The FBI Laboratory: 75 Years of Forensic Science

Part 2 Questions:

1. In the investigation of John Gilbert Graham and the airplane bombing from Denver, what was discovered as his motivation for his actions?

2. How large was the crash site from Pan Am 103 and what pieces of evidence were used to link the act to two Libyan intelligence operatives?

3. What was the final amount of evidence processed, amount of debris the FBI had gone through and number of crime scene photographs collected as a part of the investigation in New York in connection to Sept. 11?

4. How through research and development is the FBI Laboratory today advancing areas in the forensic sciences?

5. What is CODIS?
The FBI Laboratory: 75 Years of Forensic Science Service

Kim Waggoner
Forensic Science Communications
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Part 2

Bombing/Terrorism Investigations

The FBI is one of several federal agencies with jurisdiction in bombing matters. Many of these incidents involve acts of terrorism, where the FBI has primary jurisdiction. Unfortunately, over the years, the FBI has been called on more and more to investigate bombings both in the United States and overseas. Often involving hundreds or thousands of pieces of evidence, such crime scenes require the efforts of numerous FBI Laboratory employees.

Colorado Plane Crash

On November 1, 1955, United Airlines Flight 629 exploded 11 minutes after taking off from Denver’s Stapleton Airport, killing 44 people on board. FBI Laboratory personnel reconstructed the aircraft and examined thousands of airplane parts, pieces of cargo, and passenger belongings. Laboratory chemists found sodium carbonate, nitrate, and sulfur compounds—the residue left by a dynamite explosion—on the evidence. Examiners also associated pieces of metal and carbon found at the crash site with a commonly available six-volt battery. This investigation, the first documented case of sabotage in civil aviation history, represented the first time residue was used to identify an explosive.

During the investigation, agents executed a search warrant at the home of John Gilbert Graham, whose mother had died in the crash. There they found wrapping paper, tape, and copper wire with yellow insulation. This wire, the type used to detonate primer caps, also had been found at the crash site. A store manager identified Graham as the man to whom he had sold dynamite and blasting caps about a month before the crash. Confronted with this and other evidence, Graham admitted to building a bomb from 25 sticks of dynamite, two electric primer caps, a timer, and a six-volt battery. The 23-year-old Graham was trying to collect on his mother’s insurance and had placed the bomb—wrapped as a present—in her luggage. Instead of cashing in, he was convicted in Colorado state court and sentenced to death in the gas chamber.

Pan Am Flight 103

Thirty-three years later, in 1988, Pan Am Flight 103 went down over Lockerbie, Scotland, killing 259 passengers and crew, including 189 Americans, and 11 people on the ground. Debris covered more than 845 square miles. A then-unprecedented international investigation followed, as investigators from the FBI, other U.S. agencies, and several international police organizations combed the huge crash site for evidence and traveled across the globe to interview witnesses and experts. After assembling the thousands of pieces of evidence collected, forensic examiners eventually determined that a bomb had been placed inside a radio/cassette player in a piece of luggage. A tiny piece of green circuit board identified the timing device and linked it to two Libyan intelligence operatives, who were indicted for the bombing in 1991.

The Laboratory’s Investigative and Prosecutive Graphic Unit (IPGU) (since combined with the Structural Design Unit to form the Special Projects Unit) provided key services for the investigation, prosecution, and trial. A visual information specialist (VIS) traveled to Malta to interview a shopkeeper who had sold one of the suspects several items. Portions of these items were later found at the crash site and subsequently identified. The information the shopkeeper provided allowed the VIS to prepare a composite drawing of the suspect. Another VIS worked with Explosives Unit personnel to develop three-dimensional (3-D) reconstructed images of the airplane showing the damage from the blast; the explosive device and its location inside the radio; the location of the radio inside a cargo container; a seating chart showing where each passenger sat on the plane; and a debris-distribution chart showing the entire area in which debris was found. To prepare the
images, the VIS traveled to the Boeing plant in Washington state where the plane had been manufactured. Boeing engineers and technical representatives provided the VIS with blueprints and information to complete the drawings. Several VISs produced charts, maps, and diagrams that were used as demonstrative evidence in the suspects’ trial.

