while, it must allow the City to decrease this time by at least 25% so that the officers can spend more time preserving public safety. Saving 10
minutes on each of the 300 arrestees processed per month will grant the Columbia Police Department an additional 50 hours to devote to patrol each month.

Approximately 15% of all arrest reports currently are incomplete since there is no mechanism to ensure that all mandatory information fields are filled. Once an omission is discovered, it is virtually impossible to find the information retroactively. Often, information crucial to sentencing or incarceration decisions is missing. Since information is not collected at the source, there is no way to guarantee data integrity once it is entered at the court system. To prevent missing information, the City needs to impose constraints on the booking report process to mandate that certain fields, at a minimum, are completed.

Also, funding for Columbia is getting tighter. The City currently employ two data entry clerks who do nothing but type the hand-written arrest reports into the court's system and then file arrest materials. If arrest reports were automatically sent to the future RMS, the data entry personnel could be re-deployed to needed administrative positions that are currently unfilled. The City would not have to spend money to hire additional personnel. Salary, benefits, and training for the data entry personnel each year amount to a total of $125,000. This money could be invested in other things with the advent of an automated system.

The City has budgetary constraints. The concept of a BIS is not new to them, and they have managed to allocate $700,000 as an initial investment to design, develop, and deploy a BIS with $150,000 per year allotted to system operation and maintenance for five years. Any system would have to undergo a life-cycle cost analysis to ensure it fell within the City's budget.
The need, therefore, is to:

- Eliminate interpretation of hand-written reports and attain 100% accuracy at the court
- Impose constraints on booking form completion and ensure mandatory fields are filled
- Allow judges and prison personnel to make decisions based on complete, accurate information
- Save the City money by releasing arrestees when they merit freedom (based on complete, accurate arrestee information)
- Devote more time to public safety / patrol; induce at least a 25% savings of every booking session.
- Improve public safety by holding arrestees for as long they deserve (based on complete, accurate arrestee information)
- Eliminate the court data entry function, re-deploy current data entry clerks to currently-unfilled administrative positions, and eliminate the need to spend money to hire additional personnel for those positions. (Saving approximately $125,000 per year.)
- Fall within the City’s budgetary constraints.

2.2 Feasibility Analysis

The purpose of a feasibility analysis is to evaluate the viable technical approaches that can be applied in developing a system. These include: communications, component make or buy decisions, and processor method.
2.2.1 Communications

The BIS has a requirement to communicate with the City of Columbia’s RMS. Viable alternatives include: a dedicated leased line or utilizing public switched phone lines. Communication must be one-way only, that is, the BIS must transfer files to the RMS; there is no need for the RMS to transfer anything to the BIS. The amount of communications time required each day, calculated in the Performance Requirements subsection of this report, denotes about 25 minutes. The nature of the information to be communicated is sensitive but not proprietary: mugshots and personal history information of arrested individuals. The cost of a leased line varies considerably depending on the technology used (T1, Fractional T1, etc.), but the set-up charge and monthly utilization charge are invariably more than 25 minutes per day of local phone charges. The amount of communications per day, and the nature of the data to be transmitted make public switched phone lines most feasible. If the City elects, they can encrypt the data sent over the public switched line, thereby eliminating any future concern for privacy of data.

2.2.2 Make or Buy Decision

Decisions often encountered by organizations embarking on system development regard whether to build from scratch or to buy COTS system components, both hardware and software. The project assumes a COTS-buying tendency, predominantly due to the reasons cited in the Commercial-Off-The-Shelf Concept subsection above. Columbia does not have any system needs that are unique enough to merit building hardware components from scratch. Columbia does, however, follow a specific process for booking individuals, and has data fields and requirements in their booking report unique to them. There is most likely no COTS software product that can satisfy Columbia’s unique booking needs. There are several COTS application development packages available that
will allow Columbia to adhere to the standards requirements they have set while programming to their own operational requirements. This makes the most sense and is most feasible. Columbia would have to totally eliminate many of their booking procedures in order to take advantage of commercial packages right off-the-shelf, with no customization at all. On the other hand, to develop an application totally from scratch is unnecessary, and would be time- and cost-prohibitive.

2.2.3 Processor Method

There are various processor methods available to the City of Columbia for their future BIS. They include: mainframe, high-end workstations, and Intel-based PC’s. Using a mainframe is not feasible here. Mainframes are generally used in configurations when a sizable investment has already been made in a legacy system, or are introduced in enterprise-wide systems that track millions of records daily. Today they can cost in the order of magnitude of hundreds of thousands of dollars, and can require specialized talent to maintain. The term ‘high-end workstations’ as used in this project denotes processors such as the Sun SPARC or Hewlett-Packard RISC (Reduced Instruction Set Computing)-based processors. These processors are UNIX-based and support a different array of products that are not necessarily Microsoft Windows-compliant. Introducing disparate systems into the City’s computing infrastructure (based on Windows PC’s) is unnecessary and impractical as it would require a different maintenance concept and different skill-set to support and maintain. Intel-based PC’s are quite appropriate and feasible for Columbia’s needs. They are cost-effective and are available with an abundance of RAM (at least 128 MBytes), hard disk (at least 2 Gbytes of SCSI-based hard drive), and clock speed (66 Mhertz is now standard). They are fully equipped to run Microsoft Windows-based applications and often come bundled with Windows from the manufacturer.
2.3 Operational Requirements

Operational requirements detail how available the system must be to meet Columbia’s needs. This includes maintenance and environmental conditions.

1. The system must be available 23 hours per day, with one hour reserved for preventive maintenance activities such as checking cables, disk capability, and individual components; reloading printer paper, fingerprint cards, and printer ribbon; ensuring cameras are in focus; and reviewing the audit trail if necessary. Backups shall take place during this time.

2. The exception to the availability requirement above is if corrective maintenance is required. This shall entail replacing defective hardware components with a spare part maintained for that purpose. Should a hard drive crash, time will be required (based on which server crashes) to restore data from the DAT backup. During such time that the system is unavailable longer than one hour for corrective maintenance purposes, operations shall revert back to the manual method, i.e. hand-writing arrest reports, Polaroid cameras for mugshots, and rolled ink fingerprints.

3. The system must be designed to survive for five years with only minor hardware and software upgrades required to prevent obsolescence.

4. The system shall be powered on all the time, except during preventive maintenance when the power shall be cycled.

5. The system shall be located in the booking room of the County Jail where arrestees are currently processed prior to being placed in a jail cell.
6. The system shall be operated in an environmentally-controlled room (i.e. 60-72 degrees Fahrenheit); it will not be subjected to extreme heat or cold.

7. The system shall not undergo vibration or shock, unless subjected to natural disaster.

8. All table-top components shall be bolted to a sturdy, wooden table that can support at least 500 foot-pounds of force.

9. All system components shall be connected to an uninterruptable power supply (UPS) provided by the City to compensate for loss of power, interruptions in power, and line spikes. The UPS should supply at least 15 minutes of back-up power for the entire BIS.

The system shall be operated in accordance with the functional flow depicted in figure 2-1.
2.4 Life-Cycle Cost Goals

The City of Columbia has allocated $700,000 for system development and deployment to include research, development, production, and construction. The City plans to allocate up to $150,000 each year for five years to cover operation and maintenance support. At the end of five years, the City will evaluate if the entire system needs to be replaced, or if certain subsystems and
components need to be replaced immediately or over time. This will be based on system reliability, maintenance history, requirements at the time, current budgets, and current technology.

2.5 Maintenance Concept

In planning the BIS, a maintenance concept must be addressed. This include levels of support, maintenance personnel responsibilities, repair policies and constraints, and the maintenance environment.

According to Systems Engineering and Analysis by Benjamin S. Blanchard and Wolter J. Fabrycky, three possible maintenance levels are: organizational maintenance, intermediate maintenance, and depot or producer-supplier maintenance. Organizational maintenance and depot maintenance will be performed most; intermediate maintenance can be considered as BIS personnel bringing a failed component to a facility within the County Jail after replacing it with a spare in the booking facility. What cannot be done through organizational maintenance by BIS maintenance personnel will most likely require manufacturer-level maintenance.

The City of Columbia must be prepared to supply personnel responsible for daily preventive maintenance provisions. This includes checking all cables and connections, ensuring consumables are stocked, checking all peripheral devices, and performing basic software maintenance.

Given the mission-critical nature of the BIS, all unique components should be spared. Personnel should be trained in the ability to de-install any component that fails to a point beyond recovery through organizational maintenance. They should be able to replace the failed component with a

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spare component. The manufacturer will then be responsible for repairing the failed component. This 'spare then repair' philosophy will help ensure a high level of system availability.

BIS personnel are constrained by the fact that many possible equipment failures will require the manufacturer to repair them. They are limited by the facilities and tools available within the County Jail. The preventive maintenance environment is the booking facility itself. Some time should be allocated for preventive maintenance every day in which no booking can take place. If officers bring a subject into the jail during this time, the subject must be held temporarily in a holding cell until maintenance is complete. Corrective maintenance that can be performed by BIS personnel should take place inside the booking facility if possible so that the component can be put back on-line as soon as possible to not disrupt operations. If the component is beyond repair in the booking facility, it should be removed, replaced with the spare, and sent to the manufacturer for repair if necessary. The City of Columbia should anticipate the use of basic computer and general purpose tools to perform preventive and some corrective maintenance tasks. Routine maintenance functions be modeled after the maintenance functional flow depicted in figure 2-2.

![Maintenance Functional Flow](image)

*Figure 2-2 Maintenance Functional Flow*
3.0 FUNCTIONAL ANALYSIS

According to Benjamin S. Blanchard and Wolter J. Fabrycky in their book *Systems Engineering and Analysis*,

"The system life-cycle approach stems from the identification of a need that develops as a result of a problem or deficiency and the subsequent want or desire for a system of some type. From the identification of a given need, one must define the basic requirements for the system in terms of input criteria for design." ⁶

From this standpoint, a need has been identified and a solution concept has been recommended.

What are the basic requirements for the BIS? In this section, functional requirements, performance requirements, maintenance requirements, and operational requirements will be specified.

3.1 Functional Requirements

System functional requirements detail *what the system must do*. There are several functions that the BIS must support at a system level and at a process level.

3.1.1 System-Level

1. System processes arrestees at County Jail - personal history information, mugshots, fingerprints, and personal effects

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2. System must allow the user to perform easy data entry, mugshots digitized from a video camera, fingerprints digitized from a fingerprint scanner, and other images entered from various video devices and digitized

3. The system must support up to five total dedicated user workstations for a combination of arrestee processing and research

4. Search capabilities must allow checks for prior arrests, aliases, arrestee status, and personal information

5. Database searches must not be detained by alternate processing taking place

6. Image searches must not be detained by alternate processing taking place

7. All elements must be printed (images, fingerprints, and text). Forms must be generated within the computer, allowing blank paper to be placed in the printer trays, except for fingerprint cards which must be loaded.

8. System must allow information transfer to Columbia’s Records Management System (RMS) via a dedicated server

9. The user interface must allow entry via keyboard, mouse, or touchscreen

10. System architecture must be modular and scaleable.

3.1.2 Technology

1. The BIS must follow Columbia’s planned technological direction:

   - Ethernet Local Area Network (LAN) protocol

   - Intel-based processors
• MD-DOS, MS-Windows, or UNIX operating systems in all system processors

• Processors with clock speeds of at least 60 MHzertz

• Microsoft Windows-based applications and graphical user interface (GUI)

• Standard Query Language (SQL) database standards

• Joint Photographic Experts Group (JPEG) capture / compression standards for images

• National Institute of Standards and Technology (NIST) fingerprint capture standards for gray-scale or compact gray image types

• Federal Bureau of Investigation (FBI) mandated requirements satisfaction for live-scan fingerprints, as published in the Minimum Image Quality Requirements for Live-Scan, Electronically Produced Fingerprint Cards.  

• National Television Systems Committee (NTSC) format video sources

• Super Video Graphics Adaptor (SVGA) or better display formats

• Communications at a baud rate of 19,200 bits per second.

3.1.3 Data Entry

1. Personal history information should be entered by selecting displayed choices wherever possible. Original information will be typed in with the keyboard

2. Menu choices and list selections can be chosen with the keyboard, mouse, or touchscreen

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3. Data fields will accommodate a maximum number of characters determined by studying a sample of 100 manually-created forms

4. Tabbing between fields is desired

5. Fields must be in an order similar to the order of fields in current forms. The field data sequence will dictate tabbing rules.

3.1.4 Image Capture (Mugshots)

1. Up to 10 images (including personal effects) shall be allowed per arrestee file, e.g. front view, left side, right side, with glasses, etc.

2. A standard NTSC video camera shall be used. Once the subject’s face is centered, the frame will be ‘frozen’ and digitized.

3. Users can see mugshot results on-screen immediately, and can redo as desired.

4. Images will be captured and compressed in a JPEG-compatible format.

5. Images will be in color with a resolution of Super VGA (SVGA) or better. This implies greater or equal to 800 by 600 picture elements (pixels).

6. Images will be digitized to a pixel depth of 24 bits per pixel.

3.1.5 Image Capture (Fingerprints)

1. Fingerprints will be captured by placing each of the subject’s fingers on the fingerprint system platen for scanning, minutia measurement, and digitization
2. Arresting officers will be guided through the fingerprinting process by the fingerprinting application. Officers will be prompted by the application as to which finger or combination of fingers to place on the platen.

3. The fingerprint image shall be immediately viewable on the monitor. Officers will be able to assess the quality of each fingerprint and reject them redo if necessary.

4. The fingerprinting system shall allow operators to select codes in place of rolled fingerprints if the finger is missing or abnormal.

5. The fingerprinting system must allow data transfer from the booking station, if they are to be separate systems. Demographic information such as race, sex, height, weight, etc. which is required on both booking reports and fingerprint cards shall be sent to the fingerprinting system after it is collected during booking report completion.

6. Once transferred, booking information will be combined with the fingerprint images of the subject being booked. Text and fingerprint images will be printed together on the same fingerprint card.

7. After printing the full fingerprint card, officers will be able to select fingerprints for rescanning, capture a new image, and re-print the fingerprint card with the new fingerprints as required.

