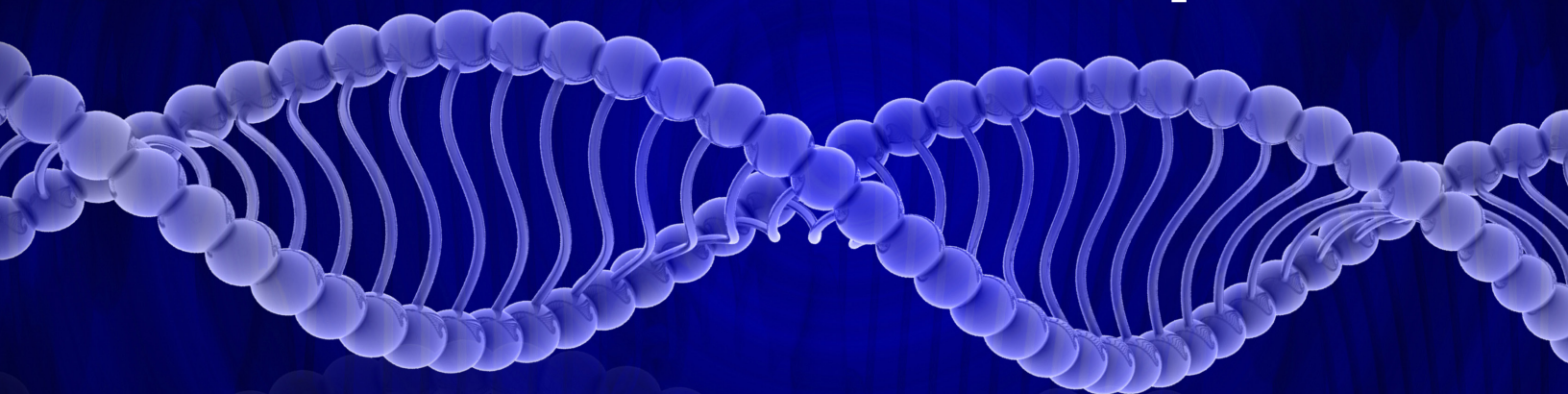


A Hands-On Introduction to **Forensic Science** *Cracking the Case*

SECOND EDITION



Mark M. Okuda
Frank H. Stephenson



CRC Press
Taylor & Francis Group

A Hands-On Introduction to Forensic Science

Cracking the Case

Second Edition



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Preface

The aim of this book is to present a novel way of teaching forensic science and, more importantly, a different way of presenting any science discipline, whether it be chemistry, physics, or biology.

Most science textbooks today are formatted and presented in a compartmentalized manner; students are likely to encounter a chapter entitled “Cell Structure and Function” in a biology textbook “States of Matter” in a chemistry textbook, “Newton’s First Law of Motion: Inertia” in a physics textbook, or “Blood Spatter” in a forensic textbook. These compartmentalized units present an extensive list of vocabulary words as well as scientific principles and concepts to be mastered. The student takes notes, conducts lab experiments, and, at the conclusion of the unit, is evaluated by some form of written assessment. This cycle repeats itself with the next chapter, until the course is completed at the end of the academic year. This format often lacks the connections between the material covered in previous chapters and that of the current chapter under study. Science, on the other hand, is about making connections.

The disconnect that commonly exists between science textbooks, science courses, and the way real science operates will be addressed in this book. Science works with a problem or an observation that requires an integrated approach involving many different disciplines of science coming together and the connections that these disciplines can provide to help solve a problem or explain an observation.

This book attempts to capture the student’s interest by means of a unique format. It begins with a story about two characters who go about solving a missing person’s case. It reads like a murder mystery novel, with each succeeding chapter revealing new characters, new information, and new physical evidence to be processed. Following the storyline, the reader is introduced to the appropriate science necessary to process the physical evidence. The final component of each chapter consists of a series of lab activities that train the student in processing, analyzing, and documenting the physical evidence revealed in the narrative.

The final chapter takes into consideration all the evidence and presents it in a mock trial setting, where information is presented in a court of law and the jury decides the fate of the suspect.

We hope that by reading this book, you will gain a better appreciation of how science operates in the real world and the important role it plays in our lives. Having gone through this experience, some readers may even entertain the idea of pursuing a career in forensic science or the legal system. Enjoy the journey upon which you are about to embark.



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Authors

Mark M. Okuda earned his BA in biology, with a minor in chemistry, from the University of the Pacific. He went on to earn his MA in natural science from San Jose State University. Mr. Okuda taught for 33 years at Silver Creek High School and currently serves as an adjunct faculty member at Evergreen Valley College, teaching human heredity and forensic biology. During his tenure as a high school science teacher, Mark was the recipient of the Santa Clara County Teacher of the Year, Synopsys Outstanding Science Teacher Award, East Side Union High School District Innovative Teacher Award (Forensic Science), and National Biotechnology Education Conference Teacher Award and held a patent for a biotechnology kit marketed by Bio-Rad, entitled “Secrets of the Rain Forest.”

Frank H. Stephenson earned his PhD in molecular biology from the University of California (UC) Berkeley and performed postgraduate work at UC San Francisco Medical School. He spent several years with Berlex Biosciences as a senior research scientist prior to joining the technical training department at Thermo Fisher Scientific where he teaches next-generation sequencing and DNA analysis. Dr. Stephenson taught molecular biology with the UC Berkeley Extension program and, for 10 years, served as a part-time faculty member with Foothill College, where he conducted evening classes in PCR. Dr. Stephenson has published several books in the biotech field, including *DNA: How the Biotech Revolution Is Changing the Way We Fight Disease* and *Calculations for Molecular Biology and Biotechnology: A Guide to Mathematics in the Laboratory*. This textbook evolved from summer workshops in forensic and DNA analysis given at Life Technologies to high school teachers and students, in collaboration with his coauthor, Mark M. Okuda.



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Introduction

A Hands-On Introduction to Forensic Science, Second Edition, continues in the tradition of the first edition of taking a wholly unique approach to teaching forensic science. Each chapter begins with a brief, fictional narrative that runs through the entire book; it is a crime fiction narrative that describes the interaction of a veteran homicide detective teamed with a criminalist and the journey they take together to solve a missing person's case. Step by step, the book reveals pieces of information about the crime, followed by the more traditional presentation of scientific principles and concepts on a given forensic topic. Each chapter concludes with a series of user-friendly, cost-effective, hands-on lab activities that provide the students the skills necessary to analyze the evidence presented in that chapter. The new edition is completely updated, with special focus on new techniques in DNA sequencing, DNA phenotyping, and bioinformatics.

Students will engage in solving a missing person's case by documenting the crime scene, analyzing physical evidence in the lab, and presenting findings in a mock trial setting. Within the chapters, students learn about the technical, forensic concepts presented within each of the opening story segments. The book culminates with having the students play the roles of the main characters in a trial—attorneys, scientific experts, suspect, judge, bailiff, and jury—to present and judge the evidence in a mock trial setting. The mock trial will mimic what takes place in a real courtroom, and the jury will be asked to deliberate on the evidence presented to determine the guilt or innocence of the suspect.



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Crime Scene

Police Headquarters, Monday 9:12 AM

“Jenkins!”

His head pulled upright like that of an African gazelle when startled at a watering hole by the sound of a twig snapping accidentally under the paw of a stealthy predator. *Maybe that was just a sneeze*, he thought. Maybe. Alert, he strained to filter out the background din. Nothing. He went back to his reading.

“Jenkins!”

There it was again, but closer this time.

“Where’s Jenkins?”

He recognized that growl, and by its Doppler shift, it was coming up fast behind him. He jerked his heels off the wastebasket and yanked the steaming coffee mug from his lips, splashing a dose on the pages of his latest issue of *True Detective*, which he quickly flung shut and slipped under a stolen vehicle report. Lieutenant Robert Jenkins, swiftly wiping several fugitive doughnut crumbs from his chin, reeled his head around to see the department head, Captain Stan White, strutting down the path between the rows of desks littered with a dozen detective staff who were either tapping away on computer keyboards, talking prattle, or flipping through stacks of papers as they squeezed their telephones between ear and shoulder. They parted like cars on a two-lane road, yielding the right of way to a black and white, sirens blaring, as the captain barreled through them. They closed ranks behind him in his wake. Captain White cultivated a no-nonsense, tough-guy image and wore it tight to his skin like body armor. He downshifted as he approached Jenkins’ desk, and, as if he were a traffic cop flagging a commuter through an intersection, waved a manila folder in a southbound direction. “In my office, now!” he grumbled. Jenkins pried himself from his chair and merged a pace behind him.

Every time Jenkins stepped into the captain’s office, he felt as if he was trespassing the bounds of a mausoleum. It wasn’t decorated in a way that invites company or makes a soul feel cozy. Thin parallel layers of light sifting through the cracks of thick wooden blinds hanging like ribs against the windowpane etched a grate of glare and shadow across the opposite wall tiled in bronze plaques, framed certificates, and a collection of photographs picturing the captain shaking hands with a generation of mayors. A human skull stared vacant from the top of a filing cabinet, and the cadaver of a desiccated weeping figure collected dust in the back corner, a present, at one time, from his department to celebrate 20 years of service in law enforcement. Captain White dropped into a frayed armchair. As he lurched forward against a cluttered and scarred mahogany desk, his chair scratched along the linoleum like a lid sliding closed on a stone sarcophagus. He twisted the knob on the side of a banker’s lamp that then spilled light over a pile of forensic journals and glowed as green as kryptonite through the cover glass.

“What’s up, Captain?” Jenkins asked as he closed the door behind him, flicked the light switch on, and took up a standing position by the gallery wall.

The captain shot a brief but annoyed glance at the overhead light. “We’ve got, what we thought, is an unclaimed vehicle in impound, a white Subaru station wagon,” the captain replied, placing the fingers of his right hand lightly on the manila folder and skimming it back and forth across a small clearing on the top of his desk. “We were just about to sell it off on auction when Gonzales over in Motor Pool noticed a large stain on the cargo liner.”

“Blood?” Jenkins inquired, starting to feel a little like a dog being teased with a Frisbee.

“We don’t know yet.”

“How long has the car been back there?”

“That’s a problem,” the captain replied. “It’s been over six months. According to an inventory log, it was towed from Seaport Boulevard on January twenty-third.”

“And no one followed up? No one checked the registration?”

“Apparently, it fell through the cracks.”

“Any record of who may have had access to the vehicle since then?” Jenkins pressed.

“No.”

“And the towing company? Any record of who towed the vehicle?”

“Fell through the cracks,” the captain responded.

“Fell through the cracks?” Jenkins asked incredulously.

“Do you remember Sergeant Hayes?”

“Of course, he got transferred downtown to credit card fraud.”

“It was his case. When he left, it fell through the cracks.”

“But cases get reassigned,” Jenkins noted. “Yeah, it’s the responsibility of the department...er, ah, never mind Captain.”

Captain White glared up at Jenkins. “Anyway,” the captain continued, “I just had Henderson check it out. The vehicle’s registered to an Erica Holmes in the city.”

