a. A key element of document examination focuses on handwriting, which includes hand printing and signatures.

b. Despite minor variations due to type of writing instrument, mood, age or stress, everyone's handwriting has their own unique style.

\* Once a person starts writing subconsciously, characters form as a result of habit and unique handwriting is formed.

d. Handwriting examination and comparison is based on three main principles:
   i. Given a sufficient amount of handwriting, no two skilled writers exhibit identical handwriting features.
   ii. Every person has a range of natural variation to his or her writing.
   1. No one writes with machine-like precision every time, and variations are evident in a person's handwriting even within the same document. For example, if a person writes an entire page of signatures, each one will vary slightly. A trained forensic document examiner can discriminate between natural variations in a writer's own handwriting and significant differences denoting different writers.
   iii. No writer can exceed his or her skill level (for example, it would not be possible for a person who has only learned to produce very basic hand-printed letters to execute perfectly formed, highly skilled cursive writing).

c. Major factors influencing handwriting:
   i. Size of fingers, hands, arms
   ii. Muscular makeup
   iii. Education
   iv. Style and personality

Before fingerprints, retinal scans, or DNA, our signatures served as our identifying “mark” for thousands of years. As we progressed from stone to papyrus to paper, the signature has served to identify artists, solidify contracts, and communicate the personal messages of writers.
12 Major Characteristics of Handwriting:

i. **Line Quality** - Do the letters flow or are they erratic and shaky?
   
   *Smooth*: Jack and Jill went up the Hill.
   *Shaky or nervous*: Jack and Jill went up the hill.

   a. forensics science
   b. forensics science
   c. forensics science
   d. forensics science

ii. **Spacing** - Are the letters equally spaced or crowded?
   
   *I am having good morning.*
   *I am having good morning.*
   *I am having good morning.*
   *I am having good morning.*

   a. the lazy
   b. the lazy
   c. the lazy
   d. the lazy

iii. **Size Consistency** - Is the ratio of height to width consistent or inconsistent?
   
   a. *The Right of the People*
   b. *The Right of the People*
   c. *The Right of the People*
   d. *The Right of the People*

iv. **Continuous** - Is the writing continuous or does the writer lift the pen?
   
   a. forensics science
   b. forensics science
   c. forensics science
   d. forensics science

   Generally, the same sort of living costs less in the country than in the city.
   She was long gone. The sound of thunder.

v. **Connecting Letters** - Are capital and lowercase letter connected and continuous or not?
   
   a. *Across the River*
   b. *Across the River*
   c. *Across the River*
   d. *Across the River*

   *Elizabeth*
   *Before we part...*
vi. **Lettering Complete** - Are the letters formed completely or are parts missing?

![Image of handwritten text](image1)

vii. **Cursive and Printed Letters** - Are the letters printed, written in cursive, or both?

![Image of handwritten text](image2)

viii. **Pen Pressure** - Is the pressure equal or unequal when applied to upward and downward strokes?

<table>
<thead>
<tr>
<th>Heavy Pressure</th>
<th>Light Pressure</th>
</tr>
</thead>
<tbody>
<tr>
<td>forensic science</td>
<td>forensic science</td>
</tr>
<tr>
<td>forensic science</td>
<td>forensic science</td>
</tr>
</tbody>
</table>

![Image of handwritten text](image3)

ix. **Slant** - Is there a slant? Is it left, right, or variable?

![Image of slant diagram](image4)

![Image of handwritten text](image5)
x. **Line Habits** - Is the text on, above, or below the line?

Straight on line:

Jack and Jill went up the hill.

Words leave baseline below it:

Jack and Jill went up the hill.

Words start from baseline:

Jack and Jill went up the hill.

2(a)

I am a doctor

2(b)

To far wonderful year

xi. **Fancy Curls or Loops** - Are there fancy curls or loops on any of the letters?

Love and kisses!

Minnie Mouse

XOXO

Sincerely,

Ernie

f. **Placement of crosses on t’s and dots on i’s** - Is the placement correct? Are t’s crossed high, low, or middle? Are the dots on the i to the left, right, or centered?

Are t’s crossed?


Are i’s dotted?


right right right right

f. **Margins** - Experts can also look at formatting, such as the margins a writer leaves empty on the page.
a. In order to analyze handwriting, a forensic expert also needs an **exemplar**, which is a known sample of the suspect’s writing, which can be compared to the questioned document.