8. Single-sided printing of fingerprint cards will be effected; only the first side of the cards is required to be printed.

9. The ability to interface to an Automated Fingerprint Identification System (AFIS) must exist should Columbia elect to do so in the future.
3.1.6 Image Capture (Personal Effects)

1. Up to ten images (including mugshots) can be stored with an arrestee’s file.

2. Items such as address books, driver’s licenses, and evidence can be captured, digitized, and saved as images with the arrestee’s file.

3. A Red-Green-Blue (RGB) or NTSC video source such as video scanners, motion video cameras, and still video cameras can be fed into the system for image capture.

4. Users can view capture results on-screen immediately, and can redo as desired.

5. Images shall be captured and compressed in a JPEG-compatible format.

6. Free-form text describing the image can be saved with the image.

3.1.7 Storage

1. Text, images, and fingerprints shall be stored separately. Fingerprint images shall be stored local to the fingerprint system as they will be retrieved only from that system.

2. Images shall be stored in JPEG-compatible compressed format (which is greater or equal to 15:1).

3. Text will be stored in ASCII format.

4. Text and images shall be stored separately on optical Write-Once-Read-Many (WORM) disk. Key fields associated with images (i.e. arrest number) shall serve as pointers to images.

5. The directory structure shall be such that image and text files can easily be found. Directory names shall include the date that images and text were stored. New directories shall be created each day the system stores text or images.
3.1.8 Display

1. Text and images shall be displayed on the same monitor; fingerprints shall be displayed from the fingerprinting system monitor.

2. Personal history information and mugshots shall be displayed simultaneously. Fingerprints and fingerprint card information shall be displayed simultaneously.

3.1.9 Printing

1. Booking reports, other reports, and fingerprint cards shall be printed by a laser printer with two trays for each kind of stock (one for reports and one for fingerprint cards).

2. Mugshots and personal effects images shall be printed by a graphics printer that accepts a video input.

3. Users shall be able to view a preview of the image or report before they print.

4. Printing of reports and images shall be effected by selecting one area on the screen or pressing one keyboard key.

5. Fingerprints shall be printed at a resolution of 500 dots per inch (dpi).

6. Postscript-compatible fonts shall be supported.

3.1.10 Reporting

1. Users shall be able to generate and print activity and statistical reports such as:

   - number of arrests by crime category, officer, time-frame, and location
   - arrestee history and status.
2. Future reports that will be uploaded to the BIS over radio frequency communication directly from patrol cars must be considered. These include: Record of Stored Vehicle (Tow Slip), Field Interview Card, Incident, and Accident.  

3.1.11 Back-ups

1. Text files shall be backed-up to digital audio tape (DAT) on a daily basis

2. Image files shall be backed up to DAT on a weekly basis.

3. Restore utilities shall be established to recover the previous day’s backup should a disaster occur.

4. DAT drives shall hold five Gbytes of data.

5. The selected DAT drives shall be internal to the servers using them.

6. DAT compression is permitted to increase file transfer speeds.

3.1.12 Security

1. Passwords and user IDs shall be required upon user log-in

2. Various access levels shall be assigned to users by the system administrator depending on users’ need to know. Access levels include: all functions; read only; read and print only; and read, edit, and print

3. The same user may have different access levels for different reports.

4. Sensitive files such as juveniles can be assigned a special security level so only assigned users can gain access to them

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5. Audit trails recording system actions by user ID, date, and time shall be maintained

6. Only system administrators may delete files.

3.1.13 Communications

1. Communications between the BIS at the County Jail and the RMS at City Hall shall be effected via a public-switched telephone line

2. A separate BIS communications server shall initiate uploads to the RMS

3. The line will be designated as a ‘modem line’ in the booking facility; it will not be shared between voice and data

4. Upon initial implementation, only booking text files shall be transferred to the RMS (no images).

3.1.14 User Interface

1. Columbia’s BIS users shall comprise arresting officers and investigators

2. Users shall know where they are in the application at all times via screen labels

3. Exiting to the next highest level in the menu hierarchy shall be possible through an ‘exit’ button placed in a consistent location on every screen.

4. Users can issue commands by touching the monitor with their finger (touch screen), typing on the keyboard, or pointing and clicking on the screen with the mouse.
5. The BIS user applications shall be designed in accordance with Microsoft Windows graphical user interface development guidelines per The Windows Interface: An Application Design Guide.⁹

6. Pre-set selections for all fields shall be accessible via screen buttons and pull-down menus

7. On-line help shall be available for every function.

3.2 Performance Requirements

Performance requirements detail how much and how fast various aspects of the system must function. The City of Columbia has no real baseline for a system such as the BIS, and therefore does not have as many performance requirements as they could have. Instead, the City requires a system that can grow and improve as their performance requirements evolve.

3.2.1 Storage

Storage calculations are for a five-year duration.

300 arrestees are processed per month. Over five years, data for 18,000 arrestees will be stored on the system. Each text file requires 2.5 Kbytes. Over five years, 45 Mbytes will be stored on the local hard drive. That is quite easy to accommodate with today’s hard drive volumes.

Up to ten images can be stored with each arrestee’s file. Over five years, that equates to up to 180,000 images. Each image, uncompressed, is .5 Mbytes in size. All images must be compressed at a ratio of at least 15:1. That means each image will now be approximately 34 Kbytes compressed. Over five years, 6 Gbytes will be required. It is recommended to use a Write-Once-

Read-Many (WORM) unerasable optical drive using 1.4 Gbyte WORM disks. That means a new WORM disk will be required in the drive every fourteen months. If searching for an arrestee whose images are on a prior WORM disk (not in the drive), the user would be prompted to enter the correct WORM disk into the drive to access the images.

Fingerprint images shall be stored locally on the fingerprint system’s hard drive. The 300 arrestees that are processed per month are fingerprinted. Over five years, fingerprints for 18,000 arrestees will be stored on the system. Compressed, each fingerprint card file requires 50 Kbytes of storage. This includes images for all ten fingers separately, both thumbs together, and the four fingers on each hand taken together. For 18,000 sets of fingerprint images, total storage requires 900 Mbytes. This is accommodated in a 1 Gbyte hard drive with the fingerprint system.

Fingerprint card text is a sub-set of the booking information text and does not require separate storage.

Given that 300 arrestees are processed per month, the system must allow 10 arrestees to be processed per day on average, and 20 per day peak.

### 3.2.2 Printing Speed

1. Booking reports shall print at a rate of at least eight pages per minute.

2. Mugshot and personal effects images shall print at a rate of at least two pages per minute.

### 3.2.3 Communication

File transfer shall take place at a baud rate of at least 19,200 bits per second. Since there are eight bits in a byte, the baud rate is 2,400 bytes per second. A complete arrestee file of text and up to 10
images can require up to 362.5 Kbytes. At the specified baud rate, an arrestee file will take 151 seconds, or just over two and one-half minutes, to transfer to the RMS.

If 300 arrestees are processed per month, seven days per week, then on average ten are processed per day. Each day, approximately 25 minutes will be required for file transfers from the BIS to the RMS.

3.3 Maintenance Requirements

Maintenance requirements evolve from performance and operational requirements. For the BIS, all hardware and software components are Commercial-Off-The-Shelf (COTS) and as such have been mass-produced. Software code that will be custom-developed for the BIS will be created using COTS application generator packages. These commercial components have under-gone more stress-testing, integrity-testing, and performance-testing than is typically possible for components manufactured by small groups for only their use. "Shrink-wrapping" a product means the manufacturer puts their name behind the product and will not be able to stay in business if the product's integrity or maintainability is questionable. For this reason, a major criterion for selecting hardware and software components for this project is the reputation of the manufacturer.

If the particular manufacturer is known for developing high-quality, long-lasting products, there is confidence in selecting them. They have already gone through the quality-assurance testing cycle; we do not necessarily have to. The products themselves should require very little maintenance. To that end, all hardware and software components in the BIS will be selected based on the following maintainability criteria:

1. All BIS components shall be available 23 hours per day, with one hour reserved for preventive maintenance activities such as checking cables, disk capability, and individual
components; reloading printer paper, fingerprint cards, toner, and printer ribbon; ensuring cameras are in focus; and reviewing the audit trail if necessary. Backups shall take place during this time as well as uploads to the RMS.

2. The exception to the availability requirement above is if corrective maintenance is required. This shall entail replacing defective hardware components with a spare part maintained for that purpose. Should a hard drive crash, time will be required (based on which server crashes) to restore data from the DAT backup. During such time that the system is unavailable longer than one hour for corrective maintenance purposes, operations shall revert back to the manual method.

3. The system must be designed to survive for five years with only minor hardware and software upgrades required to prevent obsolescence.

4. All hardware components shall be warranted for at least one year for full replacement by the manufacturer.

5. The system shall be powered on all the time, except during preventive maintenance when the power shall be cycled, and corrective maintenance if required.

Additional maintenance requirements include the following:

6. An on-site ‘replace then repair’ strategy must be adopted as the first tier of support for corrective maintenance, even during the warranty period. Given the system’s operational availability goal, all hardware components must be spared by the City. That means a set of duplicate hardware components must be maintained on-site in a County Jail store room. Similar components need only one spare for all. For example, one server CPU can be
spared to cover all active servers. During the warranty period, City personnel will swap in a spare for any failing component; the manufacturer will then repair the original part.

7. The second tier of support for corrective maintenance must be to repair the original component that was replaced by the spare part. The component must be sent back to the manufacturer for repair. If still under warranty, repair will take place free-of-charge. If outside of the warranty period, the City of Columbia shall fund any necessary repair work.

8. County Jail staff must be identified and trained on hardware and software maintenance, which shall be performed during one hour of every day the system is functioning.

9. Software version maintenance shall take place by receiving upgrades from the manufacturers of the original software products, as well as receiving upgrades to the custom-developed applications including any client-requested enhancements.

3.4 Life-Cycle Cost Requirements

A BIS must satisfy the following life-cycle cost requirements:

- Cost less than or equal to $700,000 for system design, development, and initial deployment
- Cost less than or equal to $150,000 per year for five years to maintain and operate.
4.0 PRELIMINARY DESIGN

For each subsection in this section, requirements allocation will be performed. Applicable requirements will be listed first, then the provisions to meet the requirements will be discussed. First, an overall system concept will be presented.

4.1 Overall System Concept

The BIS comprises hardware, software, networking, and system-level interfaces. The interface between servers and workstations is the network used to transfer information. The interface between the BIS and the outside world is a communications server that sends booking information to the RMS. The interface between the BIS and the human user is multi-fold. Humans will interact predominantly with the booking and retrieval stations to input booking information, retrieve information, and print materials. Humans will also interact with the three servers in the system architecture to ensure data storage and retrieval, image storage and retrieval, and communications are effected properly.

There are several different paths of information flow. During the booking process, information flows from the arresting officer to the booking station, then to the image/optical server and the database/print server. Information also flows from the booking station to the fingerprinting system. During retrieval from the booking station and the retrieval station, information flows from the image/optical server and the database/print server to the booking or retrieval station, whichever requested the information. During uploads to the RMS, information flows from the image/optical server and the database/print server to the communications server, then out to the RMS via a phone
line and modem. Figure 4-1 depicts the overall system, its system-level interfaces, and a representative flow of information during the booking process.

![Diagram showing system components and information flow]

**Figure 4-1 Overall System**

The following interfaces will be enabled during system development:

- User interface for booking and retrieval (software)

- Interface between all servers and workstations to effect information sharing (network cards)

- Interface between booking station and fingerprinting system to enable transfer of arrestee information captured at booking station that also is required on fingerprint cards (development required at booking station to transfer information serially to fingerprinting system.

Fingerprinting system is already equipped to import ASCII text)
• Interface between communications server and modem to achieve transfer of booking data and images to RMS (development on communications server to request data from database/print server and image/optical server, repackage it, and send it to the modem through comm port)

4.2 Servers and Workstations

The system-level requirements which will drive the architecture design are listed below:

1. System processes arrestees at County Jail - personal history information, mugshots, fingerprints, and personal effects

2. System must allow the user to perform easy data entry, mugshots digitized from a video camera, fingerprints digitized from a fingerprint scanner, and other images entered from various video devices and digitized

3. The system must support up to five total dedicated user workstations for a combination of arrestee processing and research

4. Search capabilities must allow checks for prior arrests, aliases, arrestee status, and personal information

5. Database searches must not be detained by alternate processing taking place

6. Image searches must not be detained by alternate processing taking place

7. All elements must be printed (images and text). Forms are generated within the computer except for fingerprint cards

8. System must allow information transfer to Columbia’s Records Management System (RMS) via a dedicated server
9. The user interface must allow entry via keyboard, mouse, or touchscreen.

10. System architecture must be modular and scaleable.

The best solution today for achieving a system architecture that is modular and scaleable employs client/server technology with clients and servers interconnected by a LAN. The BIS design will include such an architecture. To satisfy the first requirement, physical space is available and must be allocated at the County Jail for the recommended system. To perform the required functions of the BIS, individual servers are needed for maximum efficiency and modularity. The system will be designed to support at least five clients: booking and retrieval workstations. This is done through the number of servers and amount of RAM. To maximize efficiency and satisfy the requirements that database and image searches must not be detained by alternate processing taking place, database storage/retrieval and image storage/retrieval must take place on separate servers. Both functions can be processing-intensive.

Printing of all elements is required. The amount of print requests generated per day (up to 10 arrestees, up to 10 images each, three fingerprint cards each, and one booking report each) does not merit the expense and space required for a separate server dedicated only to printing. Since database files are generally much smaller than image files (database files will be two-three Kbytes versus 500 Kbytes per image), the database server will be configured to handle printing processes as well. The database server will satisfy the requirement that prior arrests, aliases, arrestee status, and personal information will be checked upon entering a new arrestee.