“Can she come get it? I hate to think of the accrued storage fee she’ll have to pay but at least she’ll have her car back and maybe we can get an explanation for the blood stain.”

“Again, now, we don’t know it’s blood, and, unfortunately, she can’t come claim it,” the captain replied.

“Why not?” Jenkins asked, cocking his head slightly like a puzzled beagle.

“We got a hit on a cross-reference. She’s a missing person.”

"This just keeps getting better," Jenkins said, starting to salivate like one of Pavlov's dogs. "How long has she been missing?"

"A report was filed on January twenty-fourth."

"The day after her car was towed?"

"It seems so," the captain responded. "Now, for the part you're not going to like."

"You're giving the case to someone else?" Jenkins asked, deflated.

"No, I'm giving you the case, but you're going to be working with a partner." The captain seemed to brace himself for what he knew was coming.

Jenkins stood there for a moment and let his brain sift the particulates like a coffee filter. "A partner?" Jenkins asked skeptically. "Is this a disciplinary action? Captain, I can handle a missing person."

"Bob," the captain responded, his voice taking on an edge, "I'm tired of relying on the backlogged county lab. We've acquired the equipment, and we've hired someone to do DNA for us. She's a graduate from Berkeley—a molecular biologist—and I want her to work with you on this one."

"She's fresh out of school?"

"Yep."

"Oh, for Pete's sake, Captain. Don't saddle me with some wet-behind-the-ears rookie—some CSI wanna be! You can't expect me to..."

"You'll be fine," the captain interrupted.

And there they were. Those three words: "You'll be fine." This was hardly the first time he'd heard them, and he knew they weren't meant to reassure. But, rather, they were a demarcation—a line he didn't dare cross. They were the signals that the discussion was over and that any further attempt to influence an outcome would be a waste of their times.

"Here's the missing person's report," the captain said, handing Jenkins the manila folder. "Your partner's name is Helen Chang. She'll be meeting you at the Subaru in the back lot." With that, the captain turned his attention to a stack of reports piled on the left side of his desk. "And Jenkins!" the captain said without looking up.

"Hmm?"

"The light!"

"Right, Captain," Jenkins sighed, flipping the light switch off and stepping out of the office. He did not catch the captain's glance again as he left the room, closing the door behind him.

Back at his desk, Jenkins lifted the metal case containing his crime scene evaluation equipment onto his desk and flicked the latches open. He verified its contents against his checklist:

☐ Barrier tape	☐ Eye dropper
☐ screw drivers (Phillips and FH)	☐ Sterile saline solution
☐ Graph paper, sketch paper	☐ Evidence envelopes
☐ clipboard	☐ Evidence bags
☐ Pencils and pens	☐ Sealable plastic bags
☐ flashlight	☐ Test tubes
☐ Steel tape measure	☐ Cotton swabs
☐ compass	☐ spatula
☐ Magnifying glass	☐ Cotton
☐ Ultraviolet light	☐ Latex gloves
☐ Digital camera, memory cards	☐ chalk
☐ batteries	☐ Tongue depressor
☐ forceps	☐ Sharpee
☐ brush	☐ ruler
☐ photo log sheets	☐ camera lenses
☐ collection vials	☐ lint pickup roller
☐ Methyl embelliferyl phos.	☐ Numbered marker tents
☐ video camera and tape	☐ tripod
☐ Fingerprint kit	☐ Clear Packaging tape
☐ Hemastix	☐ Distilled water

Satisfied that all his equipment was in place, he headed through the gauntlet of detectives that cluttered his passage to the back of the building.

“Hey, Bob!” a rough voice called from his right. It was Detective Sanders. “Heard you have a new partner. Just be yourself there, buddy! If she bails on you, I win five bucks.” “Was I the last person to know about this?” Jenkins sighed to himself, shaking his head slowly as he left the floor into the hallway.

Lieutenant Bob Jenkins had been a detective for close to a quarter of a century, and he’d seen it all, from the missing toddler he’d tracked down to the digestive system of a neighbor’s boa constrictor to the serial killer, the whack job from The Mission District, who dispatched his victims with a syringe full of Drain-O. (The press had dubbed that psycho “The Pipe Cleaner.”) The assaults, the kidnappings, the blackmailings, the murders.... Jenkins had come up against each one on that unsavory list. And every time he closed a file, every time he cracked a case, he gave credit to what he believed was his best crime-solving tool ... his gut. He could feel a crime scene. Its color. Its texture. Its layout. Its smell. Everything told a story, and it was his gut that took it all in. It was his gut that nagged him to look in places that others on the force wouldn’t dream of. It was a feeling in his gut that had always led him to the bad guy. His gut spoke only to him. Jenkins worked alone.

But now, here he was, the guy they mockingly called a gumshoe and a maverick, getting partnered up. His gut began to churn. *A partner*, he thought. *And a graduate from Berkeley! At least the tie-dye T-shirts have gone out of style. But she’ll probably have a tattoo on the small of her back, and her ears will be plugged into an iPod—someone consumed by the latest gizmos and gadgets. How am I going to make a criminalist out of someone like that! Solving crimes is about interrogating witnesses, chasing down leads, and crawling around the dirt inside the criminal mind. It’s about getting all that grunge hurled at you and trying not to let too much of it stick to your heart in a permanent way. She’d better at least be damn good with DNA.*

Jenkins paced down the corridor toward the back impound lot, carrying his case in one hand and the manila folder in the other. He flipped the folder open with a downward snap of his wrist and read the missing person's report. There, in the upper right-hand corner, was a picture of Erica Holmes. *Young, pretty*, Jenkins thought. *Probably a boyfriend or an ex-boyfriend, jilted, turned stalker.* Jenkins' mind almost always went first to murder.

Missing Persons Report

Form MPR 1182

Date January 24, 2014
Case Number CA087953
Name Erica Holmes
Date of Birth January 7, 1988
Address 2834 Cherry Hill Rd
San Francisco, CA
94122



Description of Missing Person

Caucasian female, 5'4", 120 lbs, blue eyes, blond hair, last seen wearing blue coveralls and black Converse sneakers. No distinguishing marks.

Reported by Dwayne Holmes (father)

Information on Case

Erica Holmes is an auto mechanic at The Nuts and Bolts of It Auto Service & Repair at 317 Geary, San Francisco. By her father's statement, her boyfriend, Sam O'Neill, had picked Erica up at her home at 8:30 A.M. on January 23, 2014 and dropped her off at work at the service station. O'Neill's vehicle was in for repair at this location and Erica had allowed him the use of her vehicle, a 2001 white Subaru Legacy station wagon, until his vehicle was operational. At the time of this report, Erica has been missing for 34 hours.

Investigating Officer Winthrop Hayes

Jenkins toggled the sheet with a finger. The second page in the folder was a vehicle registration form.

AUTO		REGISTRATION VALID FROM		TYPE	LICENSE NUMBER
10/02/2013 TO 10/02/2014		11		4GRSR2	
VEHICLE IDENTIFICATION NUMBER					
3FASP15J6R16185A8					
BOY TYPE MODEL	CYLS	DATE FIRST SOLD	CLASS	MAKE	Yr. Model
SW	00/00/2001	CR	SUBARU	2001	
DATE ISSUED	TYPE VEH	MP	AX	WC	UNLADEN/GCW
09/30/2013	125	G			
TOTAL FEES PAID					
\$96					4010
REGISTERED OWNER HOLMES ERICA P 2834 CHERRY HILL RD SAN FRANCISCO CA 94434-3010					
					
L0030					
R0058					
141020040439199					
STATE OF CALIFORNIA DEPARTMENT OF MOTOR VEHICLES VALIDATED REGISTRATION CARD READ REVERSE SIDE - IMPORTANT INSTRUCTIONS					X 1604350

Jenkins pushed through the double-glass doors that emptied to the stairway above the expansive back impound lot. From the top of the landing and across the pit of derelict automobiles, he could see the white Subaru station wagon parked against the chain-link fence on the far side of the blacktop. He could make out the figure of a woman in blue jeans and a pale T-shirt, meandering toward the vehicle. Jenkins realized that he was now in a race. He skidded down the steps and zigzagged his way through the maze of cars. Trying to suppress an overwhelming urge to pant, he arrived at the Subaru. But he was too late.

The Subaru's hatchback door gaped open, and the bottom half of a woman, bent at the waist, leaned out from the cargo bay. Her light blue T-shirt hiked up to her waist and exposed a circular design tattoo at the base of her spine. A cell phone was holstered to her jeans by her left back pocket. A small tackle box sat on the pavement a few yards from the Subaru's back bumper. Jenkins cleared his throat, loudly, deliberately, announcing his arrival. The woman, visibly startled, quickly came upright and faced him. Jenkins scanned her as if he were in an MRI machine. Wire-rimmed glasses magnified her dark eyes—exotic. Warm. Her hair, nearly black, had a slightly reddish tint to it and was pinched back, through a crooked part, into a ponytail. She had a soft, pleasing, and reassuring face. Although each ear was pierced, she was not wearing earrings. She wore almost no makeup to speak of, but her lashes were so dark that they may have been cosmetically enhanced—Jenkins couldn't quite be sure. A silver necklace spelled the name "Helen." She wore neither a diamond engagement ring nor wedding band. Neither did she have a tan line on her ring finger to indicate she had ever worn either. But she could have been too young for that anyway. She brushed a stray lock of hair behind her left ear, and Jenkins caught a glimpse of a pale and narrow two-inch scar running down the inside of her left forearm. Jenkins scanned her for the iPod he knew had to be part of her accoutrement. A thin, rectangular shape distorted her left front jeans pocket, and two white wires ending in black earphone pads dangled from the opening. *That must be it*, he thought. His gut, it occurred to him, was uncanny.

"Bob? Good morning. It's nice to meet you," she said politely while quickly stretching out her right hand. "I'm Helen Chang." A spark danced across her eyes when she spoke.

"I can see that," Jenkins replied, pointing to her necklace. "And call me Lieutenant Jenkins." She was pleasant. Affable. Jenkins wasn't in the mood for either. He took her hand, grudgingly, and shook it twice, though lightly. Her hand was slender and feminine, feline almost, but sturdy and durable, nonetheless. Jenkins, still winded, took in a few breaths. "Have you ever heard of Edmond Locard, Miss Chang?" Jenkins asked on the exhale.

"I don't think so," she replied.

"In 1912, a young woman was murdered in Lyons, France," Jenkins began while setting down his case on the hood of the adjacent vehicle. He popped open its lid and removed a roll of yellow barrier tape. He tied one end to the chain-link fence and then proceeded to drape the yellow plastic ribbon in a large rectangle around the Subaru, using a rearview mirror and antennae of adjacent vehicles as posts, leading the other end back to the chain-link fence at the front of the vehicle. The words CRIME SCENE DO NOT ENTER, reiterated on wide yellow ribbon around the automobile, now twisted gently in a subtle morning wind. "Her boyfriend, Emile Gourbin, a bank clerk, was suspected of the murder and was taken into custody," Jenkins continued. "He had an airtight alibi, however. Or so

he thought. He had spent the night of her murder, he claimed, with friends of his, out in the country. The forensic scientist, Edmond Locard, was called onto the case. He went to the morgue and examined the body of the victim. She had marks, bruising, around her neck. She'd been strangled, Locard concluded. He went back to Gourbin's prison cell and collected scrapings from underneath the suspect's fingernails. When he looked at that material under a microscope, he found skin cells covered with a cosmetic powder. Analysis showed that that powder was made from a unique collection of compounds. Locard then had the police recover the victim's cosmetics from her home. Her face powder, it turned out, made by a local druggist, had all the same components as the cosmetic clinging to the skin cells scraped from underneath Gourbin's fingernails. When confronted with this discovery, Emile Gourbin confessed and was convicted of her murder."

