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FINAL REPORT  
2003-LP-CX-K005

Final Report: Crime Laboratory Improvement Grant  
Decreased Turn – Around Time for Forensic Genetic Testing

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**PROJECT OBJECTIVE:** At the time of the initial CLIP grant application, the Biological Science Section of the New York State Police Forensic Investigation Center was in the process of implementing a program with dual objectives which were to 1.) eliminate a current forensic DNA analysis casework backlog and 2.) decrease average casework turn – around time from approximately three months to thirty days.

**PROJECT OVERVIEW:** The DNA casework backlog and turn-around period at the time of application are provided in Table 1. As indicated in that table, the two objectives described for this project have not yet been fully achieved. All aspects of the program must be implemented before it will be possible to fairly assess the success of our approach. We are continuing to make progress in each of the components that were recognized as essential to our overall strategy and have implemented additional measures toward achieving those goals. Our current progress and the contribution of the funds available through the CLIP grant to that progress are described below.

Table 1. Comparison of Casework Production Status Currently and at CLIP Grant 2002 Application

<b>DNA CASEWORK PRODUCTIVITY</b>					
<b>Productivity Measure</b>	<b>Initial</b>	<b>Current</b>	<b>Initial</b>	<b>Current</b>	
				<b>Last Quarter</b>	<b>Total</b>
Backlog (Cases)	801	1205	N/A	N/A	N/A
Turnaround – average (days)	N/A	N/A	82	37	142
Turnaround – range (days)	N/A	N/A	11 minimum 342 maximum	4 minimum 69 maximum	4 minimum 697 maximum

Table 1. indicates the total backlog of all cases pending analysis in the Biological Science Section currently and at the time of the original grant application. The turn – around time at the time of application (2002) is the average for the 455 items analyzed from March 1, 2002 to May 31, 2002. The current turn-around is available in greater detail due to the implementation of our LIMS system during the tenure of the CLIP 2003 grant. Two measures are given: 1.) DNA casework turn-around for cases that were both submitted and closed during the third quarter of 2005 (45 “priority” cases); 2.) DNA casework turn-around for all other cases closed during the third quarter of 2005 (191 cases). The lengthiest (maximum) and shortest (minimum) duration for case turn-around times are given for each measure.

**PROJECT AIMS:** The overall goal of the project plan of The Biological Science Section of the New York State Police Forensic Investigation Center as described in the Crime Laboratory Improvement Grant (FY 2003) has been to increase DNA casework

productivity. The plan had four components which together constituted a comprehensive strategy to eliminate projected casework production bottlenecks and to support a shift to more automated processes. The aims that constitute the plan of action to attain the objectives presented in this proposal are described below.

AIM 1. ACCELERATED STAFF TRAINING: One response of the New York State Police to the challenge of higher throughput and backlog reduction was to increase the number of competent DNA analyst / examiners in the Biological Science Section. At the time of Grant application, the Section had completed a round of hiring that provided as additional 20 Forensic Scientists and 15 supporting Senior Laboratory Technicians. (The job title Forensic Scientist in the New York State Police Crime Laboratory System is equivalent to the position of DNA examiner/analyst described in the current federal DNA Advisory Board Guidelines). Without exception, these new forensic scientists and technicians were hired with no prior forensic DNA casework experience. In the past, an experienced competent mentor would have trained these new staff over an extended period of time. As can be expected, such an approach negatively impacts the casework output of the mentor and extends the training period far beyond the applicable guidelines.

To facilitate training of these new employees, the NYSP renovated a training facility on the East Campus of the State University of New York in East Greenbush, NY. This facility, dubbed the *NYSP Forensic DNA Training Laboratories*, was a working model of a modern forensic genetic training laboratory and held much of the equipment necessary to examine and identify biological stains on simulated casework samples and then perform forensic Short Tandem Repeat DNA analysis.

During the duration of the grant, equipment purchased with grant funds allowed the Biological Science section to position key items, including thermocyclers and capillary electrophoresis genetic analyzers, at the training facility. Grant funds also provided equipment, such as computers, micro-centrifuges, and a microscope, which helped alleviate major bottlenecks in the training program. The availability of a well-equipped training facility effectively reduced the duration of training from thirteen months to approximately seven months.