1. **Collected writing specimens**: writings that were completed by the subject prior to the investigation.
   a. These might include letters, diaries, cards, personal notes, cancelled checks, signed receipts, tax records, or other signed legal documents.

ii. The investigator should obtain known writing samples that are **similar in character** to the document in question.
   1. If it is written in **cursive**, it should be compared to known cursive writing.
   2. If it contains upper and lowercase letters, the known writings must also contain upper and lowercase letters.
   3. Wherever possible, the investigator should also obtain known writing containing similar combinations of letters and numbers seen in the questioned documents.
   4. For comparison purposes, it is recommended that investigators obtain **20–30** repetitions of signatures, **15–20** repetitions of bank checks, 3–4 repetitions of entire written letters.

2. **Requested writing specimens**: writings dictated by the investigator to the writer.
   a. These are used primarily when collected writing specimens are not readily **available** and the suspect is asked to write a sample under carefully controlled conditions, with the writer being closely monitored.
   b. It is best not to inform the suspect of the **intention** of comparison.
   • **Known samples should be as similar as possible to the questioned document.**
   • Including the writing implement, paper, and words written.
iii. The investigator should also attempt to obtain known writing that is prepared around the same time period as the questioned writing.

1. This is particularly important in cases involving writing from young people (up to mid-teens), as writing formation may still be at a developmental stage, and by elderly persons, as writing may deteriorate with age or illness.

b. The expert will examine the questionable document for detectable traits and record them.

c. Finally, the expert will compare and draw conclusions about the authorship of the questionable document.

i. If a sufficient amount of evidence is submitted, an examiner will reach a conclusion that may range from identification (a definitive determination of authorship or source) to elimination (a definitive determination of non-authorship or from another source).

1. Two writings came from one person if their similarities are unique and no unexplainable differences are found.

“Handwriting comparisons are based on the principles that no two people write exactly alike and that characteristics reoccur throughout every person’s writing, although no one writes exactly the same way twice. This combination of characteristics is unique to every individual and is used by document examiners for comparison.” -- http://www.fbi.gov
ii. If no determination can be made based on the evidence, the examiner will issue an inconclusive result.

iii. Most laboratories also permit a broader range of conclusions, called qualified conclusions, that fall somewhere in between the definitive conclusions of identification or elimination.

iv. Many practitioners also choose to provide a defining description of the results of their examination. For instance, for a handwriting exam, identification may be phrased, “The evidence very strongly supports the proposition that the questioned writing was written by the writer of the specimens.”

---

**Handwriting Analysis Activity:**

**Activity:**
Copy the following sentence and numbers two times.

**Copy:**
The quick brown fox jumps over the lazy dog. 1234567890

- Do you know why this sentence is used?
- Look for unique characteristics in your handwriting. Focus on each of the 12 elements we discussed in class (Data table on next slide).
- Discuss your results and compare with a classmate.

---

**Handwriting Analysis Activity:**

**Data Table**

<table>
<thead>
<tr>
<th>Question</th>
<th>Yes</th>
<th>No</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Are the letters uniform?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Are words and margins evenly spaced?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Is the ratio of small letters to capital letters consistent?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Is the writing continuous?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. Are capital letters linked?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. Are capital letters upright?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7. Are the letters connected?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8. Are capital letters written with a single motion?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9. Are capital letters written with a single motion?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10. Are all letters written on the line?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11. Are there fancy curls or loops?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12. Are all small letters uniform?</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

---

**Shortcomings in Handwriting Analysis**

Although an experienced document expert can detect many cases of forgery, some may be missed.

Difficulties can occur when:
- Not enough known samples to use for a comparison
- Questioned writing contains only a few words
- Writing is deliberately disguised
- Drugs or alcohol alter writing habits

To help eliminate deception:
- Require several pages of writing
- Write from dictation
- Do not show the suspect the questioned document or give direction on spelling or punctuation
- Write the desired text at least three times
- Combine signature with other writing
Additional Activity:

- Each student in the class is to find an old writing assignment. Tear off the top corner so your name is removed (Keep the missing piece, this is another great way to show how matches can be found and will be used and the 'answer key' later). Teacher will collect these, shuffle, and randomly pass them back out to students.

- Students should display their exemplars (created using the previous slide) around the room.

- Students are to circulate the room until they have identified who their paper belongs to.