"Do you think that has something to do with this vehicle?" Helen asked.

"More so now than before since you opened the hatchback," Jenkins replied. "The point is that every time you touch something, you leave a little of yourself behind and you take a little of what you touched away with you. That's Locard's exchange principle. Every contact leaves a trace, in both directions. You opened the latch of the hatchback door. Your fingerprints, your skin oils and sweat, and all the host of chemicals they contain are now on that latch, and you will now have the skin oils of the other people who have touched that latch and fragments of their fingerprints on your hand along with any chemical residue from the latch itself. You were leaning into the hatchback area. A hair of yours may have fallen into the vehicle or fiber from your clothing, or by static electricity, fibers from the vehicle may now be attached to you. Any time there's contact, there's an exchange of material. In forensics, we're only limited by our ability to detect that exchange."

"I think I get it," Helen exclaimed. "You have coffee this morning, let's say, for example. You leave your fingerprints on the mug and your saliva on the rim. You may take away a drop of coffee on your nice white shirt."

"Exactly!" Jenkins said while quickly flicking an extended finger at her in the air like the strike of a cobra and being quite pleased with himself for making the point. But then, her words found their mark, and he quickly glanced down at the front of his shirt, and there, by the second button, was a coffee stain the size of a quarter. *Must have been from when the captain snuck up on me this morning*, he thought.

"Lieutenant Jenkins," Helen said, redirecting his attention, "Captain White asked me to see if I could recover DNA from the stain on the cargo bay liner. I was only going to swab it for a small sample."

"Yes, but let's hold off on that a moment," said Jenkins. "Won't the very act of swabbing the stain change its appearance? And might fibers from the swab slough off onto the stain?"

"Well, yeah, okay, I suppose so. But, again, I was told by the Captain to get a sample."

"What kind of person drives a 2001 Subaru Legacy station wagon, Miss Chang?"

"Excuse me?"

"Would it be a wealthy person?"

"I would think not. More likely, someone who is concerned about making ends meet. Maybe a student or a teacher or a waiter. I don't know. Why?"

“Young or old?”

“Young, I would guess. Or someone who still acts young.”

“Anything else?”

“Lieutenant Jenkins, is there a point to this?”

“You don’t see one?”

“No, Sir. And do you always answer a question with a question?”

“Shouldn’t I?”

“I think I should go talk to Captain White. Maybe you should work with someone else on this case.”

“Suit yourself, Miss Chang. But I’d hate to see Detective Sanders win five bucks.”

“What?”

“We’re getting a feeling for the owner of this vehicle, Miss Chang. That’s all. Now, can you say anything else about the person who owns this car?”

Helen stood there a moment. She leaned her head back to the sky. Her hair cascaded down behind her like a waterfall. She took a long, protracted breath and straightened her glasses. “Okay,” she finally said, “it gets decent gas mileage. Again, that points to someone who’s frugal and perhaps someone concerned about the environment.”

“Ecologically minded. An environmentalist. Good, Miss Chang.”

“It’s a Japanese make, so the owner’s not into the ‘buy American’ credo. And, it’s sporty—an outdoor kind of car,” Helen continued. “The owner is probably athletic and likes outdoor activities, maybe biking, skiing, surfing, or snowboarding.”

“Or, they want to give the appearance of being athletic and outdoorsy,” Jenkins added. “A modest man’s midlife crisis vehicle.” He started to pace slow circle around the automobile, looking for anything out of place. Helen followed.

“I suppose,” Helen said. “Or, since it’s a wagon, the owner could be a parent.”

“True,” said Jenkins. “But the child would have to be at least six years old or over sixty pounds.”

“How could you possibly...,” Helen started.

“State law, Miss Chang,” Jenkins interrupted. “No child seat.”

“Oh, yeah, that’s right.”

“And what kind of car do you drive, Miss Chang?” Jenkins asked as he leaned over a moment to examine a small dent on the right side of the front bumper. He looked up to find Helen staring at the gun in his shoulder holster.

“Oh, perfect!” Helen said aghast, “you carry a firearm?”

“I’m a sworn officer, Miss Chang,” Jenkins replied. “Now, about your car?” Helen stood there, staring at the area on Jenkins’ left chest, where his revolver rested in its holster. Her lungs surged in and out at a beat above normal respiration. “Miss Chang,” he repeated, “your car?”

“A Prius,” she finally replied. She gathered herself together into a firmer bundle. “A graduation present from my dad.”

“Makes sense,” said Jenkins. “A young professional. Upwardly mobile. Your father knows you.”

“And you, Lieutenant Jenkins?” Helen asked.

“A 1980 Oldsmobile Cutlass Calais.”

“Wow, who would have imagined,” Helen said, trying not to give up a grin.

“Yeah, well, it’s a classic,” Jenkins said, shooting her a quick, disapproving glance. He resumed his stroll around the vehicle. “If I were to tell you, Miss Chang,” Jenkins continued, “that the owner of this vehicle is a woman, what would you say would be the characteristics of her boyfriend?”

“Why do you assume she has a boyfriend? Maybe she’s single. Or maybe she has a girlfriend.”

“Now who’s answering a question with a question? But your point is well taken. For the sake of argument, however, let’s say, she has a boyfriend.”

“I think people are attracted to those who share similar values.”

“I agree with you,” Jenkins said. “We’ve secured the area. Let’s get busy. First, I need to photograph the vehicle, and, Miss Chang, if you wouldn’t mind writing up the log,” he asked, handing her a log sheet. “Please note the date, the time, location, case number ... it’s CA087953,” he said, glancing at the manila folder, “and who’s here. That’s Jenkins, J, E, N, K, I, N, S.”

“Wait a minute,” Helen protested. “You’ve cordoned off the area, and we don’t even know if this is really a crime scene or not.”

“We’re going to treat it as if it is,” Jenkins replied. “The owner of this vehicle is a missing person, and until we’re convinced otherwise, this is a crime scene.”

“Shall I close the hatchback door?” Helen asked hopefully.

“No, leave it up,” Jenkins replied.

“Do I have to write in the log that I opened it?”

“Yes, you do, Miss Chang. Now, nothing personal, but if you wouldn’t mind moving out of the frame....”

Crime Scene Investigation

A *crime scene* encompasses the largest area that might contain physical clues to the circumstances and participants of an unlawful act. If a person has been hacking into bank records, the crime scene might be as small as their computer. When terrorists destroyed New York’s World Trade Center in September 2001, the crime scene included several city blocks. In the Erica Holmes missing person case, the crime scene is the recovered Subaru station wagon.

The first few minutes of a crime scene’s processing can be the most critical moments of an entire investigation. At no other period will the investigators be closer to the moment when the crime was committed. Investigators will never have the area more pristine or more unfettered from contamination. In those first few minutes, fingerprints, shoe prints, tire prints, trace evidence, and the state of the victim are all most informative. And yet, at no other time are mistakes more likely made that can potentially jeopardize successful prosecution of the crime’s perpetrator.

Because Locard's exchange principle haunts every crime scene, human contact with any physical or biological evidence can result in its contamination or loss. One of the first acts of a first responder, therefore, must be to restrict access to all those not directly involved in the investigation. Cordoning off the area with yellow crime scene tape is the method most frequently used to limit trespassing by the unaware or curious members of the press or public. To minimize contamination, the taped-off perimeter should allow access to the scene at only one spot, and all those entering and departing the scene should be carefully documented. The secured area should be large enough to contain the most obvious elements of the criminal act—the victim, blood stains, a discarded murder weapon, any disturbed furniture, etc.—but must also allow for careful examination of all possible paths by which the perpetrator may have gained access to the victim and then exited the area.

Documenting the Crime Scene

Once the area is secure, investigators can then perform an initial *walk-through* in which they try to glean an understanding of the nature and scope of the crime and determine what evidence should be collected and from where. Prior to removing any evidence, however, it should be photographed or videotaped to document its state and its position within its surroundings. Much of the crime scene can also be recorded by 3D laser scanning to give investigators an even more refined image of the crime scene and its overall layout (Figure 1.1). Photos of smaller items should be taken with and without a reference (such as a ruler and a coin) to give a measure of scale. Although photographs provide the most accurate documentation of the physical elements of a crime scene, sketches are also made to show the relationships and distances



Figure 1.1 The Leica Geosystems 3D laser scanner is integrated with a high-resolution panoramic camera giving a detailed image of the crime scene's 3D layout. It is shown here in front of the Texas School Book Depository in Dealey Plaza, Dallas, Texas, scene of the John F. Kennedy assassination. (Courtesy of Leica Geosystems, Houston, TX.)

between those elements. Are doors open or closed? Are glasses on the dining room table? Does anything seem out of place? Sometimes, even the most trivial detail can be important. These sketches don't necessarily require that the investigator be a talented artist, but they do demand enough accuracy to show the crime scene layout and the relative locations of any evidence. Careful notes taken at the crime scene can effectively supplement photo, videotape, and sketch documentation.

Information gathered from the crime scene will help the investigator file an official report. Most police departments use report forms specific to the crime. For example, a kidnapping, a homicide, and an incident of domestic violence may each have their own associated report form. The homicide report prepared for the assassination of President John F. Kennedy in 1962 is shown in Figure 1.2.

Talder
2150

FORM OF HB-400
POLICE DEPARTMENT

HOMICIDE REPORT

CITY OF DALLAS

Last Name of Person Killed KENNEDY, John F. (PRESIDENT OF U. S.)		First Name		Middle Name		Race		Sex		Age		Residence of Person Killed Washington, D. C. (White House)		Offense Serial No. F-85950											
Reported By		Title or Relationship		Race		Sex		Age		Address of Person Reporting		Phone of Person Reporting													
Offense as Reported (Crime) MURDER												After Investigation Changed to													
Place of Occurrence — Street and Number or Intersection Elm St. (approx. 150' W of Houston)												Division H&R		Platform 2		Box 101		Officers Making Report		I.D. No.		Name		I.D. No.	
Day of Week Fri		Date of Occurrence 11/22/63		Time of Day 12:30PM		Date Reported 11/23/63		Time Reported 5:10PM		Report Received By Mayo		Received—Time—Typed 5:10PM													

DESCRIPTION OF DEAD PERSON

Age		Height		Weight		Eyes		Hair		Beard		Complexion		Identifying Marks, Scars, Etc.		Clothing	
Coroner Notified Joe B. Brown										Name of Coroner Attending—Time of Arrival A.M. _____ P.M. _____				Name of Prosecutor Attending—Time of Arrival A.M. _____ P.M. _____			
Physician Dead by Physician Dr. Kemp Clark, 1PM, Parkland Hospital										Person With Whom Aboard Lived or Associated							

DETAILS OF OFFENSE (Give Circumstances of Occurrence of Offense and Its Investigation) Use Both Sides of This Sheet.