In total, fourteen Forensic Scientists completed STR DNA analysis training at the East Greenbush facility and subsequently successfully passed appropriate competency examinations. Eighteen Forensic Scientists also trained and established competency in a curriculum intended to impart DNA evidence recognition, collection and handling skills as well as a solid knowledge base in body fluid stain identification (Forensic Serology). At the facility, we also were able to train three Senior Laboratory Technicians in the extraction, species determination and quantification of DNA from casework samples. Table 2 is a summary table showing the number of forensic scientists and senior laboratory technicians that successfully established these core competencies during the grant period. Grant funds were also applied to provide specialized in-depth training to staff Forensic Scientist through attendance at a full day workshop in capillary electrophoresis at the Northeast Association of Forensic Scientist annual meeting.

The duration of training for the latest training cycles has been reduced to seven months as measured from the beginning of training until internal certification of competency in Forensic DNA analysis. Based on this, the training period for a Biological Science staff member to achieve competency in forensic DNA analysis has been decreased to essentially the minimum six-month period required by the federal DNA Advisory Board Standards. Updated training modules, a dedicated training facility, modern equipment, skilled instructors and an emphasis on important performance measures [moot court, oral boards, examinations] has allowed the Biological Science section to achieve this aim without sacrificing the quality of the training provided to the staff.

Table 2.

Training Topic	Staff Competent
Forensic Scientist - Serology	18
Forensic Scientist - DNA Analysis	14
Technicians – DNA Extraction and	3

Table 2. Staff Training at the NYSP DNA Training Labs Table 2 shows the total number of Biological Science Staff trained in forensic DNA related specialties during the tenure of the CLIP 2003 grant.

Even with the initial staff expansion described above, the need for additional casework forensic scientists and supporting laboratory technicians became clear. The goal has been to support rather than limit the enthusiasm of law enforcement for DNA testing technology. Further staff expansion has thus been achieved in two ways:

- 1) Increased efficiency in the NYS Convicted Offender DNA Databank yielded excess testing capacity which, in turn, allowed that facility to re-assign five Forensic Scientists to the casework unit of the Biological Science Section.
- 2) Senior Laboratory Technician positions were converted to Forensic Scientist job classification. The converted positions have recently been re-instituted and are in the process of being filled from an applicant pool.

AIM 1 FUTURE: At the end of the grant period the NYSP decided to close the training facility because the main contingent of new hires had completed training. Future training will be carried out both in-house and through training opportunities available through the Northeast Forensic Training Institute which is located on the University at Albany campus near to the Forensic Investigation Center.

AIM 1 PERFORMANCE MEASURE: The availability of a well-equipped training facility successfully reduced the duration of training from thirteen months to approximately seven months. The fourteen new analysts are expected to provide capacity for analysis of at least 1000 additional DNA cases each year.

AIM 2. ELIMINATION OF PRODUCTION BOTTLENECKS: Approximately 3,100 sq. ft. of laboratory space was renovated to support casework by the staff of newly trained Forensic Scientists (described above). Obviously, bringing such a large number of staff on-line at once threatened to result in significant equipment bottlenecks. The items in the list below were identified by the Biological Science Section supervisory staff and were described in the original budget narrative as necessary to ensure that the new staff could be integrated smoothly into the section with out incurring delays in casework analysis.

1. ABI Prism 3100-Avant Capillary Electrophoresis Genetic Analyzer
2. Nikon Eclipse E400 Microscopes (7)
3. Applied Biosystems GeneAmp<sup>R</sup> PCR System 9700 (2)

The ABI Prism 3100-Avant Capillary Electrophoresis Genetic Analyzer is a high-throughput 4 capillary instrument which is upgradeable to 16 capillaries. This device thus allows 4 samples to be analyzed during a single 40-minute run of the instrument. This run time compares very favorably with the turn-around-time on the ABI Prism 310 Capillary Electrophoresis Genetic Analyzer (CE310) which is the instrument currently employed by the Biological Science Section for casework STR DNA analysis. Run time for a single sample on the CE310 typically requires twenty-six (26) minutes. To date, the validation of the four capillary instrument has been completed according to federal guidelines for casework. The validation study is undergoing review before approval to be used to support the efforts of the Biological Science Section to implement automated processes (see specific aim 3).

Equipment items have been purchased, using funds available through the CLIP 2003 grant, to alleviate bottlenecks in the production of STR DNA profiles for casework evidentiary and reference specimens. These items include three Nikon Eclipse E400 Microscopes. These scopes are employed for sperm identification and for assessment of the success of differential sperm / epithelial cell extraction. These evaluations are labor intensive and time-consuming. Previously, the Biological Science Section had only five [5] microscopes for a staff of 21 Forensic Scientists performing identification of biological stains. Without the grant funds, 26 forensic scientists would have been vying to use this equipment creating an obvious bottleneck.