To satisfy the requirement that the system must allow information transfer to the RMS via a dedicated server, a dedicated communications server will be included. Servers include: database/print server, optical/image server, and communications server.
The requirement to support up to five dedicated user workstations for booking and retrieval functions is attainable through the client server architecture and assigning separate workstations for these functions. For example, one booking station will be included which is enough to satisfy Columbia's current arrestee volumes. This booking station shall also support fingerprinting functions through separate fingerprinting components that are connected. Up to four retrieval stations can be attached to support research and investigation. The booking station will satisfy the requirement to enter text, images, and fingerprints associated with an arrestee. It will be configured with peripherals to support the entry requirement. The user workstations, which are the booking and retrieval stations, will allow entry via touchscreen, mouse, or keyboard. Keyboard entry will always be required when original text not derivable from lists and menus is needed.

Peripheral devices include both input and output components. All input devices will feed into the booking station. Output of video devices such as cameras and video scanners will feed into a video switcher that will control which input gets into the booking station. The fingerprint scanner output will feed directly into the fingerprinting system. Text input will be entered via keyboard. Output devices are printers. Text and fingerprints will be printed on a laser printer. Mugshots and other photographic images will be printed on an image printer. Retrieval workstations will be view-only and will allow users to bring up records, mugshots, and fingerprints for analysis and printing. A conceptual diagram of the servers and workstations follows.
Based upon the system requirements, the following server and workstation descriptions have evolved. Requirements for individual components within the servers and workstations will be allocated in later subsections.

**Image/Optical Server** - This server controls the repositories of images - mugshots and evidence. It receives compressed images from the booking station for storage. It keeps image pointers on its hard drive, and the images themselves are stored to WORM disk. The image/optical server responds to requests for images from any of the clients. It serves the communications server with images for upload to the RMS.

Major components of the image/optical server include: a robust PC, monitor, keyboard, mouse, ethernet card, tape backup drive, application software, and one WORM drive for images. The WORM drive will be connected to the PC via the Small Computer Systems Interface (SCSI) standard. A SCSI adaptor will reside in the PC, and the drive will be connected directly to the adaptor via a SCSI cable. Figure 4-3 depicts the image/optical server architecture.

**Database/Print Server** - The relational, SQL-based database will reside on the database/print server. This server will maintain and update all tables required for the BIS. It will also maintain a
set of image pointers that are identical to the image pointers in the image/optical server. Once the
database/print server returns the results of a query, it will send the associated image pointer(s) to
the image/optical server. The database/print server will send the requested database elements to
the client; the image/optical server will send the associated image(s) to the client.
This server will be responsible for printing as well. Print requests for data and images will go to
the database/print server; requests for printing fingerprints will be served by the fingerprinting
system. Since a set of image pointers resides on this server, it will be able to request the
appropriate image(s) from the image/optical server, merge the image(s) with the data, and send the
data and image(s) to the correct printer.
Major components associated with the database/print server include: a robust PC, monitor,
keyboard, mouse, ethernet card, laser printer, image printer, database software, application
software, tape backup drive, and large internal SCSI hard drive. Figure 4-4 depicts the
database/print server architecture.

Communications Server - The communications server provides an interface between the BIS and
the RMS. The initial BIS implementation will enable one-way communications; uploads will be
made from the BIS to the RMS. Booking information from the BIS will populate fields of the
RMS database, providing booking information to supplement the historical records of the RMS.
Uploads will take place upon command during daily maintenance; they will not be automatic to
ensure that the system is free whenever an officer needs to book someone. Communication will
take place over a public-switched line.
Major components of the communications server include: a robust PC, monitor, keyboard, mouse, application software, communications software, ethernet card, and a modem. The modem must employ error correction and other techniques to ensure data integrity.

Uploads will be initiated at the communications server. The server will poll the database server to determine which records have not been uploaded. The database server will copy those records to a temporary directory on the communications server. The database server will also request the corresponding compressed images from the image/optical server to be copied to a temporary directory on the communications server. The database server will then mark the copied files as uploaded. The communications server will package the files and images for transmission, and send them to the RMS via the modem and communications line. Once confirmation of receipt is given by the RMS, the communications server will delete the sent records and images from the temporary directory. Figure 4-5 depicts the communications server architecture.

**Booking Station** - The booking station is the means of entering and receiving booking information from the BIS. It will allow capturing arrestee information, mugshots, evidence images, and fingerprints. Means of issuing commands to the booking station are the keyboard, mouse, and touchscreen monitor. Data will be entered at the booking station and saved over the network to the database server. Images will be captured by the booking station's peripherals, compressed by the booking station, and sent to the image/optical server. All requests from the BIS user will be issued through the booking station, except viewing residual fingerprints which will be issued through the fingerprint system. This includes queries, reports, and prints. The booking station itself will be connected to a fingerprinting system that will handle the capture, merging with data, storage, and
retrieval of fingerprints. Printing of fingerprints will be initiated at either the fingerprinting system, booking station, or retrieval station.

During arrestee processing, the booking station will be operated as follows:

1. Login and password entry - designates user privileges (read-only, read and entry, etc.)
2. Arrestee report completion - text field entry
3. Mugshot capture using video camera
4. Personal effects image capture using video scanner
5. Fingerprint capture initiation (pertinent fingerprint card data sent to fingerprinting system)
6. Fingerprint scanning at fingerprinting system
7. Report, image, and fingerprint card printing
8. Logout when finished processing arrestees.

Major components of the booking station include: a robust PC, touchscreen monitor, keyboard, mouse, application software, video camera, video scanner, compression software, video switcher, image capture card, network card, and fingerprinting system. Figure 4-6 depicts the booking station architecture.

**Retrieval Station** - The retrieval station will be used by officers and analysts to issue queries and print reports, images, and fingerprint cards. These capabilities are provided by the booking station as well, but its primary use will be for text and image capture. If the user has the requisite permissions, he or she may update an arrestee’s file. The user will request files whose text will come from the database server and images will come from the image/optical server.
Major components of the retrieval station include: a robust PC, touchscreen monitor, keyboard, mouse, application software, and ethernet card. Assuming one booking station, the system as designed can support up to four retrieval stations; more than enough for Columbia’s present and anticipated future needs. Figure 4-7 depicts the retrieval station architecture.
Inside CPU:
SCSI Board (connected to WORM drive)
ETHERNET Card
Monitor Port
Keyboard & Mouse Connectors

Figure 4-3 Image/Optical Server Architecture
Inside CPU:
SCSI Controller (for internal drive)
SCSI Hard Drive
ETHERNET Card
Parallel Port for Laser Printer
Serial Port for Image Printer
Monitor Port
Keyboard & Mouse Connectors

Figure 4-4 Database/Print Server Architecture
Inside CPU:
ETHERNET Card
Comm. Port for Modem
Monitor Port
Keyboard & Mouse Connectors

Figure 4-5 Communications Server Architecture
Inside CPU:
Video Capture Board (connected to A/B switch)
Touchscreen Monitor Controller
ETHERNET Card
Keyboard & Mouse Connectors

Figure 4-6 Booking Station Architecture
Figure 4-7 Retrieval Station Architecture
### 4.3 Hardware Components

Each major hardware device type is listed below based on requirements, along with what client or server it will be used in, input(s), output(s), and the process employed to convert inputs to outputs. In this manner, each device is treated as a system with inputs, outputs, and processes. Employing the systems approach to the hardware components can aid in understanding the components and their role in the entire BIS.

<table>
<thead>
<tr>
<th>Device</th>
<th>PC (client) - System Level Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>Used In</td>
<td>Booking Station</td>
</tr>
<tr>
<td>Input</td>
<td>Video Switcher Output, Fingerprint Scanner, Keyboard, Mouse, X,Y Coordinates from Touchscreen</td>
</tr>
<tr>
<td>Output</td>
<td>ASCII Text, Compressed Images, Compressed Fingerprints</td>
</tr>
</tbody>
</table>
| Process| - Interpret commands issued by keyboard, mouse, and touchscreen and perform them  
  - Convert keystrokes and selected choice list options into ASCII text  
  - Capture video frames from video devices, digitize them, and compress them  
  - Send appropriate booking report data subset to fingerprinting system for integration with fingerprint images  
  - Format images and text and send them to the display monitor |

<table>
<thead>
<tr>
<th>Device</th>
<th>PC (client) - System Level Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>Used In</td>
<td>Retrieval Station</td>
</tr>
<tr>
<td>Input</td>
<td>Keyboard, Mouse</td>
</tr>
<tr>
<td>Output</td>
<td>ASCII Text, Requests to Servers</td>
</tr>
<tr>
<td>Process</td>
<td>- Interpret commands issued by keyboard and mouse and perform them</td>
</tr>
</tbody>
</table>
- Convert keystrokes and selected choice list options into ASCII text updates
- Format images and text and send them to the display monitor

**Device:** PC (client) - System Level Requirements

**Used In:** Booking Station

**Input:** Video Switcher Output, Keyboard, Mouse, X,Y Coordinates from Touchscreen

**Output:** ASCII Text, Compressed Images, Requests

**Process:**
- Interpret commands issued by keyboard, mouse, and touchscreen and perform them
- Convert keystrokes and selected choice list options into ASCII text
- Capture video frames from video devices, digitize them, and compress them
- Format images and text and send them to the display monitor

**Device:** PC (server) - System Level Requirements

**Used In:** Database Server, Image/Optical Server, Communications Server

**Input:** Requests from clients, ASCII Text, Compressed Images, Keyboard, Mouse

**Output:** ASCII Text, Compressed Images

**Process:**
- Interpret commands issued by keyboard, mouse, and touchscreen and perform them
- Fill requests from clients (send out text and images across network)
- Store text (database server)
- Store images (image/optical server)
- Format images and text and send them to the display monitor
- Upload text to RMS (communications server)

**Device:** Monitor

**Used In:** Communications Server, Database Server, and Image/Optical Server

**Input:** Super Video Graphics Adaptor (SVGA) signals from PC
Output: Signal displayed on monitor screen

Process: Move input signal from PC to display on screen

Device: Touchscreen Monitor - Display and User Interface Requirements

Used In: Booking Station and Retrieval Station(s)

Input: 1) Finger touching glass of touchscreen
         2) SVGA signals from PC

Output: 1) X,Y coordinates to PC for interpretation into commands
         2) Displayed signals on screen

Process: 1) Using Surface Acoustic Wave (SAW) technology, detect coordinates of touch
          (where wave was interrupted and energy absorbed) and send X,Y coordinates to PC
          2) Move input signal from PC to display on screen

Device: Laser Printer - Printing Requirements

Used In: Database Server

Input: Text signal, fingerprint images, and command from PC

Output: PostScript compatible Print

Process: Interpret print command and format signal into printed text and fingerprints

Device: Image Printer - Printing Requirements

Used In: Image/Optical Server
Input: Graphics signal and command from PC
Output: Image Print
Process: Interpret command and convert signal into print

Device: WORM Drive - Storage Requirements
Used In: Image/Optical Server
Input: Compressed mugshot/evidence images from server
Output: Compressed mugshot/evidence images to server
Process: Receive images from server, record to open sector on disk, and send the location back to the server to serve as a pointer to the images

Device: Tape Backup Unit (5mm digital audio tape) - Backup Requirements
Used In: Database Server and Optical/Image Server
Input: Backup files (text and compressed images)
Output: Backup files (text and compressed images) upon demand
Process: Receive files from server, locate free space on tape, record location and store the files

Device: Modem - Communications Requirements
Used In: Communications Server
Input: Text and Image Files to Be Sent to the RMS and Transmission Commands
Output: Transmission-formatted Text and Image Files
Process: Receive request for sending files, dial RMS, establish connection, handshake, move files to communications line

Device: Fingerprint System - Image Capture-Fingerprints Requirements

Used In: Booking Station (connected to)

Input: Analog Fingerprint Signals, Demographic Data from Booking Station

Output: Digitized Fingerprint Minutia and Demographic Data

Process: Measure distance from source to points (valleys and peaks) in fingerprint, digitize the points, merge with demographic data, store as an integrated file, and print to laser printer when requested.

Device: Video Camera - Image Capture-Mugshots Requirements

Used In: Booking Station

Input: View of Subject (mugshot)

Output: Analog video signal to video switcher

Process: Convert whatever the lens ‘sees’ into an analog video signal connected to the video switcher

Device: Video Scanner - Image Capture-Personal Effects Requirements

Used In: Booking Station

Input: View of material on scanner’s platen

Output: Analog video signal sent to video switcher
Process: Convert whatever the scanner’s lens ‘sees’ into analog video signal sent to video switcher

4.4 Hardware Component Market Survey and Requirements

Allocation

All hardware components used in the BIS were subject to a market survey. The survey was conducted to surface at least two manufacturers whose products were heavily in use and fit the basic requirements presented. From there, the components were evaluated based on rated performance, price, reliability, and ease of use where applicable. The author relied upon reviews written by industry experts; benchmark testing for each component was not feasible within the scope of this project. Prior to the requirements allocation and market analysis for each component, the minimum requirements for that component are presented.

PC CLIENT (BOOKING AND RETRIEVAL STATIONS)

The minimum requirements for the PC clients are taken from the Technology requirements subsection.

The BIS must follow Columbia’s planned technological direction:

- Intel-based processors
- Processors with clock speeds of at least 60 MHz
- Microsoft Windows-based applications and graphical user interface (GUI)

The PC’s used as clients for the BIS should provide good value, performance, and reliability.

According to Bruce Brown in the February, 1994 issue of Computer Shopper:
Individuals and corporations looking for good all-purpose microcomputers can get excellent value for the money by purchasing fully configured systems based on the Intel 80486 [chip]. Such systems, currently priced from $1,500 to $3,000, are definitely the best deals on the market. These machines provide robust performance for nearly all mainstream business applications, including those that use graphics. 10

Three manufacturers whose ‘mainstream’ PC’s surfaced as good price/performance/reliability combinations are IBM, Gateway, and AST. Specifically, the IBM ValuePoint 466DX2, Gateway 4DX2-66V, and AST Bravo LP Green. All three have 66 Megahertz clock speeds, representing a negligible increase in price to get twice the clock speed as a year ago. They have at least 340 Megabytes of hard disk storage, are Microsoft-Windows-compatible, and are based on the 486DX Intel processor. All three are just under $3,000 list price and are pervasive enough in the PC marketplace so that parts are plentiful. The one that shines, however, is the AST Bravo LP Green since it comes standard with a three-year on-site warranty, all other features considered equal to the other two.