The expired was riding in motorcade with wife and Governor John Connally, and his wife. Witness heard gun shot and saw the expired slump forward. More shots were heard and the expired fell into his wife's lap. Governor Connally was also shot at this time. Car in which they were riding was escorted to Parkland Hospital by Dallas Police Officers.

Witness Taken Into Custody		Address		Witness Taken Into Custody		Address	
All witnesses affidavits are in Homicide Office.							

Known, Suspected or Possible Motives

DESCRIPTION OF SUSPECTS OR PERSONS WANTED

Name if Known		Alias		Address		Sex		Color		Age		Height		Weight		Eyes		Hair		Complexion	
Breed		Nativity		Occupation		Dress and Other Marks		Cause for Suspicion													

Name if Known		Alias		Address		Sex		Color		Age		Height		Weight		Eyes		Hair		Complexion	
Breed		Nativity		Occupation		Dress and Other Marks		Cause for Suspicion													

Name if Known		Alias		Address		Sex		Color		Age		Height		Weight		Eyes		Hair		Complexion	
Breed		Nativity		Occupation		Dress and Other Marks		Cause for Suspicion													

Persons Arrested—Name—Address Lee Harvey Oswald										Race		Sex		Age		Arresting Officers Lt. E. L. Cunningham 464 MN McDonald 1178		I.D. No.		Charge MURDER	
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Officers Assigned to Investigate (Include I.D. No.) <i>Sharity - Blessing - Brown</i>										This Offense Declared Unfounded ☐ Cleared by Arrest ☐										Pending ☐ Date _____		Commanding Officer	
Case File										Disposition Code										By _____		Date _____	

REMARKS:

INVESTIGATION BUREAU

Figure 1.2 The Homicide Report prepared by the Dallas Police Department on the assassination of President John F. Kennedy on November 22, 1963.

Collecting Evidence

Evidence is anything that can be used to probe the events and identify the participants of a crime. Investigators gather two types of evidence during an investigation, direct and circumstantial. *Direct evidence* refers to the information gathered from statements made by a surviving victim, suspects, and eyewitnesses. This type of evidence, however, is notoriously unreliable. Perceptions of an event, as they pass from the eyes to the brain to the vocal chords, can be filtered and distorted in a number of ways. The accuracy of a person's account is subject to filtration by the witness's own visual acuity and is susceptible to distortion as it's refracted through the powerful lens of their bias, prejudice, and experience. An eyewitness's account is also vulnerable to flaws in continuity through the witness's own capacity, or lack thereof, for accurately remembering information and the order in which the events of the crime occurred.

Circumstantial evidence usually refers to items such as blood, fingerprints, hair, fibers, and DNA. This type of evidence is more amenable to scientific examination than direct evidence. And, since various controls can be run with any type of scientific test designed to identify its source, circumstantial evidence tends to be more reliable. Nevertheless, circumstantial evidence still requires that a court make a judgment as to its relevance. For example, if DNA analysis shows that a suspect's blood was found at the scene of a murder, a jury still must weigh the arguments made that such evidence necessarily places the suspect at the scene during the time the crime was committed.

But what types of evidence and how much of any one type should be collected? If a murder, assault, or burglary is being investigated, any type of evidence that can place a suspect at the scene should be collected. This is usually obvious; fingerprints, a murder weapon, bloodstains, and shoeprints can all be critical to solving a crime. Not so obvious, however, might be those items that are not readily visible, such as dirt, pollen, hair, and fibers. These items of trace evidence might prove that the perpetrator came from a certain outside geographical region having a unique flora and geology. Collecting absolutely everything from a crime scene, from a couch down to the dust, however, would create a documentation and storage nightmare and might actually hinder speedy and successful prosecution of the case. Experience becomes the best teacher as to what items will have the most relevance for the investigation of each type of crime.

Packaging Evidence

Evidence can make or break a case. To the attentive investigator, it is the *silent witness* that reveals the events of an illegal act. Without it, the prosecution has little hope of tying the alleged criminal to the crime. As such, it must be handled in a way that protects it from loss, damage, or contamination.

Different types of evidence should be packaged in ways that ensure their longevity, and that packaging should be clearly marked, denoting it as evidence. Dry items such as small swatches of cloth, scraps of paper, and wood splinters can be folded in paper and placed in a sealable plastic bag. Nonbiological liquids such as water, bleach, gasoline, and paint should be stored in an airtight plastic container. Since any type of biological evidence is a potential food source for bacteria and mold, it's best that such material is stored in a way that will prevent the retention or accumulation of moisture that would encourage microbial growth and destruction of

the sample. Bloodied or semen-stained cloth, for example, should be allowed to dry. Once desiccated, it can be packaged in a sealed bag and, as such, should be stored safely for years.

Each evidence bag must bear a description of the item it contains, the name of the person who found it, the case number, the date, the location where the item was found, and the name of any witnesses who observed its discovery. Evidence should be stored in a secured room to prevent its tampering.

Chain of Custody

As evidence items are gathered, careful notes must be kept, documenting where, when, and by whom the evidence items are collected. Evidence is bagged or boxed and sealed in such a way that its removal from the container is immediately obvious (Figure 1.3). It is readily apparent, for example, when tape securing an evidence bag has been torn or ripped. Such precautions can help to thwart any accusations by a defense attorney of *evidence tampering*. And each time an evidence bag is passed from one person to the next, from the time it is collected until it finds its way into the court room for the trial (and even thereafter), the person accepting the item dates and signs their name on the bag. This record is called *chain of custody*, and you can bet that a defense attorney will meticulously examine that record. If they find any irregularity, you can further expect that they will either move to have that evidence rendered inadmissible or use the investigators' lapse in protocol as a way to raise questions in the minds of a jury that that evidence was tampered with, in perhaps a sinister and calculated way, ultimately prejudicial to their client (an approach of which full advantage was taken by attorney Johnnie Cochran during the O. J. Simpson murder trial of 1995). An example of a chain of custody form is shown in Figure 1.4.

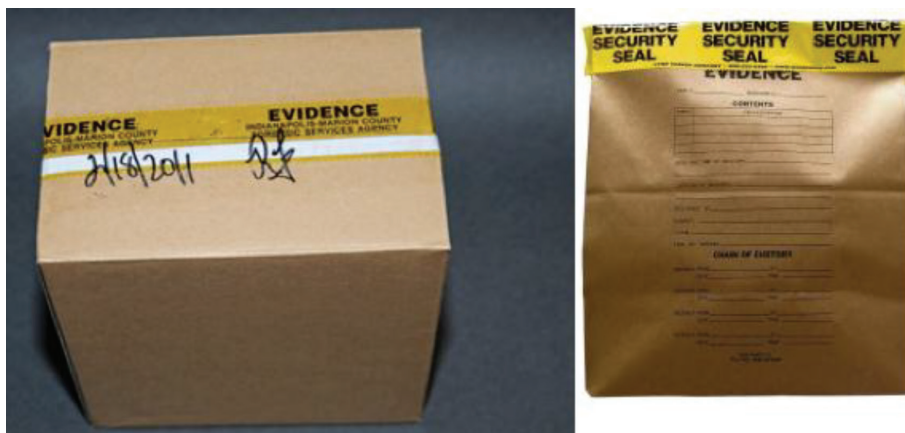


Figure 1.3 Tape is used to seal boxes or bags carrying evidence. Notice that the tape on the box on the left is initialed and dated. Notice that the initials actually overlap onto the cardboard next to the tape. Any attempt to remove the tape and to put that same tape back on again could most likely be detected as tampering. Any time the tape on the container is broken, the person breaking the tape must document it. When the lawyer, investigator, or criminalist has finished their business with the evidence, the evidence must be replaced and the bag resealed with fresh tape. (Courtesy of the Indianapolis-Marion County Forensic Services Agency, Indianapolis, IN.)

Chain of Custody

The item(s) described below were obtained as evidence by the undersigned during a criminal investigation conducted by the San Mateo County Police Department.

Case Number: _____

Description of item(s) obtained: _____

Obtained from: _____
(Title, name, location, contact information)

Printed Name of Investigator Signature of Investigator Date Obtained

Temporary disposition of item(s): (where stored; show releases below)

Released by: _____ Released to: _____
Printed name/signature Printed name/signature Date
Purpose/Reason: _____

Released by: _____ Released to: _____
Printed name/signature Printed name/signature Date
Purpose/Reason: _____

Released by: _____ Released to: _____
Printed name/signature Printed name/signature Date
Purpose/Reason: _____

Released by: _____ Released to: _____
Printed name/signature Printed name/signature Date
Purpose/Reason: _____

Final disposition of item(s): _____

Figure 1.4 A chain of custody form is used to document who has examined or taken possession of an evidence item and when that occurred.

Legalities of Evidence Collection

The right of the people to be secure in their persons, houses, papers, and effects, against unreasonable searches and seizures, shall not be violated, and no Warrants shall issue, but upon probable cause, supported by Oath or affirmation, and particularly describing the place to be searched, and the persons or things to be seized.

The Fourth Amendment of the US Constitution prevents citizens from being strong-armed by law enforcement. It provides residents of the United States a degree of sovereignty over their own property. All countries in the Free World recognize the rights of the individual against *unreasonable* search and seizure of their property by their government. In Canada, those rights are protected by Section 8 of the Canadian Charter of Rights and Freedoms. In Britain, Section 8 of the Police and Criminal Evidence Act of 1984 puts limits on the power of the police to search your property and take items from it. New Zealand and Australia offer their citizens similar protections.

However, some crime scenes (or the location of evidence involved in a crime) may be within a suspect's personal property, for example, within their vehicle

or residence. The US Constitution’s Fourth Amendment requires that a law enforcement officer obtain a judge’s permission before the right is given to search either of these properties. That permission, called a *search warrant*, is issued by a judge and will be granted only if the officer shows *probable cause*—a compelling reason to believe that the vehicle or residence contains evidence critical to a criminal investigation.

Even with the safeguards of the Fourth Amendment, searches may be conducted under special circumstances, such as when there is a life and death emergency, if evidence is in imminent danger of being lost or destroyed, and when permission is granted by the property owner. In addition, when a suspect has been lawfully arrested, their property can be searched for evidence, without the issue of a warrant.

In the Crime Lab

Activity 1.1 *Silent Witness: Interpreting Physical Evidence*

There are three ways in which crimes are solved: (a) by confession, (b) by testimony from eyewitnesses, and (c) by examination of physical evidence. A potential problem with a confession, however, is that the confessor, for any number of reasons, may admit to a crime he or she didn’t commit. Likewise, eyewitness testimony can be equally unreliable in that no two people will witness or describe the events of a crime in exactly the same way. The most important and reliable tool for solving a crime, therefore, is through careful analysis of the physical evidence. The physical evidence, the so-called silent witness, can corroborate or contradict either a confession or the testimony of an eyewitness.