Nearly a decade after they were indicted, the suspects were brought to trial. On July 31, 2001, Abdel Basset Ali Al-Megrahi was found guilty, while his codefendant, Lamen Khalifa Fhimah, was found not guilty and released. The Libyan government eventually accepted responsibility for the bombing and agreed to compensate the victims’ families.

Robert Mueller, III, the current FBI Director, oversaw the prosecution of the case. At the time, he was serving as the Assistant Attorney General of the Criminal Division of the U.S. Department of Justice.

The bombing of Flight 103 represented the most lethal act of terrorism in the air, and the ensuing investigation was the largest and most complex international terrorism case the FBI had conducted to that point. This experience, as well as the international scope of the investigation, gave the FBI the tools it would need to investigate many more acts of terrorism, both domestic and international, at home and abroad. These included the first bombing of the World Trade Center in 1993; the Oklahoma City bombing in 1995; the 1995 bombing of the Saudi Arabian National Guard Building in Riyadh; the bombing of the Khobar Towers Building in Dhahran, Saudi Arabia, the following year; the 1998 near-simultaneous bombings of the U.S. Embassies in Nairobi, Kenya, and Dar es Salaam, Tanzania; and the bombing of the U.S.S. Cole in Aden, Yemen, in October 2000.

The Cole Investigation

A small boat pulled alongside the U.S. Navy destroyer U.S.S. Cole as it refueled in the Port of Aden, Yemen. The boat exploded, tearing a 40-foot hole in the side of the Cole. Seventeen sailors died, and 39 were wounded.

Hundreds of FBI personnel responded to the scene. The forensic team included personnel from the Laboratory’s Explosives Unit, as well as Evidence Response Team personnel, Special Agent Bomb Technicians, and investigators from other FBI field offices. The remains of American sailors were recovered and sent to Dover Air Force Base, Delaware, where they were identified by members of the FBI’s Disaster Squad. DNA recovered from the evidence helped identify both victims and suspects. Fingerprint specialists from the Laboratory helped Yemeni crime scene technicians process the crime scene and compare latent prints to the suspects’ known prints. A VIS from the IPGU interviewed witnesses to prepare composite drawings of the suspects. The VIS also helped to document several locations where the suspects were believed to have stayed prior to the bombing.

Photographs taken by personnel in the Laboratory’s Special Photographic Unit (now named the Photographic Operations and Imaging Services Unit [POISU]) helped identify victims and document the crime scene. Video of the ship and the harbor before and after the bombing captured by sailors onboard the Cole and by the harbor’s security system—was examined, enhanced, and, in some cases, authenticated by the Laboratory’s Forensic Audio, Video, and Image Analysis Unit (FAVIAU).

Teams of forensic experts—including personnel from the Laboratory’s Explosives Unit, Special Photographic Unit, IPGU, and the Investigative Support Section; Special Agent Bomb Technicians; and personnel from the FBI’s New York and Jackson Field Offices—also traveled to Ingalls Shipbuilding in Pascagoula, Mississippi, where the Cole had been transported after the bombing, to further examine the ship for evidence. The trips had to be taken over a three-month period, as portions of the heavily damaged ship were made safe to access. IPGU personnel documented the damage and prepared several 3-D digital diagrams documenting its extent.

Between October and December 2000, personnel from 11 Laboratory units examined more than 1000 items of evidence from the Cole. The FBI’s extensive investigation ultimately determined that members of al-Qaeda had carried out the attack.
The bombing of the U.S.S. *Cole* was one of many horrific acts conducted by members or affiliates of the al-Qaeda terrorist network. Such events have unintended, and sometimes beneficial, effects. Often, they bring nations, governments, and people closer, creating alliances where they may never have existed. The *Cole* bombing, for example, helped the United States strengthen ties with the Yemeni government. The attack also forged a bond between the FBI Laboratory and Kirk Lippold, the *Cole*’s commander. Commander Lippold spoke at the dedication of the FBI Laboratory’s new facility in 2003, thanking the FBI for an investigation that was efficient and maintained the dignity of the victims. Then, in May 2007, at Commander Lippold’s request, the American flag that had flown over the *Cole* and the Pentagon was raised over the Laboratory. The 17 sailors killed on the *Cole* were remembered during this special flag-raising ceremony.