PC SERVER (Database Server, Image/Optical Server, Communications Server)

The minimum server requirements are as follows from the Technology requirements subsection:

The BIS must follow Columbia’s planned technological direction:

- Intel-based processors

- Processors with clock speeds of at least 60 MHzertz

- Microsoft Windows-based applications and graphical user interface (GUI)

---

The server PC's should be high-performance, cost-effective, reliable desktop systems. There are systems out today that are built to be servers, employing symmetric multiprocessors and other state-of-the-art features. The number of clients and the associated demands of the BIS do not warrant such machines, which cost generally three to four times as much as a high-end desktop PC.

Three top-of-the-line desktop systems that stood out from the competition are the Gateway P5-60, the Dell Dimension XPS 466V, and the Compaq Deskpro XE 466. The Gateway employs a 60 Mhz Pentium chip for speed and performance. Pentium chips have not yet been fully proven in the industry; they have experienced recent problems, are not fully reliable, and can be difficult to configure and maintain. It is the author's recommendation that the servers be upgraded to include Pentium chips once they have been fully proven and once the requirements of the BIS increase to a point that Intel-based processors can no longer handle efficiently. The Dell and the Compaq are roughly equivalent in terms of performance, come with at least 300 Mbytes of hard disk, and all use Intel processors and can run Windows. For the price ($3,048 for the Compaq and $3,397 for the Dell), the Compaq is the much better buy for its superior reliability, as proven over and over again in fielded applications. The Compaq Deskpro 466DX2 is recommended.

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SERVER MONITOR

The server monitors will be attached to the server processors and are meant only to interface to the servers; no real BIS user requirements. The minimum server monitor requirements are listed below:

The BIS must follow Columbia’s planned technological direction:

- Super Video Graphics Adaptor (SVGA) or better display formats.

The clients shall employ touchscreen monitors which will be discussed below. The server PC’s come with 14” or 15” SVGA monitors which are suitable for displaying server activity and commands. For consistency, SVGA monitors should be used with both clients and servers. A feature of SVGA monitors is color control. This capability can be particularly important if the user is creating documents or drawings with color that they want to later print out on a hardcopy (mugshots and evidence prints, for example). Because monitors use an RGB color system that is always different from the color system used in commercial printing, it is helpful to have some method of adjusting the screen color. 12

TOUCHSCREEN MONITOR

When booking an arrestee, officers are often under stress. If they are booking more than one arrestee, officers can feel rushed and are more prone to making mistakes. The user interface to the BIS is crucial for the above reasons. The author’s experience has shown that under these circumstances it is most beneficial to present users with a choice of input devices, including a

touchscreen monitor. At the booking station, officers will be presented with a choice of input devices: keyboard, mouse, and touchscreen. Why use touch technology? According to the Carroll Touch Handbook, \textsuperscript{13}

This method is ideal for selection-based applications because it is easier than typing a response or manipulating a mouse input device. Pointing is universally used to indicate a choice. In addition, there are some distinct benefits to using touch systems over other input devices:

- No special skills are required - you don’t have to learn how to use the input device before you learn how to use the system.

- Touch what you see - unlike other input devices such as the mouse, trackball, or joy stick, the user does not have to coordinate hand movements between the movement of an input device and the corresponding movement of the cursor on the screen.

- Touch systems respond quickly - not only is touching the screen faster than entering commands on a keyboard or other device, but the touch system can provide immediate feedback.

- Touch simplifies complex systems.

- User training time is minimal - because there is no need to memorize a complex set of keystrokes or commands.

The minimum requirements for the user display are listed below.

- Menu choices and list selections can be chosen with the keyboard, mouse, or touchscreen

(Data Entry requirements)

\textsuperscript{13} Carroll Touch Touch Handbook.
• Text and images shall be displayed on the same monitor at the booking and retrieval stations (Display requirements)

• Fingerprints shall be displayed on the fingerprinting system monitor (Display requirements)

• Personal history information and mugshots shall be displayed simultaneously.
  Fingerprints and fingerprint card information shall be displayed simultaneously. (Display requirements)

• Users can issue commands by touching the monitor with their finger (touch screen), typing on the keyboard, or pointing and clicking on the screen with the mouse (User Interface requirements)

There are several touchscreen technologies: capacitive overlay, resistive overlay, surface acoustic wave (SAW), piezoelectric, and scanning infrared. Of those, only SAW does not have a fixed monitor resolution, lending the greatest flexibility to its users. SAW provides nearly instantaneous response and superior image quality. For these reasons, it is the recommended touchscreen technology. SAW technology is based on transmitting surface acoustic waves through a glass substrate. To activate the system, a finger or other soft stylus touches the screen and damps (or flattens) the acoustic waves at the touch position. The system detects the location of the dampened wave to locate the touch activation.

There are two major manufacturers of SAW touchscreen monitors: Carroll Touch and Eloographics, Inc. Both offer a NEC Multisync XL 19” monitor for approximately $3,500. Both allow menu choices and lists to be selected through touch by programming the coordinates of the area on the screen where each selection appears. The only apparent differentiator is that
Elogographics has a broader base of support facilities and is more adept at responding to corrective maintenance requirements. For this reason, the **Elographics Intellitouch Monitor using the NEC Multisync XL is recommended.**

**LASER PRINTER**

The following are the minimum laser printer requirements:

- All elements must be printed (images, fingerprints, and text). Forms must be generated within the computer, allowing blank paper to be placed in the printer trays, except for fingerprint cards which must be loaded. (System-level requirements)

- Booking reports, other reports, and fingerprint cards shall be printed by a laser printer with two trays for both kind of stock (one for reports and one for fingerprint cards) (Printing requirements)

- Fingerprints shall be printed at a resolution of 500 dots per inch (dpi) (Printing requirements)

- Postscript-compatible fonts shall be supported. (Printing requirements)

The laser printer connected to the network must be capable of priming both arrest reports and fingerprint cards. It must support at least 500 dpi resolution for fingerprint cards and be Postscript-compatible. Two major printer manufacturers surfaced: Hewlett-Packard (HP) and Lexmark IBM. Both the HP LaserJet 4Si MX and the Lexmark IBM 4039 16L support 600 dpi resolutions and PostScript, and can be configured with two paper trays for both reports and fingerprint cards, and print at a rate of at least 10 pages per minute. The Lexmark IBM 4039 16L is $3,399. The HP has a 500-page sheet feeder that is not needed in the booking application. It
has 8 Mbytes more Random Access Memory (RAM) and 28 more fonts. It is also over $2,000 more expensive. Based on nearly identical performance and reliability, the $5,499 price of the HP, versus the $3,399 price of the Lexmark, cannot be substantiated. The **Lexmark IBM 4039 16L** is recommended.

**VIDEO CAMERA**

The following are the minimum requirements for a video camera to be used with the BIS.

- System must allow the user to perform easy data entry, mugshots digitized from a video camera, fingerprints digitized from a fingerprint scanner, and other images entered from various video devices and digitized (System-level requirements)

The BIS must follow Columbia’s planned technological direction:

- National Television Systems Committee (NTSC) format video sources (Technology requirements)

- A Red-Green-Blue (RGB) or NTSC video source such as video scanners, motion video cameras, and still video cameras can be fed into the system for image capture (Image Capture-Personal Effects requirements)

The video camera will be used as the primary input device to the booking station. It must be a full motion camera that will allow the BIS operator to freeze a frame of video when satisfied with the image. It will capture all mugshots, and any evidence/personal effects images that cannot be placed on the video scanner. It must feed color NTSC video directly into a switcher that will allow
the user to switch between camera and scanner input. There are a multitude of color video cameras on the market that can be used for this purpose. They generally require a tripod and accompanying floor space. A representative camera of this nature is made by Panasonic. The Panasonic WV-CL320 is a solid-state color camera that outputs standard NTSC video. The price for the camera body (without lens or tripod) is $950.00.

Upon searching the video camera marketplace, the following innovative camera was identified. A company called VideoLabs has created a complete desktop motion video color camera that is designed exactly for the purpose of inputting video into a computer. It's called the FlexCam Pro. The camera body sits on a gooseneck stand that allows the user to direct the camera at the subject easily. Since it can sit on the desktop, it requires no floor space. The price for the complete camera assembly is $450.00. Due to its flexibility, space conservation, and price, the VideoLabs FlexCam Pro is recommended.

VIDEO PRINTER

For consistency, there is an effort to keep all input and output image signals as video in the BIS. Therefore, the printer for mugshots and evidence images must be a video-compatible printer. The minimum requirements for a video printer are as follows:

- All elements must be printed (images, fingerprints, and text). (System-level requirements)
- Mugshots and personal effects images shall be printed by a graphics printer that accepts video input (Printing requirements)

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14 An A/B video switcher has not been specified here; it can be purchased at a consumer electronics store for under $50, and can be finalized during detail design.
Of the several available standard video printers, the Sony UP-7000 has the best reputation and provides the best price/performance ratio. The printer itself costs $3200. Like all video printers, it requires special paper and ribbon that together cost $85 for 100 prints. The City of Columbia arrests 300 subjects per month and is allowed up to 10 images per arrestee file. This equates to a possible 3,000 prints per month, and up to $2,550 for consumables per month. Over five years (180,000 prints), the City could spend $153,000 just on printer consumables! Using a Polaroid camera with 24-print film costing $8.00 a package, the same number of images would cost the City $60,000 over five years.

There is a viable alternative that is cost-effective and still eliminates manual photography. The Hewlett-Packard VidJet Pro is a video print manager that attaches to a standard laser printer and can produce video prints on 8 1/2 by 11-inch plain paper that costs pennies per print. Using plain paper for color video prints will provide the City with greater flexibility. They can produce full-size or smaller prints, and can write directly on the paper (not possible on standard video printer paper). Image printing takes place at two pages per minute. Also, the printer used with the video print manager can print text if an additional text printer is needed. The HP VidJet Pro with 1 Mbyte of video RAM costs $3,490. It is recommended that a separate color printer be used with the print manager and not the same one used to print reports and fingerprint cards, since that one only needs to be black and white and should be dedicated to those functions. An HP DeskJet 1200C 300 dpi color inkjet printer with 4 Mbytes of printer memory costs $2,700. Therefore, for a total of $6,190, the HP VidJet Pro E2530A and HP DeskJet 1200C Printer are recommended. Paper for this assembly will cost approximately $540 over five years. Replacement cartridges for the color printer are $28 each and must be replaced every 2,500 prints. Over five years, 72 cartridges will be required and will cost a total of $2,016.
VIDEO SCANNER

At times during the booking process, it may be desirable to capture and digitize personal effects such as passports, drivers licenses, address books, and photographs. These objects can be photocopied and placed in a file folder, but will not be readily accessible upon command. By scanning these objects into the booking station, capturing them as a frame of video, digitizing them, and cataloguing them in the database, they can be retrieved along with the arrestee’s automated file.

Minimum video scanner requirements are:

- System must allow the user to perform easy data entry, mugshots digitized from a video camera, fingerprints digitized from a fingerprint scanner (connected to the fingerprinting system), and other images entered from various video devices and digitized (System-level requirements)

- The BIS must follow Columbia’s planned technological direction:
  
  National Television Systems Committee (NTSC) format video sources

- Items such as address books, driver’s licenses, and evidence can be captured, digitized, and saved as images with the arrestee’s file (Image Capture - Personal Effects requirements)

- An RGB or NTSC video source such as video scanners, motion video cameras, and still video cameras can be fed into the system for image capture (Image Capture - Personal Effects requirements)

Only one manufacturer makes a device capable of scanning objects (such as address books, driver’s licenses, and evidence) in a video domain: Sony. The Sony UY-T35V color flatbed video scanner interfaces with a variety of video devices, including video capture boards in PC’s. Images can be output in NTSC, RGB, or S-Video formats. The single-pass charge-coupled device (CCD)
reproduces 24-bit images at 500-line resolution in an average of seven seconds. The Sony UY-T35V color video scanner costs $3,800.

NETWORK INTERFACE CARD

The following are the minimum requirements for a network interface card:

- Ethernet Local Area Network (LAN) protocol (Technology requirements)

There are several manufacturers providing Ethernet network interface cards that are becoming faster and lower-priced. PC Week Netweek evaluated network interface cards and identified the top ten. Xinetron Inc.'s 321TCL Ethernet adapter cards for PC's are rated a best buy according to PC Week Labs based on price and performance. 3Com Corp.'s EtherLink 3C509 adapters are rated the performance leaders of all tested cards, but do not make the top ten price/performance list because of their high cost. Therefore, the Xinetron 321TCL Ethernet card is recommended.

WORM DRIVE

The following storage device requirements have been established:

- Text and images shall be stored separately on optical Write-Once-Read-Many (WORM) disk. Key fields associated with images (i.e. arrest number) shall serve as pointers to images

- The directory structure shall be such that image and text files can easily be found. Directory names shall include the date that images and text were stored. New directories shall be created each day the system stores text or images.

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Optical technology has advanced to a point where consumers are not locked into one type of media based on the type of drive they buy. Most drives are multi-function and can support rewritable as well as write-once media. WORM media is required and recommended for text and images for Columbia at this point to ensure data integrity and permanence. Buying a multi-function drive, however, is beneficial for future applications that require erasable technology as well as non-erasable technology.

Most WORM and multi-function drives are manufactured by Panasonic and re-packaged under various brand names. Therefore, going right to the source, Panasonic’s newest optical drives are quicker than ever before with an average seek time of 45 milliseconds and data transfer up to 1.5 Mbytes per second.\(^6\) The drives come either in internal or external forms, and support 500 Mbyte, 1 Gbyte, and 1.5 Gbyte rewritable media, and 470 Mbyte, 940 Mbyte, and 1.4 Gbyte WORM media. They support directory structures and file naming conventions delineated above. The drive connects to a PC via a SCSI-2 interface. It is recommended that Columbia procure an external Panasonic LF-7300A optical drive, and plan on using 1.4 Gbyte WORM media to optimize time between changing media.

**DAT DRIVE**

Minimum backup requirements specify DAT drives and are as follows:

- Text files shall be backed-up to digital audio tape (DAT) on a daily basis

- Image files shall be backed up to DAT on a weekly basis.