In this activity, you will derive information about the participants of a crime by examining physical evidence recovered from a hypothetical crime scene.

Materials:

- Laboratory notebook
- Brown bags containing physical evidence collected from a crime scene

Protocol:

1. Your instructor will provide each lab group with (1) a bag containing crime scene evidence, (2) the circumstances under which the evidence was collected, and (3) a list of questions relevant to that evidence. Answer the questions based on the information you might be able to deduce from each item of physical evidence.
2. Reproduce the following data table in your laboratory notebook and fill in the appropriate information. Once completed, you will be asked by your instructor to report your findings to the class.

Item Description	Question(s) the Item May Be Able to Address	Interpretation





Activity 1.2 *Sketching a Crime Scene*

Photography, whether film or digital, is an invaluable tool for documenting the objects and the spatial arrangements of those objects at a crime scene. With such technical devices readily available, it might seem archaic and antiquated to make a free-hand sketch of a crime scene. A drawing, however, gives investigators valuable information about the layout of a crime scene. How many feet are there between the bedroom doorway and the homicide victim? How far away from the window was broken glass discovered? What is the distance from the front door to the body? How many inches long is the muddy boot print in the walkway? This type of information is easy to make note of on a sketch. In this activity, you will create a rough *bird's eye* (or aerial perspective) sketch of a crime scene.

Materials:

Laboratory notebook
Tape measure

Protocol:

The class will be divided into two groups. Each group will be assigned a crime scene prepared by your instructor. The students in each group will document their assigned crime scene by drawing an overhead sketch of its components and layout in their laboratory notebook. Along with your sketch, include all supporting pieces of information (time of day, general location, weather conditions, other investigators present at the scene, etc.).

Note: In this exercise, no digital and/or video cameras are allowed at the crime scene.



Activity 1.3 *Reconstructing a Crime Scene*

When a case goes to trial, the court uses the notes, photographs, and sketches collected during the investigation to reconstruct, as best as possible, the physical layout of the crime scene. Arguments as to a suspect's guilt or innocence can hinge on the accuracy of those accounts.

In this activity, you will help to reconstruct a crime scene based on the notes and sketches taken by other students.

Materials:

Other student's lab notebook containing description of the crime scene
Tape measure

Protocol:

1. You will be divided into the same groups as those created for Activity 1.2. Exchange notebooks with a student in the opposite group. Using the information provided in the student's notebook, reconstruct the crime scene that the other student had examined. Place all the objects of the crime scene in their relative positions, as documented.
2. When your group has finished, the instructor will take a digital image of your reconstructed crime scene.
3. For comparison, your instructor will display digital images of (1) the actual crime scene setup by your instructor on day one and (2) the crime scene you recreated based on your classmate's notes from their laboratory notebooks.

Analysis:

In your laboratory notebook, record your responses to the following questions:

1. What parts of your reconstruction were reproduced accurately when compared with the real crime scene?
2. What parts of your reconstruction were reproduced incorrectly when compared with the real crime scene?
3. If you had to repeat the previous activity (Activity 1.2), what would you do to improve the accuracy of your documentation?

Activity 1.4 Documenting the Position of Objects at a Crime Scene

When investigators document a crime scene, whether it's by digital photography or by sketch, they may often make note of the relative positions of the items within the scene by their relation to the points of a compass or by the place they occupy within an imaginary geometric grid. Accurate measurements of where items are located will help a court recreate a crime scene, if it is necessary, at a date later than when the original investigation was conducted. Reference points used to take measurements and to position evidence items within a crime scene, therefore, should not be items that can be easily moved.

Investigators may use either imaginary triangles or rectangles to record the position of an evidence item. Constructing a rectangle containing an evidence item within its bounds requires the lengths of two adjoining sides and fixtures at right angle to each other (90°) from which to reference (Figure 1.5). By placing an evidence item at the corner of a rectangle and by knowing the lengths of the two sides that meet at that corner, an investigator can precisely recreate its location.

Accurately determining an object's position within a triangle requires the length of one side and the two angles formed by lines leading from either end of that imaginary line to the object. For example, if we know that the distance between two reference markers is 10 ft, the angle of a line drawn from the evidence item to one reference marker is 34° , and the angle of a line drawn from the evidence item to the other reference marker is 80° , we can draw lines having the proper angle from each end of the measured line until those two lines intersect. The distance from each marker to the evidence item can then be determined (Figure 1.6).

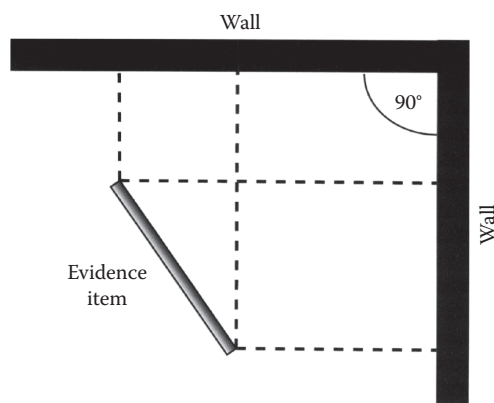


Figure 1.5 Using rectangles to map the location and orientation of an item within a crime scene requires a nearby reference marker having sides at a right angle to each other (here shown as two walls). By knowing the distances of at least two points on the evidence item from each wall, the evidence item can be precisely placed at its original position if the crime scene needs to be reconstructed.



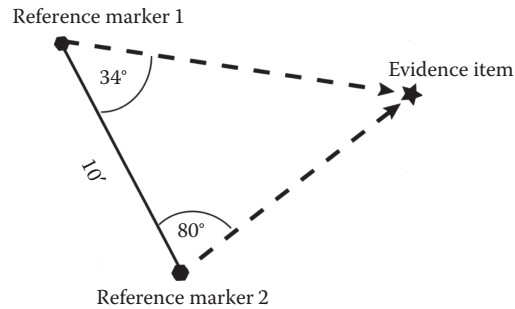


Figure 1.6 A straight line between two reference markers (designated 1 and 2) measures 10' in length. The angle formed by that imaginary line and a line leading from Reference Marker 1 to the evidence item is 34°. A line leading from Reference Marker 2 to the evidence item creates an 80° angle. To re-create a crime scene, an investigator or officer of the court can draw the 34° angle line from Reference Marker 1 and the 80° angle line from Reference Marker 2 until they intersect. The investigator will then place the evidence item at that intersect point.

Noting the location of an evidence item in relation to the points of a compass requires that the investigator must also know a little bit about geometry. A compass heading is based on a 360° circle (Figure 1.7). North is designated as 0°. Moving clockwise around the compass, due east is 90°, due south is 180°, and due west is 270°. All directions in between are designated by their corresponding angle from magnetic north.

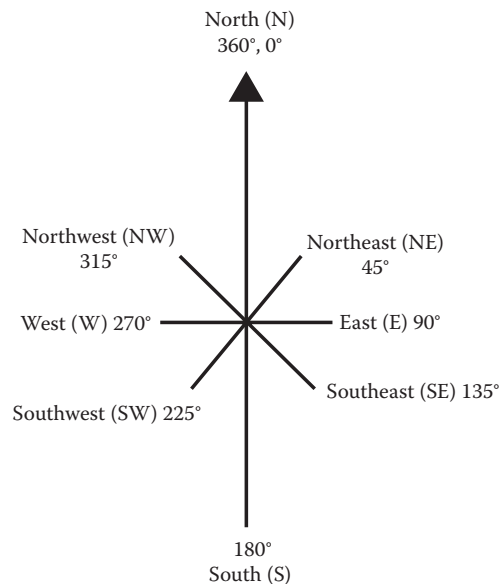


Figure 1.7 The headings of a compass are related to the degrees of a circle. If the object is facing due north (N), the compass heading will read and point to 0°. If the object is facing due east (E), the compass heading will read and point to 90°. If the object is facing due south (S), the compass heading will read and point to 180°. If the object is facing due west (W), the compass heading will read and point to 270°. If the object is facing north east (NE), south east (SE), south west (SW), or north west (NW), the compass heading is reading 45°, 135°, 225°, and 315°, respectively. If the object is pointing between 0° and 45°, the orientation is north, north east (N, NE). If the object is pointing between 45° and 90°, the orientation is east, north east (E, NE). The same nomenclature applies to the other compass quadrants. Note that the compass headings are magnetic north, not true north.

In this activity, you will document the location of an evidence item within a crime scene by using a digital image, compass orientation, and/or coordinate position within a geometric grid.

Materials:

Laboratory notebook
Ruler
Protractor

Protocol:

Describe the position of the evidence item within each digital image by using its relation to the positions on a compass or by using its location within an imaginary geometric grid.

Analysis:

In [Figure 1.8](#), the surfing wet suit booty (center) is the item of evidence. It was discovered beneath the deck window of a burglarized apartment. Assume that the deck railing and the garden hose wall are at 90° to each other.

In your laboratory notebook, record your responses to the following questions:

1. What method(s) can be used to describe the position of the surfing booty on the porch deck shown in [Figure 1.8](#)?
2. What items should not be used as reference points and why?
3. Draw a recreation of this image in your laboratory notebook. Using a ruler, draw the appropriate lines to identify the position of the evidence item (the surfing booty).
4. The surfing booty measures 25 cm heel to toe. How far is the heel of the surfing booty from the garden hose wall?

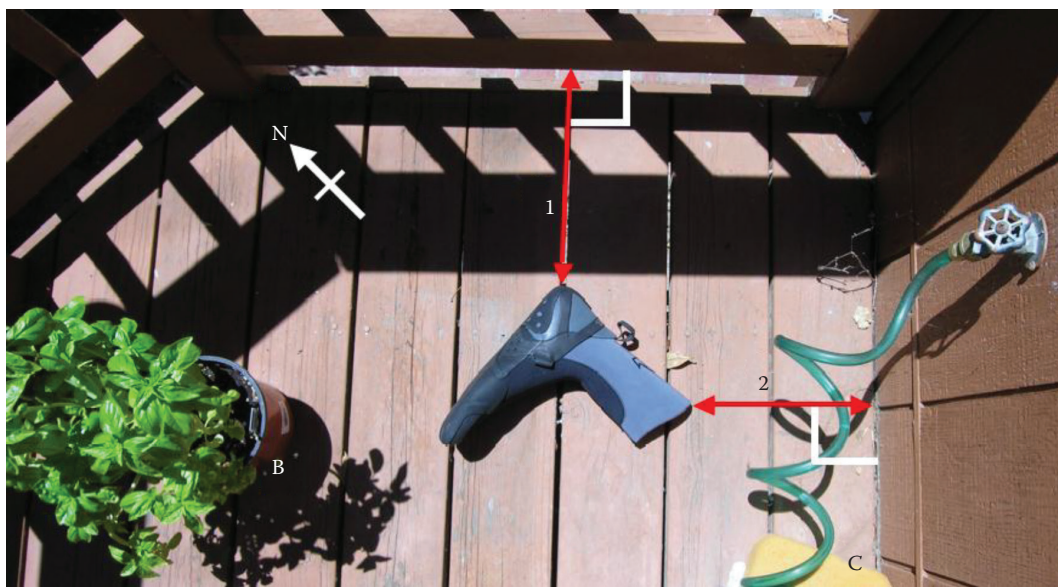


Figure 1.8 Digital image of a surfing booty on a porch deck. 1 represents an example of a possible measurement that can be taken. (From the edge of the deck to the heel of the surfing booty). 2 is another possible point of measurement. (From the wall of the house to the back rim of the surfing booty). B is a potted plant and C is a sponge. N represents north.