### September 11

Despite the number of terrorism-related investigations the FBI had conducted previously, nothing could have prepared the Bureau, and, in fact, the world, for what occurred on September 11, 2001. Up until then, the bombing of Pan Am Flight 103 had been the largest and most complex investigation the FBI had ever conducted. All of that changed in the blink of an eye, when two airliners slammed into the World Trade Center towers in New York, another flew into the Pentagon, and a fourth crashed in a field in rural Pennsylvania. The ensuing response and investigation used more FBI resources than any other investigation before or since. Employees from across the globe—at FBI Headquarters, field offices, and legal attachés; both special agents and support staff—worked wherever they were needed. They joined personnel from other government agencies, employees from private industry and nonprofit organizations, and members of the public. From evidence response and recovery to the creation of demonstrative evidence for courtroom testimony, work on the FBI’s biggest case in history continues to this day.

The Laboratory’s Explosives Unit coordinated the identification, collection, and examination of the massive amounts of evidence at the three crime scenes. Personnel from the Bomb Data Center, which is now part of the FBI’s Critical Incident Response Group (CIRG), coordinated the response of Special Agent Bomb Technicians from FBI field offices, who cleared each scene for potential explosive devices and supported the Evidence Response Teams. The Crisis Response Unit, also now a part of CIRG, ensured constant, secure communication between the crime scenes and FBI Headquarters. Personnel from the Technical Programs Section (now assigned to the Operational Technology Division) restored radio communications at the FBI’s New York Field Office and deployed to the Pentagon and Pennsylvania crash sites with emergency communications equipment.

The Hazardous Materials Response Unit (HMRU) assessed the hazards—including jet fuel, bloodborne pathogens, sewage, structural and confined-space issues, and electrical and explosive environments—present at the crash sites. Working with local emergency medical personnel, the HMRU ensured the health and safety of personnel working at the scenes.

The Laboratory’s Evidence Response Team Unit coordinated the deployment of the FBI field office Evidence Response Teams and provided the specialized equipment and supplies they needed to recover human remains and collect and preserve physical evidence at the crash sites. The teams also coordinated the search of rubble removed from the crash sites to off-site locations. The mountains of evidence at each site required the coordinated efforts of numerous personnel, including FBI and other federal, state, and local employees who would not normally work such matters. Evidence Response Team personnel provided on-the-spot training to individuals eager to serve. These enhanced teams were able to find many significant items of evidence.

The Disaster Squad deployed to the three crash sites, assisting the New York Police Department’s Missing Persons Unit at the World Trade Center. The Laboratory’s Latent Print Units conducted 126,632 fingerprint comparisons from approximately 3833 pieces of evidence received between November 12, 2001, and January 17, 2002.
From September 12 to November 30, 2001, the Questioned Documents Unit received more than 1600 pieces of evidence. Fire and moisture had damaged some documents; others were torn. Using specialized techniques, QDU personnel were able to stabilize and reconstruct the documents to extract information of potential value, including indented writing and deciphered numbers.

Personnel from the Laboratory’s DNA Analysis Units supported the identification efforts at all three crash sites. Items recovered from the crash sites and the hotel rooms where the hijackers had stayed allowed DNA examiners to develop DNA profiles for several of the hijackers.

In the first 30 days of the investigation, the Computer Analysis Response Team (now assigned to the FBI’s Operational Technology Division) examined more than 35 terabytes of data. Examinations covered computers and disks used by the subjects, data obtained from Internet Service Providers, and a disk recovered from the Pennsylvania crash site.