Personal computers have been procured for the interpretation of STR DNA data from the ABI analytical platforms and for data quality review. These additional computers provide increased data interpretation throughput which, in our experience, has proven to be a critical need in order to avoid a production bottleneck. Three of the four requested computers were intended to avoid this limitation; the fourth was intended to replace a currently inoperable computer.

Grant funds have also been applied to connect a wireless computer system on all forensic scientists' laptops at the Forensic Investigation Center in order to provide portability and continual access to our Laboratory Information Management system during DNA evidence examination and analysis. A paperless documentation system is being developed to expedite and increase efficiency of evidence logging, tracking, analysis and reporting. The

system will speed-up report generation and facilitate production of accurate productivity statistics. Deployment of the wireless network also has allowed for greater standardization of our analytical processes as newly Forensic Scientist come on-line. The entire Biological Science Section is now using a LIMS on laptop computers for recording notes while evaluating and isolating evidence for downstream DNA analysis. This capability has endowed the process with efficiency through greater portability and ease of access to case-related information. The availability of LIMS on laptop has conferred the ability to work without accessing a desktop computer which, in turn, has removed space constraints.

Additional funds were used to provide two Applied Biosystems GeneAmp PCR System 9700 thermocyclers to update and replace the same number of aging PCR System 9600 thermocyclers in use in the Biological Science Section. In addition to updating these instruments, the new thermocyclers also provide increased DNA amplification throughout in support of a more automated approach. The section has completed validation of these equipment items for forensic DNA casework applications and, on the basis of that experience, has switched to exclusive use of the 9700 thermocyclers.

AIM 2. PERFORMANCE MEASURE: The performance measures for AIM 2 are elapsed casework turn – around time and backlog reduction. The data for these measures are given in Table 1.

AIM 3. FORENSIC CASEWORK AUTOMATION The Biological Science Section has made steady progress implementing high throughput, automated forensic genotyping. We have established a high-throughput facility and validated liquid handling systems [robotics] to extract, quantitative and normalize samples for downstream DNA amplification. We have introduced bar coding and sample tracking into the process and are presently completing the integration of the high-throughput system into our newly implemented Laboratory Management System. We have provided staff for the facility and are also currently integrating the output of our analytical platforms with the Cybergenetics Inc. TrueAllele system for data quality review and interpretation. This is an important enabling sub-project with Cybergenetics, Inc., a Pennsylvania – based genetic analysis firm. As designed, the entire system can be configured to produce 200 STR DNA profiles in a 5-day workweek. This capacity, which is in excess of 10,000 profiles annually, would alone triple our current casework output (4,600 STR patterns produced annually).

The funds available through the CLIP grant have provided two key components of this project. The first is the high-throughput genetic analyzer, the ABI Avant Model 3100 Genetic Analyzer, described in Aim 2. This instrument has been installed in the Biological Science Section and, upon review and approval of the corresponding forensic validation, will be placed on-line for batch processing of casework.

The second key component was system integration with the Porter-Lee Best Laboratory Information Management System that is being custom-installed in the Biological Science Section. The Best LIMS system handles evidence-receiving functions for the Forensic Investigation Center. The CLIP award provided funds for detailed planning of expanded LIMS System functionality and the preparation of a documented Statement of Work. This planning document laid the groundwork for the Biological Science Section's automation

program. The expected outcomes of an automated process can include decreased throughput times, enhanced process quality, improved reproducibility, and superior data traceability.

According to that program, an integrated LIMS system serves as the “backbone” that will support batch processing, enhanced sample flow and an entire automated process. The thoughtful design and development of this custom software solution has been foremost in achieving out goals of backlog elimination and 30-day turn-around times. The critical need for this second integration component derives from its multi-functional capabilities. The system will provide the capability to manage “work lists” that can be used to assign samples to instrument plates or other tests. The software system provides the user with the capability to track sample plates or other containers throughout the analytical process and to view information associated with the samples in the wells of a plate. Barcode labels can be printed for specimen containers, plates and storage containers to allow the analyst to quickly and accurately scan information into forms. The system will also provide instrument sample sheet generation for the high-throughput capillary electrophoresis device. The system will also provide tools for generating laboratory management reports. Reports can be written to summarize, for example the number of samples processed through the laboratory by analyst, instrument or sample type. These types of reports, which form the basis for important performance measures, are currently manually compiled.