5. Using the compass heading given in the figure, describe the orientation of the evidence item. (E.g., in which direction is the toe pointing?)
6. Which fixed objects in [Figure 1.8](#) can be used as references to recreate the crime scene?

[Figure 1.9](#) shows a surfing booty (the evidence item) in the barbeque area of a burglarized home. Use this image to answer Questions 7 through 13.

7. During the original processing of the crime scene, a brick (marked “C”) was placed into evidence. Three months later, the court is asking the investigators to recreate the crime scene. The brick has a width of 9.5 cm. What is the true distance of line “3”?
8. What is the true distance of line “4”?
9. What is the compass orientation of the brick marked “C”? (State your answer with respect to the front edge of the brick proximal to the booty.)
10. What is the true distance of line “1”?
11. What is the true distance of line “2”?
12. What orientation is the rubber booty in relation to the points on a compass? (State your answer relative to the direction of the toe and ankle.)
13. Which fixed objects in [Figure 1.9](#) can be used to recreate the crime scene in a drawing or reconstruction?
14. Which coordinate technique (rectangular and/or triangular) would you use to determine the position of the knife shown in [Figure 1.10](#)?
15. Which fixed points would you use to establish the coordinates of the knife?
16. Which two points on the knife shown in [Figure 1.10](#) would you use to measure distances from the fixed points that you identified in Question 15?



Figure 1.9 Aerial photograph of a surfing booty adjacent to an outdoor brick barbecue. Line 1 is a measurement from the brick wall to the booty's heel. Line 2 is a measurement from the corner of the brick wall to the corner of the brick (marked as “C”). Line 3 is a measurement from the brick wall to the toe of the booty. Line 4 is a measurement from the brick wall to one of the other corners of the brick (C).



Figure 1.10 A photograph taken from an aerial perspective of a knife on the fourth stair leading up the front porch of a residence in which an assault has occurred.

17. Recreate [Figure 1.10](#) as a drawing in your laboratory notebook, and using a ruler, draw the actual lines that you would measure at the crime scene.
18. What is the compass heading of the knife in [Figure 1.10](#) with respect to the direction in which the tip of the knife is pointing?

Activity 1.5 *Sketching a Crime Scene Revisited*

For this exercise, your instructor will create two crime scenes and assign a group of students to document each scene. This activity will give you practice in documenting a crime scene and will give you an opportunity to apply your skills at creating coordinate systems for accurately positioning evidence items within a crime scene sketch.

Materials:

Laboratory notebook
 Measuring tape
 Compass
 Crime scene tape
 Protractor
 Map of school campus (which includes compass heading)
 Measuring wheel (optional)

Protocol:

1. Make an overhead sketch of the crime scene assigned to you by your instructor.
2. Note the orientation of the evidence items within the crime scene in relation to the points of a compass. With a laboratory partner, take the necessary measurements needed to locate the evidence item(s) using a rectangular and/or triangulation coordinate system.
3. Share and compare your measurements with the other members of your group.

Note: No digital and/or video images will be taken at the crime scene.





Activity 1.6 *Crime Scene Reconstruction Revisited*

In this activity, you will use a directional compass and coordinate measurements to reconstruct a crime scene from notes taken by other students.

Materials:

Laboratory notebook
Measuring tape
Compass
Crime scene tape
Protractor
Map of school campus (should include compass heading)
Measuring wheel (optional)

Protocol:

1. In Activity 1.5, your instructor divided the class into two groups—each group documenting a different crime scene. Exchange your's and your laboratory partner's notebooks with a pair of students in another group, and using the information they have provided, recreate the crime scene they documented.
2. When you have finalized the reconstruction of the crime scene, have the instructor take a digital image.
3. Compare your recreated crime scene with the digital image taken by your instructor.

Erica Holmes Missing Person Case

Figures 1.11 and 1.12 are photographs of Erica Holmes' vehicle in impound and the large stain on the rear cargo bay liner.



Figure 1.11 Erica Holmes' Subaru station wagon in the impound lot.



Figure 1.12 The large bloodstain on the cargo bay liner of Erica Holmes' vehicle.

Questions

- 1.1 What was done to protect the crime scene?
- 1.2 What improvements could have been made in the manner in which Lieutenant Jenkins and Criminalist Chang secured and evaluated the crime scene?
- 1.3 How might a defense attorney use any procedural lapses made by these investigators to protect a suspect charged with involvement in a homicide case?

Review Questions

- 1.1 What is Locard's exchange principle?
- 1.2 What defines the size of a crime scene?
- 1.3 What is the purpose of a crime scene walk-through?
- 1.4 Give four examples of circumstantial evidence.
- 1.5 Why is it a good idea to allow blood or other bodily fluids to dry when taken into evidence from a crime scene?
- 1.6 Why is it important to maintain a *chain of custody* document for the evidence items collected from a crime scene?
- 1.7 What is a warrant?
- 1.8 What is profiling?
- 1.9 When documenting a crime scene, why is a *bird's eye* sketch preferable to one taken from ground or eye level?
- 1.10 What is the rectangular coordinates method of describing an object's location?
- 1.11 When positioning objects within a crime scene, why is it important that the measurements be taken from fixed objects?
- 1.12 When implementing rectangular or triangular coordinates to describe the position of an evidence item, why is it important that two different reference points be chosen?

- 1.13 During an initial investigation of a crime scene, what other notation(s) (besides position measurements) should be recorded before removing an item from its original location?
- 1.14 What other tool would aid the crime scene investigator in addressing the issue posed in Question 1.13?
- 1.15 What is the triangulation coordinates method?
- 1.16 When would triangulation coordinates be preferred over rectangular coordinates in describing the position of an evidence item?
- 1.17 A shell casing has been found in the street at the scene of a murder. A signpost and a mailbox are nearby. The distance from the signpost to the front, right leg of the mailbox is 6'. The angle from the shell casing to the front, right leg of the mailbox to the signpost is 55° . The angle from the shell casing to the signpost to the front, right leg of the mailbox is 30° . (a) What is the distance from the shell casing to the front, right leg of the mailbox? (b) What is the distance from the shell casing to the signpost?

Further Reading

Evaluating the Crime Scene

Crime Scene by L. Ragle, Avon Books, New York, 1995.

The Criminal Investigation Process and the Role of Forensic Evidence: A Review of Empirical Findings by F. Horvath and R. Meesig in *Journal of Forensic Sciences*, Vol. 41, No. 6, pages 963–969, 1996.

Crime-Scene Investigation (Chapter Two) by J. Nickell and J.F. Fischer in *Crime Scene: Methods of Forensic Detection* (The University Press of Kentucky, Lexington, KY), pages 23–53, 1999.

What Educational Background Do Crime Laboratory Directors Require from Applicants? By K.G. Furton, Y.-L. Hsu, and M.D. Cole in *Journal of Forensic Sciences*, Vol. 44, No. 1, pages 128–132, 1999.

The Scene of the Crime (Chapter One) by N.E. Genge in *The Forensic Casebook: The Science of Crime Scene Investigation* (Ballantine Books, New York), pages 1–19, 2002.

At the Crime Scene by R. Platt in *Crime Scene: The Ultimate Guide to Forensic Science* (DK Publishing, New York), pages 11–23, 2003.

Crime Scene Investigation (Chapter 8) by M.T. Miller in *Forensic Science: An Introduction to Scientific and Investigative Techniques* (S.H. James and J.J. Nordby, Eds., CRC Press, Boca Raton, FL), pages 115–135, 2003.

The Crime Scene (Chapter One) by J.T. Dominick, S.A. Koehler, S. Ladham, R. Meyers, T. Uhrich, C.H. Wecht, and M. Welner in *Crime Scene Investigation* (Reader's Digest, Pleasanton, New York), pages 16–35, 2004.

Working the Scene: Evidence Collection and Protection (Chapter 3) by D.P. Lyle in *Forensics for Dummies* (Wiley Publishing, Hoboken, NJ), pages 29–48, 2004.

Profiling

Stalking on Campus: The Prevalence and Strategies for Coping with Stalking by W.J. Fremouw, D. Westrup, and J. Pennypacker in *Journal of Forensic Sciences*, Vol. 42, No. 4, pages 666–669, 1997.

An Investigation of the Psychological Characteristics of Stalkers: Empathy, Problem-Solving, Attachment and Borderline Personality Features by S.F. Lewis, W.J. Fremouw, K. Del Ben, and C. Farr in *Journal of Forensic Sciences*, Vol. 46, No. 1, pages 80–84, 2001.

- Communicated Threats and Violence Toward Public and Private Targets: Discerning Differences among Those Who Stalk and Attack** by J.R. Meloy in *Journal of Forensic Sciences*, Vol. 45, No. 5, pages 1211–1213, 2001.
- The Contract Murderer: Patterns, Characteristics, and Dynamics** by L.B. Schlesinger in *Journal of Forensic Sciences*, Vol. 46, No. 5, pages 1119–1123, 2001.
- Stalking: Developing an Empirical Typology to Classify Stalkers** by K. Del Ben and W. Fremouw in *Journal of Forensic Sciences*, Vol. 47, No. 1, pages 152–158, 2002.
- Criminal Personality Profiling** by M.R. Napier and K.P. Baker Miller in *Forensic Science: An Introduction to Scientific and Investigative Techniques* (S.H. James and J.J. Nordby, Eds., CRC Press, Boca Raton, FL), pages 531–550, 2003.
- A Day in the Life of a Criminal Profiler** by D.A. Wideman in *Crime Scene Investigation* by J.T. Dominick, S.A. Koehler, S. Ladham, R. Meyers, T. Uhrich, C.H. Wecht, and M. Welner (Reader's Digest, Pleasanton, New York), pages 16–35, 2004.
- A Case of Stalking in the Workplace and Subsequent Sexual Homicide** by K.A. Morrison in *Journal of Forensic Sciences*, Vol. 52, No. 3, pages 726–730.



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2

Lifting Prints

Vehicle Impound Lot, Monday 10:30 AM

Make the best of it. That's what her father always told her. Make the best of it. She would remind herself of that free wisdom whenever she found herself obligated to a situation that was unpleasant or otherwise not to her liking. Waves of doubt cresting with regret, however, surged over her as she stared at an anonymous white station wagon with a large dried-up pool of blood in the back, stuck in a forgotten corner of a police impound lot. Was taking this job the worst mistake she had ever made? What had she gotten herself into? This car had a secret, probably a dark and sinister one. It represented human beings at their worst, most desperate, and most depraved and forgiveness and trust as discarded and decayed as the dried bloodstain. There was nothing joyous here. Someone's life could have ended in that car. She struggled not to allow herself to detach from the reality she was now feeling so close to drowning in. Make the best of it. A degree in molecular biology, two years of postgraduate study, and work as a technician in a genetic analysis lab didn't prepare her for the psychology that she was now realizing had to be a necessary part of what she was taking on. And to make things as bad as possible, for her first day on the job, she's stuck with a pompous, arrogant, anal-retentive, gun-toting gasbag. *Make the best of it* now seemed little more than platitude.