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• Restore utilities shall be established to recover the previous day’s backup should a disaster occur.

• DAT drives shall hold five Gbytes of data.

• The selected DAT drives shall be internal to the servers using them.

• DAT compression is permitted to increase file transfer speeds.

The DAT drives for the BIS servers should be internal drives to facilitate and maximize the speed of regular back-ups. Each drive should store up to five Gbytes of data and images. These requirements can be met in the DAT drives that Compaq offers as options to its line of high-end PC’s. The Compaq DAT drives utilize file compression and can easily support the backup frequency requirements specified. Restore utilities allow users to load the previous day’s backup onto the server’s hard drive and decompress the files to their original size. Using an internal Compaq DAT drive will ensure control to the drive has been established and that the drive’s parameters are compatible with the server.
MODEM

The City of Columbia has been procuring modems for other projects and will provide a modem for the BIS. The minimum modem requirements are:

- Communications at a baud rate of 19,200 bits per second (Technology requirements)

- Communications between the BIS at the County Jail and the RMS at City Hall shall be effected via a public-switched telephone line (Communications requirements)

- The line will be designated as a ‘modem line’ in the booking facility; it will not be shared between voice and data (Communications requirements)

- Upon initial implementation, only booking text files shall be transferred to the RMS (no images) (Communications requirements)

The City either has or can easily procure a 19.2 Kbaud data modem used to interface with a public switched telephone line, whose model and manufacturer has already been specified.

FINGERPRINTING SYSTEM

The following are the minimum fingerprinting system requirements.

- National Institute of Standards and Technology (NIST) fingerprint capture standards for gray-scale or compact gray image types (Technology requirements)

Federal Bureau of Investigation (FBI) mandated requirements satisfaction for live-scan
fingerprints, as published in the *Minimum Image Quality Requirements for Live-Scan, Electronically Produced Fingerprint Cards.*¹⁷ (Technology requirements)

- MD-DOS, MS-Windows, or UNIX operating systems in all system processors (Technology requirements)

- Fingerprint will be captured by placing each of the subject's fingers on the fingerprinting subsystem platen for scanning, minutia measurement, and digitization (Image Capture - Fingerprints requirements)

- Arresting officers will be guided through the fingerprinting process by the fingerprinting application. Officers will be prompted by the application as to which finger or combination of fingers to place on the platen. (Image Capture - Fingerprints requirements)

- The fingerprint image shall be immediately viewable on the monitor. Officers will be able to assess the quality of each fingerprint and reject then redo if necessary. (Image Capture - Fingerprints requirements)

- The fingerprinting system shall allow operators to select codes in place of rolled fingerprints if the finger is missing or abnormal. (Image Capture - Fingerprints requirements)

- The fingerprinting system must allow data transfer from the booking station, if they are to be separate systems. Demographic information such as race, sex, height, weight, etc. which are required on both booking reports and fingerprint cards shall be

sent to the fingerprinting system after it is collected during booking report completion.
(Image Capture - Fingerprints requirements)

- Once transferred, booking information will be combined with the fingerprint images of
  the subject being booked. Text and fingerprint images will be printed together on the
  same fingerprint card. (Image Capture - Fingerprints requirements)

- After printing the full fingerprint card, officers will be able to select fingerprints for
  rescanning, capture a new image, and re-print the fingerprint card with the new
  fingerprints as required. (Image Capture - Fingerprints requirements)

- Single-sided printing of fingerprint cards will be effected; only the first side of the
  cards is required to be printed. (Image Capture - Fingerprints requirements)

- The ability to interface to an Automated Fingerprint Identification System (AFIS)
  must exist should Columbia elect to do so in the future. (Image Capture - Fingerprints
  requirements)

It was the author's original hope that fingerprint scanning could take place directly from the
booking station with a live-scan vendor's board set installed in the booking station processor. This
has not yet been done reliably by any of the three live-scan vendors. Fingerprint capture is still
very processing-hungry, and the live-scan vendors have not been willing to invest the research and
development money needed to exploit the newest processors for integrated potential, and won't
until the high-end processing market settles down. Therefore, a separate fingerprinting system is
required. This will be connected to the booking station and the network via Ethernet.

There are three main live-scan vendors on the market today: Identix, Inc.; Digital Biometrics, Inc.
(DBI); and Finger Matrix. All three meet NIST standards and have been certified compliant to the
FBI's Minimum Image Quality Requirements for Live-Scan, Electronically Produced Fingerprint Cards. All three use a platen for fingerprint scanning, minutiae measurement, and digitization. All three fingerprinting vendors supply systems complete with a software application that guides the user through the fingerprinting process, including which finger to place on the platen, and what to do once it is there. The three vendors allow fingerprints to be immediately viewable on the monitor; Identix and Finger Matrix allow viewing after the fingerprint has been scanned and digitized, DBI allows viewing during the fingerprint rolling (real-time). All three allow a mechanism for labeling fingers on fingerprint cards as being missing, deformed, cut, etc. They all support single-sided printing, single fingerprint rescanning, and data sharing with other systems. The DBI system is UNIX-based and is able to run MS-DOS and MS-Windows applications as well as UNIX software. The Identix system uses the IBM OS-2 operating system, which does not follow Columbia's strategic technology direction.

Also, so much effort, time, and capital is required in the development and enhancement of a live-scan system that the vendor must sell a great deal of equipment just to break even. The optical components are extremely expensive and require a great deal of programming to ensure they are calibrated properly at all times. This supports the fact that two of the three vendors, Identix and Finger Matrix, are in great risk of bankruptcy. One cannot be certain if they will be around to satisfy Columbia's five-year survivability requirement. Meanwhile, DBI was the first vendor to receive the FBI's certification, is doing a great deal of business with law enforcement agencies around the country, is profitable, and enjoys a solid reputation. They have already interfaced with major AFIS systems including NEC, PRINTRAK, and Electronic Data Systems/Cogent. Their all-in-one system is sturdy and ruggedized. For these reasons, the DBI Ten-Printer, at $60,000, is recommended for Columbia.
VIDEO CAPTURE DEVICE

A device is required to bring the video from the camera and scanner into the booking station where it will be digitized. The most common video-to-PC interface is the video capture board. Video capture boards generally have an input port that video can be fed into from a cable, and an output port where video can leave. Most video capture boards have format converters so for example NTSC video can come in, be digitized, and stored as an image; but simultaneously leave as RGB video for input into a video printer or other device. Video capture devices usually come packaged with software used to control the board and interface with whatever application software the images will be used in. Minimum requirements for a video capture device are:

- The BIS must follow Columbia’s planned technological direction:
  - Joint Photographic Experts Group (JPEG) capture / compression standards for images (Technology requirements)

- Up to 10 images (including personal effects) shall be allowed per arrestee file, e.g. front view, left side, right side, with glasses, etc. (Image Capture - Mugshots requirements)

- A standard NTSC video camera shall be used. Once the subject’s face is centered, the frame will be ‘frozen’ and digitized. (Image Capture - Mugshots requirements)

- Users can see mugshot results on-screen immediately, and can redo as desired. (Image Capture - Mugshots and -Personal Effects requirements)

- Images will be captured and compressed in a JPEG-compatible format. (Image Capture - Mugshots and -Personal Effects requirements)
• Images will be in color with a resolution of Super VGA (SVGA) or better. This implies
greater or equal to 800 by 600 picture elements (pixels). (Image Capture - Mugshots
requirements)

• Images will be digitized to a pixel depth of 24 bits per pixel. (Image Capture - Mugshots
requirements)

Three video capture boards, with software, have been identified. They are: In Motion
Technologies Inc.’s Picture Perfect video capture board, Video Associates Labs Inc.’s VideoVue
video capture board, and Anisad’s Viper Vision video capture board.

All three products allow digitization of as many images as desired, and allow input from a variety
of source formats, including NTSC video. All three allowing re-doing (unfreezing and re-
capturing) a frame until the user is satisfied, and only then saving and compressing the image. All
three also support JPEG standards, 24-bit pixel depths and at least 600 by 800 pixel resolution.

The software that accompanies the boards is key since it is what is used to interface with any
application software. The In Motion Technologies board software has experienced compatibility
problems, according to the July 1994 issue of Windows Sources. Its’ $349 price makes it quite
attractive, but not at the expense of flexibility and capability.

The Anisad Viper Vision board meets all requirements, but turns out to be an externally-mounted
board (attached to the PC’s parallel port) instead of an internally-mounted board. As practically
all PC boards mount internally, the City of Columbia did not make that a requirement. However,
in the unpredictable booking environment, keeping devices as streamlined as possible is a must.

18 DeVoney, Chris A Bargain for Capturing Single Frames from Video, Windows Sources, July 1994, Ziff-Davis
Publishing Company.
Having a board outside the PC will make it a prime candidate for getting broken off. The Viper Vision board is not recommended.

According to the August, 1994 Computer Shopper,

Video Associates Labs Inc.'s $795 VideoVue is a versatile video capture board for IBM-and-compatible microcomputers. The VideoVue enables users to capture color or monochrome video frames from any source, although an S-Video cable is not supplied. The card is ready to use as soon as it is plugged in and the cables are connected; the intelligent software automatically senses the type of incoming video, whether composite, S-Video, NTSC, or PAL, and configures the hardware accordingly. Captured frames, as well as incoming video, may be displayed under MS-DOS or Microsoft Windows. 19

The VideoVue board has become established in the industry as reliable and high-performing. It meets all stated minimum requirements and is easy to use and set-up. At $795, it is the most expensive of the three boards evaluated, but provides the greatest flexibility, performance, and suitability. The Video Associates Lab VideoVue board and software are recommended.

COMPRESSION SOFTWARE

Once images are digitized after being captured from a video source, they must be compressed to facilitate storage, retrieval, and transmission times. The compression ratio for the BIS has been specified as 1:15. Without image compression, approximately 15 times the amount of storage would be required, and it would take approximately 15 times more time to transmit images. This equates to money; more optical media would be required, and someone would have to wait at the

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BIS until all images and data were transferred. Likewise, research would take longer since searching for files whose images are uncompressed would require approximately 15 times more time to retrieve them.

Over the last five years, compression capabilities have transferred from hardware to software. In the mid-eighties when image capture was first introduced, hardware (PC board) was used to perform compression. In the late eighties, software compression was used, but usually in concert with hardware due to speed (hardware compression was much quicker than software compression). The software compression was used as a back-up in case the board failed. Recently, software compression technology has advanced to the point where it is as fast as hardware compression. It is generally less expensive and more reliable since there is no dependency on board connections and no chance for a hardware failure. For these reasons, software compression utilities are recommended for the BIS. Minimum image compression requirements are:

- Joint Photographic Experts Group (JPEG) capture / compression standards for images (Technology requirements, Image Capture - Mugshots requirements, Image Capture - Personal Effects requirements)

- Images shall be stored in JPEG-compatible compressed format (which is approximately equal to 15:1) (Storage requirements)

Two software products have been identified which utilize the JPEG image compression standard for capture and storage: Eastman Kodak Co.'s Colorsqueeze 2.0 and Storm Technologies’ PicturePress 2.5 are both image compression utilities that reduce captured images to a fraction of their original size; both use ‘lossy’ compression algorithms that eliminate some data, although the loss is usually not noticeable depending on the compression ratio used.
The following four factors were considered in evaluating the two packages: speed, image quality at a given compression ratio, convenience, and supported file formats. For speed, PicturePress has the advantage. According to the November, 1994 MacUser, PicturePress is more than twice as fast as Colorsqueeze.

It was much easier to evaluate image quality at a given compression ratio for PicturePress as it provides a slider control letting the user set the ratio from 1 to 100, while Colorsqueeze offered three fixed compression settings: Normal (best quality, lowest compression ratio), Medium, and High (lowest quality, highest compression ratio). At Medium compression, Colorsqueeze-compressed images seemed to be equivalent in quality (level of degradation) to PicturePress images compressed at a ratio of 15:1.

Colorsqueeze saves images in PICT format then compresses them in JPEG format. PicturePress saves and compresses in straight JPEG format, which resulted in less color shifting and fewer visual artifacts. Also, according to MacUser, PicturePress provides greater file format support and is more convenient and flexible to use than Colorsqueeze. Colorsqueeze is $179. PicturePress, at $199 is recommended for the BIS.

4.5 Commercial-Off-The-Shelf Software

The main commercial-off-the-shelf (COTS) software component requirements are for the front-end application builder and the SQL database software. In the Custom-Developed Software Application section, there will not be any differentiation between the database and the application

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20 Fraser, Bruce. Colorsqueeze and PicturePress. MacUser, November 1994, Ziff-Davis Publishing Company
builder in terms of capabilities and requirements. In this section, justification is given for the two products that are selected. We are in the position of recommending to Columbia products that:

- Are established in the marketplace already and appear to have permanency for the future to ensure upgradeability and supportability

- Result in a Windows-compatible, easy-to-use application

- Would not constrain future database and application size, allowing future expansion if necessary

- Are cost-effective

- Adhere to industry standards

- Our staff has experience with.

DATABASE

Minimum requirements for the database COTS package are as follows:

- Search capabilities must allow checks for prior arrests, aliases, arrestee status, and personal information. (System-level requirements)

- The BIS must follow Columbia’s planned technological direction:

- Standard Query Language (SQL) database standards. (Technology requirements)

- Data fields will accommodate a maximum number of characters determined by studying a sample of 100 manually-created forms. (Data Entry requirements)

- Text will be stored in ASCII format. (Image Capture - Personal Effects’ requirements)
One of the most notable and established SQL-based databases is Oracle. Oracle has been used for years, adapting to changing technologies, standards, and practices. A less robust and capable database could fill Columbia's current needs, however a more powerful database guarantees limitless possibilities for the future. According to the June 15, 1994 DBMS magazine describing Oracle 7,

An open, scaleable relational database management system (RDBMS) that is portable to more than 80 hardware and operating system platforms, from desktop systems to mainframes and supercomputers. Applications can run round-the-clock, because system functions such as backup, recovery, and database administration occur on-line without interrupting transaction processing. 21

Oracle is extremely established in the database market and is influential enough to guide standards and practices, not merely follow them. An Oracle database can grow to accommodate hundreds of users on multiple database servers, and our staff has in-depth experience using Oracle products. Oracle 7 for ten users costs $3,795. Oracle can certainly handle the search capabilities required by Columbia of prior arrests, aliases, arrestee status, and personal information. Although the front-end application will display the controls for certain functions, the back-end database will make it happen. The means of selecting or entering information will be controlled by the front-end application, and then the data will be transferred to the Oracle database. Oracle can handle fields of any length, including free-form text entry. It will store text in ASCII format.