Working with the National Transportation Safety Board, personnel from FAVIAU recovered data from the Flight 93 (which crashed in Pennsylvania) cockpit voice recorder, even though it had been damaged in the crash. With the help of the Federal Aviation Administration, personnel also obtained audio from the air traffic for all four flights. Other audio and video recordings came from the crash sites and FBI field offices. These recordings were restored, duplicated, enhanced, and compared. FAVIAU personnel also videotaped the Pentagon site following the crash.

The Special Photographic Unit (now POISU) provided photographic support to the investigation. Personnel took aerial photographs of all three crash sites. They also photographed hundreds of items of evidence received in the Laboratory. They photographically enhanced damaged personal identification photographs and obliterated and indented writings recovered from the crash sites. Finally, unit personnel took more than 170,000 photographs, including 5000 photographs of the hijackers and other suspects, making copies and distributing them to investigators, prosecutors, and FBI executives to use for briefings and press conferences and to distribute to the field and the media.

Many cases require models and exhibits to reconstruct the event and present the evidence clearly and cogently in court. After September 11, personnel from the Laboratory’s Investigative and Prosecutive Graphic Unit and the Structural Design Unit (now the Special Projects Unit) completed site surveys of the Pentagon crash site, detailing victim and evidence locations, building damage, and the path of the airliner and its debris. Unit personnel also created hundreds of displays for court. These ranged from simple organizational charts, to scale models of the Pentagon and the World Trade Center, to complex digital displays showing multilayered interactions between individuals and events.

In June 2003, an FBI executive testified before the Senate Judiciary Committee that the FBI had collected and submitted for analysis more than 7500 pieces of evidence, helped process more than 2.8 million tons of debris in New York alone, and took more than 45,000 crime scene photographs.

**The Terrorist Explosive Device Analytical Center**

The United States and its allies are in a war against terrorism. Every day, improvised explosive devices (IEDs) built by terrorists explode, leaving behind death, destruction, chaos, and fear. The Terrorist Explosive Device Analytical Center (TEDAC), a multiagency effort established at the FBI Laboratory in 2003, is working to identify the terrorists behind these deadly attacks.

FBI Laboratory employees from Trace Evidence, Latent Prints, DNA, Firearms-Toolmarks, and Explosives are assigned TEDAC cases. Together with personnel from other law enforcement, intelligence, and military agencies, they examine thousands of pieces of evidence to determine the composition of the IEDs, how they work, and, if possible, who built them. The information developed from TEDAC examinations is compiled in a secure, centralized database and forms the foundation of the intelligence reports written by TEDAC personnel and issued by the center to the intelligence community. In this way, the TEDAC is working to prevent terrorist attacks around the world.
Research and Development

Research and development represent the lifeblood of a forensic science laboratory. In the Laboratory's formative years, Special Agent Appel was busy analyzing evidence, creating trial exhibits, testifying in court, training new agents, and creating reference collections. He had little time for research, although his duties did include both researching and writing. By 1934, however, additional staff allowed the Laboratory to broaden its research initiatives. Appel conducted research on ballistics, while two special agent colleagues studied such diverse topics as frequency tables for ciphers, dyes for extortion packages, the chemical development of latent fingerprints, and blood groups. A support employee specialized in chemical analysis.

The FBI Laboratory continues to advance the forensic sciences by devising and validating new testing and examination methods; developing partnerships in government, academia, and private industry; and sharing resources and expertise with the law enforcement, intelligence, and forensic science communities. Although all of the Laboratory's caseworking units conduct these activities to some extent, the Counterterrorism and Forensic Science Research Unit takes the lead in research initiatives designed to help the Laboratory's partners in the community.

Counterterrorism and Forensic Science Research Unit

In the early 1970s, to respond to the long-range needs of the law enforcement community, then-Laboratory Director Briggs White initiated the first annual Crime Laboratory Development Symposium. The symposium resulted in an initiative to build a center dedicated to forensic science research and training. In 1981, the FBI Laboratory established the Forensic Science Research and Training Center (FSRTC) at the FBI Academy in Quantico. The approximately 50,000-square-foot facility houses chemical and biological research laboratories, classrooms, meeting facilities, and an auditorium. The center serves as an arena for training classes, seminars, conferences, and symposia. Thousands of FBI, police, and crime laboratory personnel have received forensic science training at the FSRTC since 1981.