"Don't you think, Miss Chang?"

"Huh?" Helen responded, bringing herself back to the moment.

"We should start collecting evidence, don't you think?" Jenkins asked dryly.

"Yeah. Okay."

"Of all the evidence we could collect from this vehicle, Miss Chang, which do you think is the most fragile—which one is in the most danger of being compromised?"

Helen didn't hesitate. "The blood, of course," she said, "because it would have the DNA."

"Well, if it is blood, it's been there for several months," said Jenkins. "It'll last a little while longer. In fact, you very eloquently demonstrated when you opened the hatchback door that it would be the fingerprints we'd need to worry about the most. And, by the way, we do have yours on file, don't we? We kind of need them now."

"They took them when I was hired," Helen replied. "But come on, do you think that after all the time this car's been out here, you could still get prints off it?"

"It's possible," Jenkins said. "Prints have been taken from ancient tombs. We might get something. Did you bring gloves?"

"I have some in my tackle box," Helen said. She pulled two latex gloves from a bag and deftly slipped them on. Jenkins snapped a pair from a dispensing box in his case. He tucked the fingers of his

left hand into the shape of an iguana's head and snapped one of the gloves around them. He stretched, pried, and pulled the glove over each finger until his hand was completely covered.

"You okay?" Helen asked, riveted by the spectacle.

"Just fine," Jenkins said, with a final snap of the last latex finger into place. "You know, putting on these gloves reminds me of a case in Wagga Wagga, Australia, back in the 1930s."

"Wagga Wagga?" Helen asked incredulously. "There's no such place."

"No, it's quite true. You'll like this story," Jenkins said.

"I'll like it? I'll reserve judgment on that."

"It was a Christmas day, and fisherman discovered a body snagged in the branches of a submerged tree limb in a river near Wagga Wagga. The body had been in the water for weeks and was badly decomposed—hard to ID. Bugs had chewed up much of the flesh, and it was peeling off the bone from decay. One hand was cut off and the other was mangled almost beyond recognition. It must have had a pretty foul stench to it and..."

"Are you trying to gross me out?" Helen interrupted, thinking she might have tasted the first hint of bile.

"Now why would I want to do that, Miss Chang?" Jenkins asked as he began to wrestle with the second latex glove.

"Ohhh, let me see. Because you hope I'll quit. Because you don't want me working on this case with you?"

"So, anyway," Jenkins continued, struggling to get all his fingers into their appropriate positions, "despite the poor condition of the corpse, the coroner could tell that the victim had taken several hard blows to the back of his skull. Detectives searched along the banks of the river for clues that might help them ID either the victim or a suspect. Stuck on a bush, out in the water, they found something that looked like a shriveled-up leather glove. But that wasn't what it was."

"Oh, here we go," Helen sighed.

"It was the skin of a right hand, hollowed out by maggots."

"I think I see where this is going."

"To recover fingerprints, one of the detectives slipped his own hand into the glove of human skin, inked the tips, and rolled the digits onto a fingerprint card. It worked surprisingly well. They were able to ID the guy."

"Who was he? Did they catch who killed him?" Helen asked.

"He was a drifter, and yes, yes, they did find his killer," Jenkins replied. "An acquaintance of his did him in—with an axe. There was something of a hiccup during the trial though. The prosecution's main witness was shot before he could testify—murdered by his own wife. She was trying to save the accused from the gallows. She had been having an affair with the murderer."

"Are you sure this is a true story and not something you dreamed up while watching reruns of *Jerry Springer*?"

“It’s quite true,” Jenkins said as he bent over for a closer look at the handle on the driver’s door. Helen crouched beside him. “I don’t see anything,” she said.

Jenkins brought himself upright with a groan—an involuntary sound effect he’d acquired around his 40th birthday and, from then on, always seemed to accompany his rising from a stooped position.

“You okay?” Helen asked.

“I’m fine,” Jenkins replied, irritated. “And you can stop asking me that.”

Jenkins drew a deep and deliberate breath. “There are three types of fingerprint impressions,” Jenkins began. “Prints made on surfaces that can hold the shape of the print—you know, on surfaces such as tar, clay, or a soft wax. They’re called plastic prints. Then, there are visible prints. Ones made by fingers coated with some transferable, colored liquid—grease, motor oil, paint, ink, blood. They may need no more processing than a good photograph. Then, there are the latent prints. The ones you can’t see, but they’re there. They have to be developed in some way to make them visible. This door handle could have latent prints.”

“Oh yeah,” Helen said, “We’re dusting for prints.”

“That’s one way to do it, yes. And that’s how we’re going to do it here. We’ll need to dust and photo-document a number of places,” Jenkins said, removing his equipment from his case. “We may only have one crack at this, so we’d better do a thorough job. We’ll start on the outside of the vehicle.”

“May I do one?” Helen asked.

“No,” Jenkins said quickly. “That is, it’s somewhat of an art. Let me take the first ones,” Jenkins said, placing the handle of the fingerprinting brush between his two palms and, rubbing his hands together back and forth, twirling the brush between them for several seconds. Helen watched inquisitively. “I’m removing any excess powder and fluffing up the brush,” he offered. “We’ll need ‘before’ and ‘after’ photos of each print location. We’ll begin with the door handles. Miss Chang, if you wouldn’t mind...”

With the digital camera, Helen took a close-up shot of the driver’s door handle.

Jenkins poured a small amount of dusting powder into the jar’s lid and dipped just the tip of the brush into the powder. “You have to make sure,” Jenkins said, “that you don’t take up too much powder into the brush. Too much can ruin a print.” In a gentle, circular motion, he then lightly brushed across the handle of the driver’s door. “You need to be careful here, too. You brush too much or too hard and that can also destroy a print. Stop when the print has become visible. Another photo please, Miss Chang.”

Click.

Jenkins then peeled a flat of lifting tape from its backing and rolled the tape over the area on the door handle that he’d just dusted. He rubbed the tape to give it a firm contact and then, grasping one end, peeled it from the door handle. Curling the tape outward in a loop and moving from one end of the tape to the other, he reaffixed the tape carrying the lifted print onto a white index card. On its reverse side, he jotted down the date, case number, print location, and his name.

Jenkins and Helen moved methodically around the vehicle, taking prints from door handles, from windows, and from the various parts of the vehicle’s body that Jenkins thought might carry latent prints. It was when moving around to the front of the vehicle—their last location—that the question Jenkins dreaded, but knew was coming, came.

“Can I try one now? Helen asked.

“Do you think you got the procedure?” Jenkins asked.

“Absolutely,” Helen replied.

Jenkins handed her the jar of dusting powder, but, as she moved to take it, the jar slipped from her hand. Jenkins grabbed it as it fell, but he succeeded only in batting the jar upward. The fine black powder burst over him like an exploding water balloon. The jar hit the pavement and rolled almost a yard, before it lost its momentum and stopped, teetering on its side.

“Oh, dear,” Helen said. “I am so sorry, Lieutenant Jenkins. Honestly.”

“Locard’s Exchange Principle, again, I suppose,” said Jenkins, spitting black dust from his mouth like a baseball player who’d just slid into home plate, face first.

Helen’s jaw had dropped.

Pinching and pulling out his shirt at the stomach, “Look,” Jenkins said glancing down, “I don’t think you can see the coffee stain anymore.”

“Oh my goodness,” Helen gasped. And then it happened. Involuntarily and without warning or conscious choice, a giggle began to percolate out of her. *No, not now!* Helen thought. *Not now!* She tried to suppress it, but that only made it worse. In seconds, she was convulsing in laughter, horrified and elated at the same time. “I’m sorry, Lieutenant,” she said through the bursts. “But you should see yourself. You look like the drummer for Kiss.”

“I need to clean up,” Jenkins said. “I’ll be back in a moment, and don’t touch anything. Is that clear?”

“Crystal,” Helen replied. “I’ll be right here, making the best of it.”

“What?”

“Nothing.”

As Jenkins walked back to the building, he tried to brush the powder off, but that only ground the dust in deeper. It smeared his chin, neck, and down the front of his shirt. He shuffled back into headquarters, hunching over as if he was soaking wet. He pressed his back against the swinging door of the men’s washroom and rolled in. A face stared back at him from a mirror above the washbasin. It was Captain White. A crooked grin torqued his face.

“Jenkins! What on earth? Is Gene Simmons looking for a new drummer?”

“Captain,” Jenkins started, “this isn’t working out. You know partners don’t work out well for me. Can we please put an end to this before I’m seriously injured or there’s a loss of life—like mine?”

“Have we been collecting prints?”

“Captain, please,” Jenkins pleaded.

“I’m counting on you, Jenkins, to help bring Miss Chang up to speed. Your experience with Detective Juarez cannot forever prevent you from working with a partner.”

“Detective Juarez really did try to kill me!”

“That was five years ago, Juarez is in the big house, and you’ve got to move on.”

“But Captain, she’s just a kid for crying out loud. And you should see...”

“You’ll be fine.”

There it was again.

Recovering Fingerprints

The crux to solving almost every crime, whether it is burglary, forgery, assault, automobile theft, or homicide, hinges on placing the suspect at the crime scene. No other forensic technique is used more often to associate a person with an article of evidence than fingerprinting.

Your fingerprints and the patterns of grooves and ridges that swirl on the gripping sides of your fingertips, as well as those on your palms, toes, and the soles of your feet, are formed in the womb, and their patterns stay with you, unchanged, for your entire life. Although they serve a common purpose—to provide friction for gripping and walking—each person’s prints are unique. Even genetically indistinguishable identical twins differ by their fingerprints.

Dr. Henry Faulds, a Scottish physician, having observed fingerprints on ancient samples of pottery, proposed in an 1880 letter to the British journal, *Nature*, that fingerprints could be used as a means to positively identify individual people. None other than the extraordinary English scientist, explorer, and mathematician Sir Francis Galton took up a comprehensive study of fingerprint patterns and published his work in 1892. He identified the three major patterns—loops, arches, and whorls. That same year, Sir Edward Henry, an India police officer, and Juan Vucetich, an inspector with the police department in La Plata, Argentina, applied fingerprint identification to the prosecution of criminal acts, and from that point on, forensic science changed forever. The first person convicted of murder on the basis of fingerprint evidence occurred in 1910. Because fingerprinting has become so familiar, juries readily accept fingerprints as evidence in a court of law, without a need for lengthy or elaborate explanations from expert witness as to their worth in placing a suspect at a crime scene.

Impressions left by fingerprints fall into three types: visible, plastic (also called patent, impression, indentation, or molded), and latent (invisible to the naked eye). *Visible prints* are formed from fingers soiled with soot, dirt, ink, paint, grease, motor oil, blood, or some other liquid or powder, making them readily apparent. *Plastic prints* form by finger contact with a moldable substance such as clay, calking, putty, wet paint, and soap. *Latent fingerprints* are formed by sweat and oils of the skin and are the type most frequently pursued by the forensic detective.