- When all students think they have found their match, have them compare with the missing corners. Is it a match?

b. Initial comparisons are done with the naked eye, a handheld **lens**, an illuminated magnifier, or **microscope**.

c. Later, **infrared** spectrometers may be used to determine if more than one type of **ink** was used, based on **wavelengths** of light absorbed and reflected by each type of ink.

d. Many forensic document examiners use only **non-destructive** techniques that use light and/or electrostatic detection to examine documents for indented impression evidence or ink differentiation.
Forensic investigators have access to tools and machines that enable them to read a letter where the ink has been washed away, see what lies beneath scribbles and read a letter from indentations left on another sheet of paper.

i. **Electrostatic Detection Device (EDD)** - Revealing text from indented impressions
   1. An Electrostatic Detection Apparatus (ESDA) uses the principle that indented areas of a document carry less negative charge than surrounding areas. This causes the toner used in the EDD to be attracted to these areas, revealing indentations that are present.

ii. **Video Spectral Comparator (VSC)** - Detecting alterations, obliterations, erasures and page substitutions.
   1. Alterations, obliterations and erasures not visible to the human eye can often be detected through use of photography and other imaging devices that utilize ultraviolet and infrared wavelengths of light.
   2. Using radiation filtered at various wavelengths, an imaging instrument such as a video spectral comparator (VSC) can reveal writing that has been added with a different ink, or has been altered or removed by exploiting variations in the way different inks respond to different wavelengths of light.

---

2. Using this technique, indented impressions have been recovered from up to seven layers of paper beneath the original writings. Research has demonstrated that impressions can be successfully visualized from documents up to 60 years old, provided the papers are not mishandled or stored improperly.

- **Video Spectral Comparator**: used to analyze inks and see whether they are the same or different. Document examiners look at them under different lighting conditions where some wavelengths of light are blocked. This can uncover layers in documents where words have been scribbled out or written over.
- **Infrared Reflectance**: used to show the residue of pencil marks. This can be done clearly even if the writing has been erased. Pencils are made of graphite which is a form of carbon – and this absorbs infrared light well.
- **Thin Layered Chromatography**: used to separate and leave a unique pattern for each ink for identification. Inks are made up of different compounds; the mixtures are often copyrighted so each company has its own.
### iii. Chromatography

Determining individual dye components

i. Chromatography is a family of techniques used for separating mixtures. It involves a small cutting from the questioned document being dissolved in a solvent then analyzed. This is one of the few **destructive** techniques employed by the document examiner. The inks can be compared to the International Ink Library, a database maintained by the U.S. Secret Service that contains data on more than 9,500 inks that have been manufactured since 1920.

<table>
<thead>
<tr>
<th>Chromatogram Image</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1" alt="Chromatogram" /></td>
</tr>
<tr>
<td><img src="image2" alt="Chromatogram" /></td>
</tr>
<tr>
<td><img src="image3" alt="Chromatogram" /></td>
</tr>
</tbody>
</table>

### f. During handwriting analyses, examiners compare samples provided from particular populations.

i. Certain agencies, such as the U.S. Secret Service and the German Federal Police, maintain larger databases. For example, the Forensic Information System for Handwriting (FISH) maintained by the U.S. Secret Service Forensic Laboratory contains handwriting samples from tens of thousands of writers.

<table>
<thead>
<tr>
<th>Forensic Document Image</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image4" alt="Forensic Document" /></td>
</tr>
</tbody>
</table>

### e. For analyses of documents created by print machines, examiners may rely on various databases created for comparison purposes.

i. Documents created on a typewriter or printed with inkjet, laser printers, fax machines and photocopiers may be sourced to a particular make or model, or even to a specific machine.

ii. When possible, the examiner should obtain **known standards** and any available accessories from the machine in question and the machine itself should be **submitted** for examination.

### g. Technology can also assist experts in analysis

i. Signature recognition research in the 1970s focused on the use of static or **geometric** characteristics (what the signature looks like).

ii. Today’s machines with touch sensitive technologies allow **dynamic** characteristics (how the signature was made).

iii. **Biometric** Signature Pads are programmed to evaluate the **speed**, pressure, and rhythm of a person's signature and are able to recognize how a person writes so that it can easily **detect** differences and recognize forgeries.

iv. Behavioral biometrics such as signature pressure profiles are a growing focus for the **security** and biometrics community.

<table>
<thead>
<tr>
<th>Technology Image</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image5" alt="Technology" /></td>
</tr>
</tbody>
</table>
The signature pad represents the “xy” coordinates of a graph. The pad senses the electro-static presence of the stylus. As it “writes” the signature, the software records its location at regular intervals, most commonly every 1/100 of a second.