21 Database Servers and Host DBMS's, DBMS, June 15, 1994, M&T Publishing Inc.
FRONT-END APPLICATION BUILDER

Today's programming sophistication has produced several fourth-generation language packages that allow users to develop applications without 'starting from scratch.' According to the May 16, 1994 InfoWorld,

As client/server technology begins to deliver on the promises of its proponents, users are harnessing the power of the desktop with increasingly sophisticated hardware and software. The current challenge revolves around how best to translate applications into client/server and onto the desktop at a minimum of time and expense. One answer lies with front-end SQL graphical user interface (GUI) development tools. 22

The minimum front-end application builder must satisfy the following requirements:

- The user interface must allow entry via keyboard, mouse, or touchscreen (System-level requirements)
- Personal history information should be entered by selecting displayed choices wherever possible. Original information will be typed in with the keyboard (Data Entry requirements)
- Menu choices and list selections can be chosen with the keyboard, mouse, or touchscreen (Data Entry requirements)
- Tabbing between fields is desired (Data Entry requirements)
- Fields must be in an order similar to the order of fields in current forms. The field data sequence will dictate tabbing rules. (Data Entry requirements)

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• Microsoft Windows-based applications and graphical user interface (GUI) (Technology requirements)

• Tabbing between fields is desired (Data Entry requirements)

• Free-form text describing the image can be saved with the image. (Image Capture - Personal Effects requirements)

• Users shall be able to generate and print activity and statistical reports such as:
  • number of arrests by crime category, officer, time-frame, and location
  • arrestee history and status. (Reporting requirements)

• Future reports that will be uploaded to the BIS over radio frequency communication directly from patrol cars must be considered. These include: Record of Stored Vehicle (Tow Slip), Field Interview Card, Incident, and Accident. (Reporting requirements)

• Columbia's BIS users shall comprise arresting officers and investigators (User Interface requirements)

• Users shall know where they are in the application at all times via screen labels (User Interface requirements)

• Exiting to the next highest level in the menu hierarchy shall be possible through an ‘exit’ button placed in a consistent location on every screen. (User Interface requirements)

• Users can issue commands by touching the monitor with their finger (touch screen), typing on the keyboard, or pointing and clicking on the screen with the mouse. (User Interface requirements)
• The BIS user applications shall be designed in accordance with Microsoft Windows graphical user interface development guidelines per *The Windows Interface: An Application Design Guide*. 23 (User Interface requirements)

• Pre-set selections for as fields will be accessible via screen buttons and pull-down menus. (User Interface requirements)

• On-line help shall be available for every function. (User Interface requirements)

PowerBuilder, Visual Basic, and Visual C++ were evaluated as front-end application builder tools. All three are Microsoft Windows-based packages with a graphical user interface, and support *The Windows Interface: An Application Design Guide*. All three afford the developer the freedom of providing entry with any input device (keyboard, mouse, touchscreen), displayed choice lists, and tabbing between fields. Images are treated as fields, and free-form text can be treated as another field that is associated with an image. Developers can make the user screens look almost any way they want, with consistent screen labels, pull-down menus, help buttons, and exit buttons.

Not only does our staff have an abundance of experience in PowerBuilder, but it is more affordable and robust as well. Powersoft's PowerBuilder 3.0 provides visual programming techniques that result in polished, easy-to-use, Windows-based user applications. PowerBuilder provides a front-end to a myriad of databases, including Oracle. PowerBuilder is established in the marketplace, employing innovative tools that allow programmers to develop capable, flexible applications. According to the May 31, 1994 *PC Magazine*,

> In short: a powerhouse of development tools, PowerBuilder is especially adept at producing polished, full-featured applications in virtually no time.

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Its suite of Painters provides a high level of productivity and polish. PowerBuilder also provides its users with a level of familiarity [attributable to Microsoft Windows standards], adding to its ease of use. 24

PowerBuilder was rated as excellent in: rapid development, querying and reporting, and programming tools. Our staff has developed many similar-purpose applications using PowerBuilder. Its list price is $3,595, compared to $3,750 for Visual Basic and $3,675 for Visual C++. 4.6 Custom-Developed Software Specification

The following subsections will describe the required functionality of the custom-developed software application for BIS users. The application will be treated as a whole, not as separate components. It will be viewed functionally, from the BIS user perspective. Programming plans and data dictionaries will be developed at a later phase and are outside the scope of this project.

PURPOSE

The purpose of the BIS application is to provide a seamless system interface to users, automate current booking activities, and provide additional capabilities not possible through manual means. The BIS must perform the following functions:

- Support the arrestee booking process (detailed below)
- Capture mugshots and evidence images
- Send pertinent fingerprint card data from the booking station to the fingerprinting system

• Print booking reports, mugshots, fingerprint cards, and evidence pictures

• Allow reports of statistics and trends

• Communicate data to the RMS at City Hall

• Store, archive, and backup text and images.

REQUIREMENTS

Most user-related requirements pertain to the custom-developed software. They are as follows:

• Search capabilities must allow checks for prior arrests, aliases, arrestee status, and personal information (System-level requirements)

• All elements must be printed (images, fingerprints, and text). Forms must be generated within the computer, allowing blank paper to be placed in the printer trays, except for fingerprint cards which must be loaded. (System-level requirements)

• Personal history information should be entered by selecting displayed choices wherever possible. Original information will be typed in with the keyboard (Data Entry requirements)

• Fields must be in an order similar to the order of fields in current forms. The field data sequence will dictate tabbing rules. (Data Entry requirements)

• Up to 10 images (including personal effects) shall be allowed per arrestee file, e.g. front view, left side, right side, with glasses, etc. (Image Capture - Mugshots requirements)

• Users can see mugshot results on-screen immediately, and can redo as desired. (Image Capture - Mugshots requirements)
• The fingerprinting system must allow data transfer from the booking station, if they are to be separate systems. Demographic information such as race, sex, height, weight, etc. which are required on both booking reports and fingerprint cards shall be sent to the fingerprinting system after it is collected during booking report completion. (Image Capture - Fingerprints requirements)

• Up to ten images (including mugshots) can be stored with an arrestee’s file. (Image Capture - Personal Effects requirements)

• Users can view capture results on-screen immediately, and can redo as desired (Image Capture - Personal Effects requirements)

• Free-form text describing the image can be saved with the image. (Image Capture - Personal Effects requirements)

• Personal history information and mugshots shall be displayed simultaneously. Fingerprints and fingerprint card information shall be displayed simultaneously. (Display requirements)

• Users shall be able to view a preview of the image or report before they print (Printing requirements)

• Printing of reports and images shall be effected by selecting one area on the screen or pressing one keyboard key (Printing requirements)

• Users shall be able to generate and print activity and statistical reports such as:
  • number of arrests by crime category, officer, time-frame, and location
  • arrestee history and status. (Reporting requirements)
• Passwords and user IDs shall be required upon user log-in (Security requirements)

• Various access levels shall be assigned to users by the system administrator depending on users’ need to know. Access levels include: all functions; read only; read and print only; and read, edit, and print (Security requirements)

• The same user may have different access levels for different reports. (Security requirements)

• Sensitive files such as juveniles can be assigned a special security level so only assigned users can gain access to them (Security requirements)

• Audit trails recording system actions by user ID, date, and time shall be maintained (Security requirements)

• Only system administrators may delete files. (Security requirements)

The custom-developed software application will be developed to meet the above requirements using the database and front-end tools specified above. The tools will allow all of the above requirements to be satisfied; it will be up to the development team to find the best way of accomplishing that. All of the security requirements can be met through Oracle. The following sections further specify the custom-developed application and what functions it must perform.

LOOK AND FEEL

The user interface will be, and look like, a Microsoft Windows application with pull-down menus, function buttons, and the same fonts, icons, and options (wherever possible). One notable difference is that the BIS application running on the booking station and retrieval stations must accommodate touchscreen control. This means that option boxes and menu selections must be
large enough for a fingertip to access, not just a mouse cursor. The application will be designed for color monitors and will take advantage of consistent colors of menu items and features across screens.

HIERARCHY

The menu item hierarchy for primary users (at the booking station) after entering Login name and password, is as follows:

MAIN MENU

1. Book an Arrestee

2. Add Supplementary Images

3. Queries and Reports

4. Exit

‘Book an Arrestee’ guides the user through entering personal history information, mugshots, and fingerprints (passing control to the fingerprinting system); then printing booking reports, mugshots, and fingerprint cards.

‘Add Supplementary Images’ allows users to capture and label personal effects images and evidence images; and then print the images.

‘Queries and Reports’ allows users to search for arrestee files (comprising text, images, and fingerprints), reprint arrestee materials, create reports, and print reports.

‘Exit’ brings the user back to the login and password screen so the next officer can use the system.
The retrieval station(s) won't have access to items 1. and 2. and will only be able to query, create reports, print booking materials and reports, and exit the application.

**PROCESS**

The booking application will be based on the following process for the arresting officer based on the operational functional flow depicted earlier in this project:

1. Login to system
2. Enter password
3. Select ‘Book an Arrestee’
4. Enter applicable text fields in the arrest report form that is on the screen (to include fingerprint card information that is identical to arrest report information)
5. Select ‘Capture Mugshots’. Screen will show camera input
6. Position arrestee so his or her face is centered in the screen
7. Capture as many mugshots as needed (up to 10 including personal effects images)
8. Select ‘Capture Fingerprints’. Fingerprint card information will be sent from the booking station to the fingerprinting system.
9. Move to the fingerprinting system
10. Place arrestee’s fingers, according to directions on the fingerprinting system screen, on the fingerprint platen, scan them, and save them when satisfied with quality of each fingerprint
11. Move back to booking station
12. Select the option, if desired, to capture supplementary images. This can either be done at the
time of booking, or afterwards at any time.

13. Capture supplementary images using the video scanner

14. Select ‘print’

15. Select arrest report, mugshots, fingerprint card, and/or supplementary images

16. Select the quantity of each item to print

17. Exit.

DATA FIELDS

According to the Unisys-developed Extended Architecture Implementation Recommendations \( ^{25} \) for
the City of Columbia, the following data items, at a minimum, are required for arrest booking:

- Location of Arrest
- Arresting Officer(s)
- Charge Information
- Charge Disposition
- Bond Information
- Arrestee Vehicle Information
- Age of Arrestee

\(^{25}\) Unisys Corporation Extended Architecture Implementation Recommendations, June 1994, Unisys Corp.
- **Sex of Arrestee**

- **Ethnicity of Arrestee**

A mechanism must be employed to prevent the arresting officer from saving and exiting the booking report file unless the above fields have been entered.

**REPORTS**

According to the *Extended Architecture Implementation Recommendations*, the following reports, at a minimum, are required to be produced by the BIS:

- **File of Known Offenders**

- **Arrest History Report**

- **Report of the Age, Sex, and Ethnicity (Vital Statistics) of Persons Arrested**

- **Daily Arrest Report**

- **Monthly Analysis of Arrests** (reported by number and type of arrest).

There will be user-defined parameters that bound the report. For example, a range of dates can be entered before producing the arrest history report, and the vital statistics report. The default, if no range is entered, is the entire history or analysis.

Reports, particularly statistical reports, can be depicted as pie charts and bar graphs if the user desires. For example, the monthly analysis of reports can show visually in a pie chart what proportion of arrests for the month of May are homicides, kidnappings, breaking and entering, carjacking, and drug-related.
PERIPHERAL CONTROL

All peripherals will be controllable through software for at least their basic functionality, such as starting the scanning process on the video scanner, instructing the printers to print a specified number, and the WORM drives to record a specified file. Settings and preferences for some peripherals will still be required to be set at the control panel of the device itself. Peripheral control is depicted in the following table:

Table 4-1 Peripheral Control

<table>
<thead>
<tr>
<th>DEVICE</th>
<th>CONTROLLED BY</th>
<th>FUNCTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Video Camera</td>
<td>Booking Station</td>
<td>Captures mugshots of arrestees</td>
</tr>
<tr>
<td>2 Video Scanner</td>
<td>Booking Station</td>
<td>Captures images of personal effects and evidence pictures</td>
</tr>
<tr>
<td>3 Fingerprint Scanner</td>
<td>Fingerprinting System</td>
<td>Captures images of arrestee fingerprints</td>
</tr>
<tr>
<td>4 Laser Printer</td>
<td>Database Server</td>
<td>Prints fingerprint cards and reports</td>
</tr>
<tr>
<td>5 Video Printer</td>
<td>Image/Optical Server</td>
<td>Prints mugshots and evidence pictures</td>
</tr>
<tr>
<td>6 SCSI Hard Drive</td>
<td>Database Server</td>
<td>Archives all data elements</td>
</tr>
<tr>
<td>7 WORM Drive</td>
<td>Image/Optical Server</td>
<td>Archives all images and fingerprints</td>
</tr>
<tr>
<td>8 Modem</td>
<td>Communications Server</td>
<td>Sends BIS data to the RMS</td>
</tr>
</tbody>
</table>

SERVERS

The server applications are responsible for various functions so that the clients can do their job. Each subsection below describes the server applications and then what a user/system administrator will be able to achieve on each server. Since all servers and workstations will be networked, the functions on each server can be accessible by any other server.

Database Server: The database server application receives text files from the clients and stores them. Likewise, the database server receives requests for text files, which may also entail
producing the pointer to associated images, and sends the result to the client that requested it. The
database server controls the laser printer and formats text for printing. The database server is also
responsible for backing up text files to DAT every day. The database server will satisfy a request
from the communications server to upload all text files to the RMS that have been created since the
last upload. It will format the text files and send them to the communications server.