Dusting for Prints

So common is the practice of *dusting for prints* that almost everyone has heard the term, seen it done on television crime shows, or been personally involved in its use during an actual criminal investigation. Dusting involves the use of a soft brush to lightly coat a surface carrying a fingerprint with a powder made from finely ground carbon, charcoal, titanium, or aluminum (Figure 2.1). The powder sticks to the lines of sweat and oil left by a fingertip’s ridges. The exposed fingerprint can then be lifted by adhesive tape and placed on a paper card or a sheet of acetate as



Figure 2.1 A criminalist dusts for fingerprints.

a permanent record. More recently, iron filings applied with a magnetic wand have been introduced as another method for dusting prints.

Although black powder is the most frequently used material for dusting, powders of other colors can be used to enhance a fingerprint's contrast against backgrounds of different shades.

Porous surfaces such as paper and cardboard can absorb a fingerprint's sweat and oil and therefore may not readily yield a fingerprint pattern when dusted with standard dusting powder (though magnetic powder can often still provide a discernible result). For these surfaces, chemical reagents such as 1,8-diazafluoren-9-one (DFO) will make prints glow under laser, ultraviolet (UV), or blue-green light. Another chemical called silver nitrate reacts with the salt in human sweat to make silver chloride and a reddish-brown print under UV light. Yet another chemical agent, ninhydrin (triketohydrindene hydrate), makes prints turn purple blue under standard white light.

Fuming

Yet another method for bringing up latent prints is known as chemical *fuming*. Forensic scientists have used iodine for this purpose for almost 100 years. In this technique, the object carrying latent prints is normally suspended in a closed chamber in which warmed iodine crystals sublime directly into vapor, filling the air within the chamber. The iodine fumes, reacting with the sweat and oil from the fingerprint's ridges, form brownish prints. As the prints developed by iodine fuming fade rapidly, a photograph must be taken quickly as a permanent record.

A second fuming method, and a very intriguing one, was discovered by accident during the late 1970s, when a hair and fiber expert with the National Police Agency of Japan kept finding his fingerprints turning up as white, chalky patterns on the microscope slides that he was using to mount hairs with Super Glue (known to a chemist as cyanoacrylate). A friend of his, a fingerprint specialist with the laboratory, refined the technique as a general-purpose method for developing prints.

Since Super Glue vapors are toxic, fuming is performed in an enclosure held within a fume hood ([Figure 2.2](#)). From several drops to a couple milliliters of Super

Glue are dispensed within a small aluminum container held on a warming plate (such as that used to heat a cup of coffee). A beaker of warm water is placed within the enclosure to provide humidity. As Super Glue is heated, vapors are released. These vapors bind to trace amino acids, proteins, and fatty acids on the fingerprint. After about an hour, the print is usually developed enough, and a photograph can be taken ([Figure 2.3](#)). Alternatively, a fluorescent dye can be applied to enhance the contrast, and the fingerprint can then be photographed under laser or UV light.

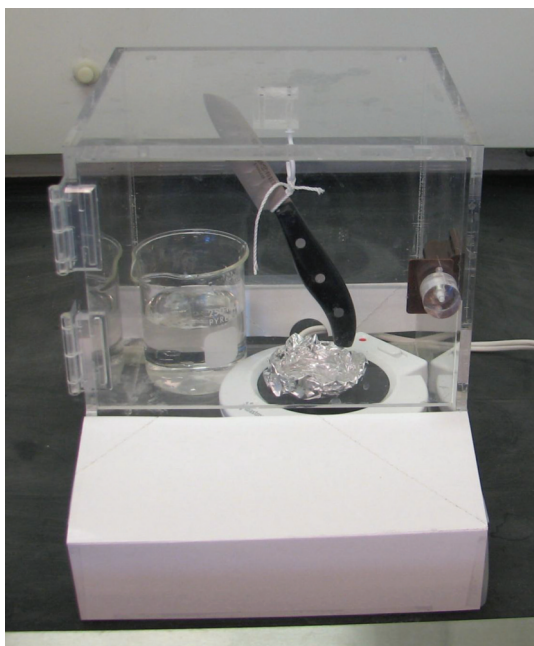


Figure 2.2 Super Glue fuming to develop fingerprints. Fuming should be conducted in an airtight enclosure placed within a fume hood. The glue is poured onto a folded piece of aluminum foil and heated by a mug warmer. Heated water is placed in the fuming chamber to aid in the development of the print. In this picture, a knife is suspended in the fuming chamber above the mug warmer.



Figure 2.3 A fingerprint developed by Super Glue fuming.

Developing Prints on Thermal Paper

A method for developing latent prints left on thermal paper such as a gas, restaurant, or ATM receipt was developed by Dr. John W. Bond of the scientific support unit of the Northamptonshire Police in the United Kingdom. Thermal paper printing is a heat-activated acid–base chemical reaction. The upper layer of the paper is made from an acid-sensitive dye. The lower layer is made of a heat-sensitive acid matrix. When the paper is heated, the heat-sensitive acid matrix releases protons into the upper layer of the paper, making the pH more acidic. The chemical dye impregnated in the upper layer is colorless. However, when it accepts the released protons, the dye changes from colorless to black.

How Latent Fingerprints Form on Thermal Paper

Our skin and hands possess numerous sweat glands (the sebaceous and eccrine glands) that secrete water, salts, oils, acids, sugars, and amino acids. If a finger touches the thermal paper, these various chemicals are transferred onto the paper's surface and affect the solubility of the impregnated dye. This mixture of sweat secretions introduces polar protic solvents that serve as a source of protons actuating the color change. Another contributor to the reaction is the polar amino acid lysine found within the pool of amino acids in fingerprint sweat. When the thermal paper is heated, lysine acts as a proton donor, triggering the dye transformation and rendering fingerprint ridges visible ([Figure 2.4](#)).

Dr. John W. Bond also developed a method for visualizing latent prints left on shell casings. Certain firearms require manual loading of live bullets into the weapon's chamber. In so doing, fingerprint salts and oils are transferred onto the metal shell casing surface. If the casing is heated to about 600°C, the salts corrode the metal surface, leaving behind a permanent fingerprint. The quality of the print is dependent on the type of metal surface, the amount of salts deposited,

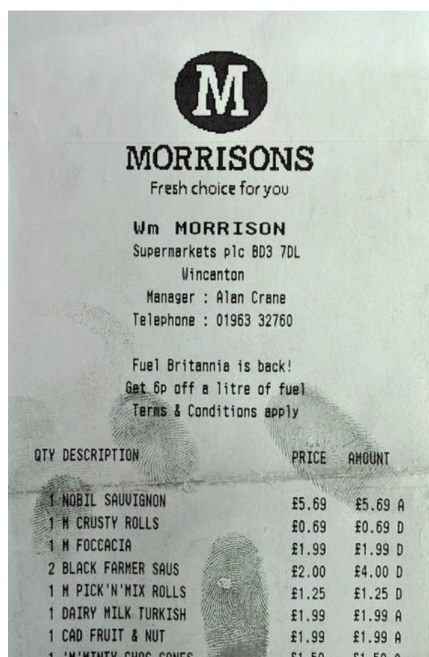


Figure 2.4 Fingerprints developed on a receipt using Consolite Forensics' Hot Print System.

and the length of time allowed for print development. The print can be enhanced by charging the shell casing surface and applying a metallic powder that adheres to the salt-corroded fingerprint ridge pattern.

Photography

Photography of prints developed by dusting or fuming can be done with a standard digital camera and standard lighting. But latent prints may also become visible with no chemical enhancement by shining a laser light or light of different wavelengths on the surface carrying the print. For example, a print made from fingers contaminated with motor oil will glow under UV light. Latent prints, particularly on glass or plastic, can often become visible simply by changing the angle of the light source. UV light can help to bring out the pattern of prints developed by fuming with Super Glue. An argon ion laser can bring out prints refractory to other visualization methods.

In the Crime Lab

Activity 2.1 Making a Fingerprint Reference Set with an Inkless Pad

A reference set of fingerprints is routinely taken from those people employed by state or national government laboratories and from those arrested or under suspicion of committing a crime. In this activity, you will gain proficiency in making a set of fingerprints. Your fingers can be designated as shown in [Figure 2.5](#).

Materials:

- Inkless fingerprint pad
- Practice sheet for right- and left-hand fingerprint impressions
- Fingerprint ID card
- Scotch tape
- Scissors

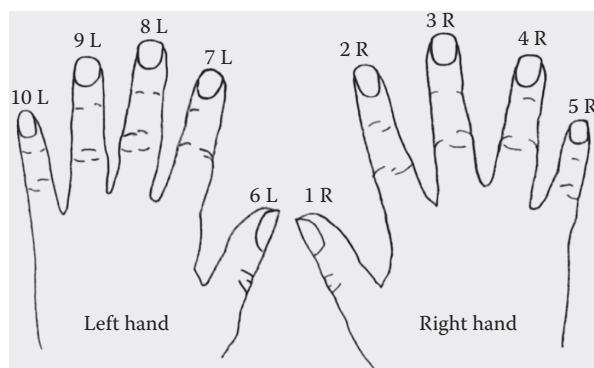
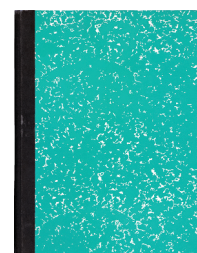


Figure 2.5 Numbering system for the fingers of the left and right hands. In the Crime Lab, renumbered picture showing hands (left/right), originally 002 × 004.eps, (assume this is the number associated w/ the left/right hand drawing) is now 002 × 005.eps, [Figure 2.4](#), is now [Figure 2.5](#).

Protocol:

Make a set of practice and reference fingerprints by using the following steps:

1. Press the lateral edge of your fingertip onto an inkless pad. Using a rolling-type motion, rotate your fingertip in a left-to-right or right-to-left manner against the ink pad. Make sure that ink completely covers your fingertip ridges.



2. Check the tip of your finger to ensure an even spread of ink on the ridge surfaces (but not within the furrows between the ridges). If too much ink is present, dab some of it off on a clean paper towel.



3. Move the paper toward the edge of your desk, and when you go to roll your inked finger, position your lower arm parallel to the floor. When transferring your thumbprint, roll your thumb towards your body. For all other fingerprint transfers, roll your fingertips away your body. Applying even, light, and continuous pressure, gently roll your inked finger onto the appropriate position on the left- or right-hand practice sheet (provided by your instructor). The impression left on the paper should appear like a square. Make five impressions for each finger. It is not necessary to reink your finger between print transfers. Once you have rolled your fingertip onto the practice sheet, do not roll it back over the initial transfer. This will cause smudging and result in an unreadable print.



4. Once you have completed all 10 digits, have your instructor circle the best print of each digit. Using scissors, cut the print from the practice sheet and mount it onto the fingerprint ID form with tape. Hand in your set of fingerprints to your instructor. These will be analyzed in [Chapter 14](#).