Over the years, the FSRTC has housed a number of units from the Laboratory and other FBI divisions as well. Today, Laboratory employees working at the FSRTC are officially assigned to the Counterterrorism and Forensic Science Research Unit (CFSRU), a name that has evolved and now reflects the unit's mission to research, develop, and deliver new technologies and methodologies to advance forensic science and combat terrorism.

DNA Discovery

The development of DNA protocols changed the face of crime scene investigation. In 1988, after more than two years of research and development, the FBI Laboratory began conducting DNA analysis on evidence stained with body fluids. Since that time, the Laboratory, often through the FSRTC (and now the CFSRU), has conducted numerous research projects to establish and validate the DNA-typing protocols used today in most forensic DNA laboratories. The advances made over the years have enabled the Laboratory not only to link suspects to crimes but also to exonerate the innocent and identify missing persons, often many years after the incident. Newer techniques such as polymerase chain reaction-based short tandem repeat and mitochondrial DNA analyses mean that even very old and highly degraded samples may produce a DNA profile. Moreover, as DNA profiles are added to the Combined DNA Index System (CODIS) database on a national, state, and local level, DNA evidence becomes an even more powerful tool for producing investigative leads.

For many laboratories, the ability to solve crimes with even degraded and minute quantities of DNA evidence has resulted in a huge increase in DNA casework. To help address this increase, the FBI Laboratory is automating DNA analysis procedures. In addition, the Laboratory established the Regional Mitochondrial DNA Laboratory Program. Four laboratories—in Arizona, Connecticut, Minnesota, and New Jersey—after being trained and equipped by the FBI, are able to accept mitochondrial DNA evidence and conduct cost-free examinations for state and local law enforcement. The Laboratory's DNA Analysis Unit II manages this important program.
Visiting Scientist Program

Through the Visiting Scientist Program, CFSRU staff work with university students, postgraduates, and faculty from various academic institutions to enhance and expand the Laboratory's research and development initiatives. Visiting Scientists have a range of backgrounds and degrees and spend anywhere from three months to three years in the program.

Visiting Scientists work on one or two projects that meet the needs of the Laboratory's operational units while providing a unique educational experience for the participants. Examples of research projects conducted over the years include the study of the effect of latent fingerprint developers and enhancers on DNA analysis, the analysis of the chemical composition of volatile organic compounds from decomposing human remains, and the creation of a new FBI facial identification catalog.

Research Partnership Program

CFSRU also sponsors the Research Partnership Program, which establishes research partnerships between the FBI Laboratory and state and local forensic laboratories. The FBI provides all funding and support for the program, which focuses on three goals:

- Conducting collaborative research and development, testing, and validation studies to transfer new forensic technologies and techniques to caseworking examiners in state and local forensic laboratories.

- Implementing protocols defined by the various scientific working groups.

- Developing national forensic databases.

Examples of recent projects include a study of the permanence of friction ridge skin and the development of an automotive carpet fiber database.

Database Development

Special Agent Appel started many of the Laboratory's reference collections. From 1932 to 1935, the Laboratory created the Typewriter Standards File, the National Fraudulent Check File, the Anonymous Letter File, the National Automotive Paint File, and the Reference Firearms Collection. Today, the Laboratory maintains several additional databases that help determine the source of the myriad pieces of evidence submitted for analysis, link suspects to crimes, and identify missing persons. These databases include the Automated Counterfeiting Identification Database, which contains images of counterfeit checks and other relevant information; the Bank Robbery Note File, used to compare notes from different bank robberies to help link them; the Explosives Reference Tool Database, a comprehensive database to help identify the components and manufacturers of explosive and incendiary devices; and SoleSearcher, a shoe print database. Probably one of the most well known FBI-maintained databases is CODIS, which allows forensic DNA laboratories to store, maintain, and search DNA profiles from crime scenes, offenders, and missing persons.