Oracle will reside on this server, and with it are powerful system administration functions. System
administrators will be able to set passwords and user ID's, access levels, time-outs, etc. System
administrators will have full audit trail capability. Once the audit trail is set up, system
administrators can view user access by user ID, time, date, files created, files changed, and files
printed.

**Image/Optical Server:** The image/optical server receives compressed images from the booking
station and stores them. The image/optical server software satisfies requests for images by sending
the compressed images to the client in concert with the database server sending associated text to
the client. It is also responsible for backing up images to DAT once a week.

Oracle allows access and control of all images stored out to optical disk. Only users with the
highest access level can access the image library to copy and delete images. On WORM disk,
images are permanently written to the disk, but by erasing the image pointer, it is virtually
impossible to gain access to the accompanying image.

**Communications Server:** The communications server application provides the interface to the
RMS at City Hall. It controls the modem that sends files over a phone line to the RMS. It
provides a user interface that tells the server when to upload; it is not automatic. The
communications server requests all files that have not yet been uploaded from the database server.
It formats them for upload, and sends them to the modem. It tracks progress of the transmission and resends any files that were not received successfully at the RMS.

4.7 Integration

We have looked at all of the separate components that together comprise the BIS and evaluated each for compliance to BIS requirements, value, performance, and industry reputation. We have viewed each component as a system with inputs, outputs, and processes. One remaining question is: how do we know they will work together? This question is a lot easier to answer today, using COTS components designed to be modular; and Microsoft Windows, designed to pull everything together, and the de-facto standard that almost all hardware and software components interface with.

There are two central cores of the BIS: the ethernet network (hardware) and Microsoft Windows (software). Each major workstation and server is connected to the ethernet network via an ethernet network card. This will effect the exchange of information and the physical connection of all workstations and servers to each other. Peripheral devices are in turn connected to the appropriate server or workstation. Connections are various: SCSI, serial, parallel, BNC (video), etc. Luckily, industry standards have become established that mitigate the need for proprietary interfaces to use a desired component. All hardware components in the BIS require minimal setup and configuration, and work together by virtue of industry standards and the fact that they were designed to be integrated into PC systems. The Microsoft Windows core brings all software components together, and enables the peripherals to be controlled through Windows-based software. Microsoft Windows 3.1 will be installed on all workstations and servers. The only software component that is not Windows-based is the fingerprinting system, which is UNIX-based.
Even this operates with Windows. The Oracle database and custom-developed application will be created using Windows tools. Also, all boards and peripheral devices that will be controlled through Windows-based software have Windows drivers. This promotes easy set-up as well as consistent peripheral interfaces.

There are some system-level interfaces that will be enabled through software. They include: the interface between the communications server and the modem; the user interfaces at the booking station and retrieval station; and the interface between the booking station and the fingerprinting system. These interfaces are part of the custom-developed software application and have been factored into the life-cycle cost analysis.

4.8 Allocation of System Support Requirements

The following maintenance provisions were extracted in part from the Maintenance Requirements section of this report. The requirement is listed first, and the maintenance provision follows in italics for each requirement. This provides a general concept of how maintenance should be undertaken for the BIS.

- All BIS components shall be available 23 hours per day, with one hour reserved for preventive maintenance activities such as checking cables, disk capability, and individual components; reloading printer paper, fingerprint cards, and printer ribbon; ensuring cameras are in focus; and reviewing the audit trail if necessary. Backups shall take place during this time. City of Columbia maintenance personnel will be trained in preventive maintenance capabilities for the BIS. A maintenance schedule will be recommended to them to conform to the 23 hour per day availability requirement.
• The exception to the availability requirement above is if corrective maintenance is required. This shall entail replacing defective hardware components with a spare part maintained for that purpose. Should a hard drive crash, time will be required (based on which server crashes) to restore data from the DAT backup. During such time that the system is unavailable longer than one hour for corrective maintenance purposes, operations shall revert back to the manual method. *City of Columbia maintenance personnel will be trained on basic corrective maintenance functions. Manufacturer points of contact shall be maintained should an error occur which is unrecoverable by Columbia personnel.* Columbia should maintain materials they are currently using for booking purposes, such as ink pads, arrest reports, and Polaroid cameras should a system catastrophe occur that requires them to revert to the manual method.

• The system must be designed to survive for five years with only minor hardware and software upgrades required to prevent obsolescence. *Components for the BIS have been selected with an eye toward the future in terms of industry trends and survivability.* Software maintenance will include receiving all version upgrades from the software manufacturers. *Before installation, the upgrades will be checked to insure the custom-developed software will function with a new version. If not, the decision will be made jointly on a case-by-case basis as to whether to not install the upgrade, or to change the custom-developed software to accommodate the upgrade.*

• All hardware components shall be warranted for at least one year for full replacement by the manufacturer. *This is a fairly standard provision in the computer industry, and will be confirmed with each individual hardware manufacturer to ensure there is no charge.*
If the City of Columbia elects to extend the warranty, there will be an annual charge for each component.

- The system shall be powered on all the time, except during preventive maintenance when the power shall be cycled, and corrective maintenance if required. *There is no restriction on any of the recommended devices to prevent constant power-on as long as operating temperature ranges are upheld.*

- An on-site ‘replace then repair’ strategy must be adopted as the first tier of support for corrective maintenance, even during the warranty period. Given the system’s operational availability goal, all hardware components must be spared by the City. That means a set of duplicate hardware components must be maintained on-site in a County Jail store room. Similar components need only one spare for all. For example, one server CPU can be spared to cover all active servers. During the warranty period, City personnel will swap in a spare for any failing component; the manufacturer will then repair the original part. *A list of recommended components to be spared will be provided to the City of Columbia. These spare components will help preserve Columbia’s operational requirements.*

- The second tier of support for corrective maintenance must be to repair the original component that was replaced by the spare part. The component must be sent back to the manufacturer for repair. If still under warranty, repair will take place free-of-charge. If outside of the warranty period, the City of Columbia shall fund any necessary repair work. *Columbia’s maintenance personnel will have a list of manufacturer repair facility addresses. They can send any damaged device to these addresses for repair and return. If outside of the warranty period, a repair price estimate can be requested from the manufacturer prior to shipment.*
- County Jail staff must be identified and trained on hardware and software maintenance, which shall be performed during one hour of every day the system is functioning. Personnel will have at least a general understanding of computer hardware and software, and will be Microsoft Windows-literate.

Software version maintenance shall take place by receiving upgrades from the manufacturers of the original software products, as well as receiving upgrades to the custom-developed applications including any client-requested enhancements. We will coordinate upgrade installation by the above provision of ensuring that all installed software will continue to operate as expected. Any enhancement to the custom-developed software will be tested thoroughly to ensure it operates properly with the COTS software.

4.9 Allocation of Performance Requirements

The following performance requirements are presented and then allocated to various system components. Allocations are shown in italics.

4.9.1 Storage

Storage calculations are for a five-year duration. 300 arrestees are processed per month. Over five years, data for 18,000 arrestees will be stored on the system. Each text file requires 2.5 Kbytes. Over five years, 45 Mbytes will be stored on the local hard drive (database server). That is quite easy to accommodate with today’s hard drive volumes.

*The recommended server contains over 300 Mbytes of hard disk; even with substantial growth, it would take much more than five years to consume the storage.*
Up to ten images can be stored with each arrestee’s file. Over five years, that equates to up to 180,000 images. Each image, uncompressed, is .5 Mbytes in size. All images must be compressed at a ratio of at least 15:1. That means each image will now be approximately 34 Kbytes compressed. Over five years, 6 Gbytes will be required. It is recommended to use a Write-Once-Read-Many (WORM) unerasable optical drive using 1.4 Gbyte WORM disks. That means a new WORM disk will be required in the drive every fourteen months. If searching for an arrestee whose images are on a prior WORM disk (not in the drive), the user would be prompted to enter the correct WORM disk into the drive to access the images.

1.4 Gbyte WORM disks cost approximately $80 each. Over five years, five WORM disks will be needed at a total cost of $400. BIS personnel can be easily trained to monitor the remaining storage capacity of the current WORM disk, then label and store disks that become full.

Fingerprint images shall be stored locally on the fingerprint system’s hard drive. The 300 arrestees that are processed per month are fingerprinted. Over five years, fingerprints for 18,000 arrestees will be stored on the system. Compressed, each fingerprint card file requires 50 Kbytes of storage. This includes images for all ten fingers separately, both thumbs together, and the four fingers on each hand taken together. For 18,000 sets of fingerprint images, total storage requires 900 Mbytes. This is accommodated in a 1 Gbyte hard drive with the fingerprint system.

The 1 Gbyte option with the fingerprint system can be utilized to accommodate the 18,000 sets of fingerprint images.

Fingerprint card text is a sub-set of the booking information text and does not require separate storage.
Given that 300 arrestees are processed per month, the system must allow 10 arrestees to be processed per day on average, and 20 per day peak.

*It currently takes 40 minutes to process an arrestee with the expectation that the BIS will cut that time in half. Even at the 40 minute time, 34 arrestees could be processed in 23 hours.*

4.9.2 Printing Speed

1. Booking reports shall print at a rate of at least eight pages per minute.

   *The recommended laser printer prints text at a rate of at least ten pages per minute.*

2. Mugshot and personal effects images shall print at a rate of at least two pages per minute.

   *The recommended image printer prints at a rate of two pages per minute.*

4.9.3 Communication

File transfer shall take place at a baud rate of at least 19,200 bits per second. Since there are eight bits in a byte, the baud rate is 2,400 bytes per second. A complete arrestee file of text and up to 10 images can require up to 362.5 Kbytes. At the specified baud rate, an arrestee file will take 151 seconds, or just over two and one-half minutes, to transfer to the RMS.

If 300 arrestees are processed per month, seven days per week, then on average ten are processed per day. Each day, approximately 25 minutes will be required for file transfers from the BIS to the RMS.

19.2 Kbps modems are prevalent. The 25 minutes per day required for file transfers can be initiated at the beginning of the hour allocated each day for preventive maintenance, so will not require additional time beyond the hour.
4.10 Life-Cycle Cost Analysis Summary

The following presents a summary of a life-cycle cost analysis for budgetary purposes. Total system cost (C) is derived as the sum of Cr, CI, and Co where Cr is research and development cost, CI is investment cost, and Co is operations and maintenance cost. Figure 4-8 depicts the cost breakdown structure for the BIS.

![Figure 4-8 BIS Cost Breakdown Structure](image-url)
4.10.1 Research and Development Cost

Research and development cost includes program management, advanced R and D. engineering design, equipment development and test, and engineering data costs. Costs are based on an hourly rate of $70 for both program management and engineering staff.
Table 4-2 Research and Development Cost

<table>
<thead>
<tr>
<th>CrM</th>
<th>$16,800</th>
<th>25% time over 6 months for 1 person</th>
</tr>
</thead>
<tbody>
<tr>
<td>CrR</td>
<td>$11,200</td>
<td>2 people 50% time over 1 month</td>
</tr>
<tr>
<td>Cre</td>
<td>$179,200</td>
<td>4 people 100% time over 4 months</td>
</tr>
<tr>
<td>Crt</td>
<td>$44,800</td>
<td>2 people 100% time over 2 months</td>
</tr>
<tr>
<td>CrD</td>
<td>$44,800</td>
<td>2 people 100% time over 2 months</td>
</tr>
<tr>
<td>TOTAL Cr</td>
<td>$296,800</td>
<td></td>
</tr>
</tbody>
</table>

4.10.2 Investment Cost

Invest cost includes system/equipment costs, system construction cost, and cost of initial logistic support. Costs are based on an hourly rate of $70 for both program management and engineering staff. The BIS does not require special facilities for mass-production as only one will be integrated. There are no construction costs for this reason, and only packing and initial transportation costs, and inspection and test costs associated with recurring manufacturing costs. All unique components will be spared, except for the fingerprinting system due to its high cost. Should it fail, the manufacturer will be called immediately and officers will revert to the manual fingerprinting method.

Table 4-3 Investment Cost

<table>
<thead>
<tr>
<th>CiM</th>
<th>$111,440</th>
<th>This is the cost of system components (no development) (Table 4-9)</th>
</tr>
</thead>
<tbody>
<tr>
<td>CiN (except CIINT)</td>
<td>$100,800</td>
<td>3 people 100% for 3 months (includes software development)</td>
</tr>
<tr>
<td>CIINT</td>
<td>$5,000</td>
<td>Integration tools and test equipment</td>
</tr>
<tr>
<td>CIR</td>
<td>$11,200</td>
<td>1 person 100% for 1 month</td>
</tr>
<tr>
<td>CiL (except CIILS)</td>
<td>$80,800</td>
<td>1 person 25% for 6 months (PM) plus 1 person 100% for 3 months (documentation) plus 2 people 100% for 1 month (training) 4 people 100% for 1 week (trainees, $50 per hour)</td>
</tr>
<tr>
<td>CIILS</td>
<td>$35,160</td>
<td>All unique components except fingerprinting system</td>
</tr>
<tr>
<td>TOTAL Cl</td>
<td>$344,400</td>
<td></td>
</tr>
</tbody>
</table>

110
4.10.3 Operations and Maintenance Cost

Operations and maintenance cost includes cost of system/equipment life-cycle operations, cost of system/equipment life-cycle maintenance, and cost of system/equipment modifications. Cost of system/equipment phase-out and disposal is not included. Labor costs are based on an hourly rate of $70 for both program management and engineering staff. It should be noted that operating personnel cost is negative since it represents a savings as compared to using the manual booking method. Booking personnel labor rates are assumed to be $50 per hour. 3,600 arrestees are processed per year, each requiring 40 minutes to process. It is estimated that the BIS will cut that time in half. Over five years, the City will save $300,000.

The current booking facility will be used to house the BIS; there are no operational facility costs associated with the system. There is no support and handling equipment cost associated with the BIS.

The following five tables present operating costs for each of five years, taking 3% per year inflation into account.