The status of the modules designated for STR DNA analysis is described in the accompanying Table 4. In general, the downstream amplification of template and subsequent production of DNA patterns already involve little user intervention and can be considered semi-automated.

Table 3. Current Status of Implementation of Automated Forensic STR DNA Analysis

Module	Status
Evidence Preparation	Staffing of the facility is complete. Training in progress
DNA Extraction	Liquid Handling System validation completed. Not on line.
DNA Quantitation	Validation completed. On line.
STR Data Production	ABI Prism 3100-Avant Capillary Electrophoresis Genetic Analyzer validation completed. Not on line
LIMS System Integration	Software development completed. In acceptance testing November 2005.
STR Data Quality Review	Software in development.
STR Data Interpretation	Software in development

AIM 3 FUTURE: Once the essential component steps for enhancing productivity through the process has been integrated into the controlling LIMS; it will be possible to implement additional upgrades. For example, once the modules for performing extraction, quantization and PCR are implemented, it will then be possible to add robotic arms for moving microtiter plates from extraction / quantization platform to a PCR set-up and then to a thermocycler. In terms of overall process, the automation of these sample movements is not critical to reliability, reproducible results or sample throughput but, rather, can enhance user convenience and walk away time. Ideally, the system should also be developed to

incorporate a quality control matrix to ensure compliance with federal guidelines and laboratory accreditation standards.

The automation of technical aspects of forensic DNA analysis can only be considered a partial solution to resolving casework backlogs and achieving reasonable turn-around times. The main challenges to achieving those goals are those steps in the analysis which remain as bottlenecks. In forensic DNA tests, there are still components of the process which are not currently amenable to automation. Identifiable bottlenecks without an easy or inexpensive solution include the identification and isolation of probative stains; a task which, for the foreseeable future, will depend on the talent of forensic scientists. This issue is especially critical since full efficiency of an automated or semi-automated genotyping system will require a steady stream of evidence into the process flow. This supply bottleneck can be somewhat addressed by forensic scientists freed from DNA extraction and quantization tasks. Also, time spent sifting through large submissions of many items can be reduced because of the capacity of the automated system. Instead of screening evidence, the analyst will simply submit the items for DNA analysis and use the final data interpretation step to determine relevance to the ongoing investigation.

In the current automation strategy, then, the key bottleneck becomes the interpretation of analytical result and the technical review process. Fortunately, although these processes are currently dependent upon manual applications, software solutions are emerging that can be implemented and integrated into an automated approach.

AIM 3. PERFORMANCE MEASURE: The performance measures AIM 3 are elapsed casework turn – around time and backlog reduction. The date for these measures is given in Table 1.

AIM 4. APPLICATION OF BACKLOG REDUCTION FUNDS: The Biological Science Section has established an effective process for providing analysis, by commercial DNA testing laboratories, of several hundred cases from our non-suspect case backlog. The aim has been to help control the growth of the number of cases pending analysis while the Biological Science Section simultaneously 1.) trained a large cadre of *new* staff, 2.) validated *new* high-throughput equipment, 3.) implemented *new* automated STR DNA analysis. The funding for this enabling subproject has been supplied by *NIJ No Suspect Casework DNA Backlog Reduction Grants* to the NY State Division of Criminal Justice Services. Personnel overtime funds have been applied to provide processing of submitted evidentiary items in preparation for shipping to vendor laboratories for subsequent analysis and, also, to provide technical review of vendor results.

The availability of the backlog reduction funds did impact significantly upon the backlog of cases with no identified suspect and, also, provided expedited entry of the corresponding perpetrator's DNA patterns into CODIS. The program is stopgap, however, and will not impact the remaining cases in the backlog nor, by itself, have a long-term effect on the section's turn-around time.

AIM 4 FUTURE: The Biological Science Section will continue to submit casework to commercial DNA testing laboratories with funds from NIJ DNA Backlog Reduction Grants FY2004 and FY2005.

AIM 4. PERFORMANCE MEASURE: To date, the Biological Science Section has sent 559 non-suspect DNA cases to vendor labs using funds available through the CLIP grant, and tallied 30 CODIS convicted offender and 11 forensic hits against the resultant DNA patterns.