Table 4-4 Operations and Maintenance Cost for Year One

| COOP  | $60,000  | This represents a cost savings since it will take 20 minutes to book a subject with the BIS as opposed to 40 minutes manually. |
| COOT  | $30,000  | 30 operators 100% for 1/2 week |
| COMM  | $18,250  | 1 person 1 hour per day for one year |
| CMX   | $1,000   | All equipment warranted for first year, only consumable cost |
| COMT  | $200     | 4 occurrences at average of $50 each |
| COMP  | $2,000   | 2 students 100% for 1/2 week |
| CON   | $5,600   | Minor modifications: 1 person 100% for 2 weeks (contractor rate) |
| TOTAL CO | $116,050 | YEAR 1 |
### Table 4-5  Operations and Maintenance Cost for Year Two

<table>
<thead>
<tr>
<th>Description</th>
<th>Cost (Year 2)</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>COOP</td>
<td>$60,000</td>
<td>This represents a cost savings since it will take 20 minutes to book a subject with the BIS as opposed to 40 minutes manually.</td>
</tr>
<tr>
<td>COTOT</td>
<td>$20,000</td>
<td>20 operators 100% for 1/2 week (New employees and refresher training)</td>
</tr>
<tr>
<td>COMM</td>
<td>$18,250</td>
<td>1 person 1 hour per day for one year</td>
</tr>
<tr>
<td>COMX</td>
<td>$10,000</td>
<td>Spares and consumables</td>
</tr>
<tr>
<td>COMT</td>
<td>$400</td>
<td>8 occurrences at average of $50 each</td>
</tr>
<tr>
<td>COMP</td>
<td>$1,000</td>
<td>1 student 100% for 1/2 week</td>
</tr>
<tr>
<td>CON</td>
<td>$11,200</td>
<td>Modifications: 2 people 100% for 2 weeks (contractor rate)</td>
</tr>
<tr>
<td>TOTAL Co</td>
<td>$120,850</td>
<td>YEAR 2</td>
</tr>
<tr>
<td>with Inflation</td>
<td>$124,475</td>
<td>(assume 3%)</td>
</tr>
</tbody>
</table>

### Table 4-6  Operations and Maintenance Cost for Year Three

<table>
<thead>
<tr>
<th>Description</th>
<th>Cost (Year 3)</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>COOP</td>
<td>$60,000</td>
<td>This represents a cost savings since it will take 20 minutes to book a subject with the BIS as opposed to 40 minutes manually.</td>
</tr>
<tr>
<td>COTOT</td>
<td>$20,000</td>
<td>20 operators 100% for 1/2 week (New employees and refresher training)</td>
</tr>
<tr>
<td>COMM</td>
<td>$18,250</td>
<td>1 person 1 hour per day for one year</td>
</tr>
<tr>
<td>COMX</td>
<td>$10,000</td>
<td>Spares and consumables</td>
</tr>
<tr>
<td>COMT</td>
<td>$800</td>
<td>8 occurrences at average of $100 each</td>
</tr>
<tr>
<td>COMP</td>
<td>$1,000</td>
<td>1 student 100% for 1/2 week</td>
</tr>
<tr>
<td>CON</td>
<td>$11,200</td>
<td>Modifications: 2 people 100% for 2 weeks (contractor rate)</td>
</tr>
<tr>
<td>TOTAL Co</td>
<td>$122,250</td>
<td>YEAR 3</td>
</tr>
<tr>
<td>with Inflation</td>
<td>$129,585</td>
<td>(assume 6%)</td>
</tr>
</tbody>
</table>

### Table 4-7  Operations and Maintenance Cost for Year Four

<table>
<thead>
<tr>
<th>Description</th>
<th>Cost (Year 4)</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>COOP</td>
<td>$60,000</td>
<td>This represents a cost savings since it will take 20 minutes to book a subject with the BIS as opposed to 40 minutes manually.</td>
</tr>
<tr>
<td>COTOT</td>
<td>$10,000</td>
<td>10 operators 100% for 1/2 week (New employees and refresher training)</td>
</tr>
<tr>
<td>COMM</td>
<td>$18,250</td>
<td>1 person 1 hour per day for one year</td>
</tr>
<tr>
<td>COMX</td>
<td>$10,000</td>
<td>Spares and consumables</td>
</tr>
<tr>
<td>COMT</td>
<td>$800</td>
<td>8 occurrences at average of $100 each</td>
</tr>
<tr>
<td>COMP</td>
<td>$1,300</td>
<td>1 student 100% for 1/2 week</td>
</tr>
<tr>
<td>CON</td>
<td>$0</td>
<td>Modifications: none</td>
</tr>
<tr>
<td>TOTAL Co</td>
<td>$100,050</td>
<td>YEAR 4</td>
</tr>
<tr>
<td>with Inflation</td>
<td>$109,054</td>
<td>(assume 9%)</td>
</tr>
</tbody>
</table>
### Table 4-8 Operations and Maintenance Cost for Year Five

<table>
<thead>
<tr>
<th>Description</th>
<th>Cost</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>COOP</td>
<td>$60,000</td>
<td>This represents a cost savings since it will take 20 minutes to book a</td>
</tr>
<tr>
<td></td>
<td></td>
<td>subject with the BIS as opposed to 40 minutes manually.</td>
</tr>
<tr>
<td>COOT</td>
<td>$10,000</td>
<td>10 operators 100% for 1/2 week (New employees and refresher training)</td>
</tr>
<tr>
<td>COMM</td>
<td>$18,250</td>
<td>1 person 1 hour per day for one year</td>
</tr>
<tr>
<td>COMX</td>
<td>$10,000</td>
<td>Spares and consumables</td>
</tr>
<tr>
<td>COMT</td>
<td>$800</td>
<td>8 occurrences at average of $100 each</td>
</tr>
<tr>
<td>COMP</td>
<td>$1,000</td>
<td>1 student 100% for 1/2 week</td>
</tr>
<tr>
<td>CON</td>
<td>$0</td>
<td>Modifications: none</td>
</tr>
<tr>
<td>TOTAL CO</td>
<td>$100,050</td>
<td>YEAR 5</td>
</tr>
<tr>
<td>with Inflation</td>
<td>$112,056</td>
<td>(assume 12%)</td>
</tr>
</tbody>
</table>

The total life-cycle cost including research and development, investment, and five years of operation and maintenance is $1,232,420.

**DEFINITIONS**

<table>
<thead>
<tr>
<th>CRM</th>
<th>Program Management Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>CRR</td>
<td>Advanced Research and Development Cost</td>
</tr>
<tr>
<td>CRE</td>
<td>Engineering Design Cost</td>
</tr>
<tr>
<td>CRT</td>
<td>Equipment Development and Test Cost</td>
</tr>
<tr>
<td>CRD</td>
<td>Engineering Data Cost</td>
</tr>
<tr>
<td>CIM</td>
<td>Manufacturing Cost</td>
</tr>
<tr>
<td>CN</td>
<td>Non-recurring Manufacturing Cost</td>
</tr>
<tr>
<td>CINT</td>
<td>Tools and Test Equipment Cost</td>
</tr>
<tr>
<td>CIR</td>
<td>Recurring Manufacturing Cost</td>
</tr>
<tr>
<td>CIL</td>
<td>Initial Logistics Support Cost</td>
</tr>
<tr>
<td>CILS</td>
<td>Initial Spare/Repair Part Material Cost</td>
</tr>
<tr>
<td>COOP</td>
<td>Operating Personnel Cost</td>
</tr>
<tr>
<td>COOT</td>
<td>Operator Training Cost</td>
</tr>
<tr>
<td>COMM</td>
<td>Maintenance Personnel and Support Cost</td>
</tr>
<tr>
<td>COMX</td>
<td>Spare/Repair Parts Cost</td>
</tr>
<tr>
<td>COMT</td>
<td>Transportation and Handling Cost</td>
</tr>
<tr>
<td>COMP</td>
<td>Maintenance Training Cost</td>
</tr>
<tr>
<td>CON</td>
<td>System/Equipment Modification Cost</td>
</tr>
</tbody>
</table>
Table 4-9  BIS Component Pricing

<table>
<thead>
<tr>
<th>Component</th>
<th>Qty.</th>
<th>Unit Price</th>
<th>Extended Price</th>
<th>Spare?</th>
</tr>
</thead>
<tbody>
<tr>
<td>PC Client</td>
<td>2</td>
<td>$3,000</td>
<td>$6,000</td>
<td>1</td>
</tr>
<tr>
<td>PC Server</td>
<td>3</td>
<td>$3,050</td>
<td>$9,150</td>
<td>1</td>
</tr>
<tr>
<td>Server Monitor</td>
<td>3</td>
<td>N/C</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Touchscreen Monitor</td>
<td>2</td>
<td>$3,500</td>
<td>$7,000</td>
<td>1</td>
</tr>
<tr>
<td>Network Card</td>
<td>5</td>
<td>$220</td>
<td>$1,100</td>
<td>1</td>
</tr>
<tr>
<td>Laser Printer</td>
<td>1</td>
<td>$3,400</td>
<td>$3,400</td>
<td>1</td>
</tr>
<tr>
<td>Video Camera</td>
<td>1</td>
<td>$450</td>
<td>$450</td>
<td>1</td>
</tr>
<tr>
<td>Video Printer</td>
<td>1</td>
<td>$6,190</td>
<td>$6,190</td>
<td>1</td>
</tr>
<tr>
<td>Video Scanner</td>
<td>1</td>
<td>$3,800</td>
<td>$3,800</td>
<td>1</td>
</tr>
<tr>
<td>WORM Drive</td>
<td>1</td>
<td>$2,200</td>
<td>$2,200</td>
<td>1</td>
</tr>
<tr>
<td>DAT Drive</td>
<td>3</td>
<td>$650</td>
<td>$1,950</td>
<td>1</td>
</tr>
<tr>
<td>Modem</td>
<td>1</td>
<td>$300</td>
<td>$300</td>
<td>1</td>
</tr>
<tr>
<td>Fingerprinting System</td>
<td>1</td>
<td>$60,000</td>
<td>$60,000</td>
<td>NO</td>
</tr>
<tr>
<td>Video Capture Device</td>
<td>1</td>
<td>$800</td>
<td>$800</td>
<td>1</td>
</tr>
<tr>
<td>Compression Software</td>
<td>1</td>
<td>$200</td>
<td>$200</td>
<td>on disk</td>
</tr>
<tr>
<td>Database Engine</td>
<td>1</td>
<td>$3,800</td>
<td>$3,800</td>
<td>on disk</td>
</tr>
<tr>
<td>Front-End Software</td>
<td>1</td>
<td>$3,600</td>
<td>$3,600</td>
<td>on disk</td>
</tr>
<tr>
<td>Initial Consumables</td>
<td>1</td>
<td>$1,000</td>
<td>$1,000</td>
<td>N/A</td>
</tr>
<tr>
<td>Misc. Cables and Connectors</td>
<td>1</td>
<td>$500</td>
<td>$500</td>
<td>N/A</td>
</tr>
</tbody>
</table>
5.0 CONCLUSION

The purpose of this project was to provide a COTS-based preliminary design to solve Columbia’s booking information-related problems. Columbia has a need for a BIS, and subsequently functional, operational, and performance requirements. By creating a conceptual design, performing a market survey, and allocating requirements, this project has demonstrated that a COTS solution can meet Columbia’s needs and requirements.

During the course of this project, I gave thorough consideration to the prevalent COTS situations systems engineers are finding themselves in today. Also, there are more constraints on time and budget than ever, and more advances in commercially-available technology, making the COTS alternative attractive when justifiable. COTS components should be used when they prove to meet functional, reliability, quality, and maintainability requirements.

A life-cycle cost analysis was performed during the course of this project. It showed that a BIS as designed could meet the life-cycle requirements that were imposed. Total system research and development and investment was $641,200 -- within Columbia’s $700,000 limit. Yearly operation and maintenance cost were developed taking a 3% inflation rate into account. Year 1 was $116,050; year 2 was $124,475; year 3 was $129,585; year 4 was $109,054; and year 5 was $112,056. All five years of operation and maintenance are within Columbia’s $150,000 limit.

Total life-cycle cost including research and development, investment, and five years of operation and maintenance is $1,232,420. Over five years, Columbia can save the cost of salaries, training, and benefits for two full-time data entry clerks, equating to $625,000. Also, using the BIS is
estimated to require half the time to operate as the manual method does. In terms of officer
salaries, this equates to $60,000 per year, or $300,000 over the course of five years.

The next logical step of this project is detail design and development, where the components and
their interfaces are further analyzed and configured. I believe the preliminary design work done so
far will be sufficient to allow the City of Columbia to make a decision about whether to proceed
with this important effort.
6.0 RECOMMENDATIONS FOR THE FUTURE

The BIS is just one facet of a total upgraded system architecture for Columbia, South Carolina.

Many recommendations for the future were presented in the Unisys Extended Architecture Recommendations document. The guidelines are either currently being implemented, or are planned for the near-term. Recommendations for future study that are a natural evolution of this project include:

- A means of ensuring with absolute certainty that data and images for one person are inextricably linked; such that there is no chance of the data for one person being displayed with the mugshots for a different person.

- The legal ramifications of digital imaging for arrest purposes. Is WORM the right method of storing images? Any legal issues relative to compressing and decompressing mugshots and evidentiary images?

- Recommendations for an AFIS so that fingerprints captured in the BIS can be automatically matched against a database of fingerprints of known offenders. This would include manufacturer, price, method of integration with the BIS, and technical specifications.

- Integrating investigative tools such as an automatic line-up function that would use a specified arrestee and search for other mugshots whose physical descriptors were similar. A line-up could be generated automatically for witnesses to view and identify criminals.

- Another investigative tool would be a link analysis capability. This could analyze crimes and motives, and then form links to other crimes and offenders.
• Other means of identification besides mugshots and fingerprints including voice matching and facial recognition. Study how they could be used to Columbia’s benefit and the advantages and disadvantages as compared to the standard means of identification.

• Re-engineering the booking process. The BIS for the most part automates the current manual process. A study could be done to determine what the most efficient and easiest arrest process would be.

• A BIS link to state and national databases such as the FBI’s National Crime Information Center (NCIC) to automatically search and determine if an arrestee has committed crimes in other states or has warrants.


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