Current Technology Used in the Laboratory

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Goals

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    - Measuring Devices
    - Mass/weight, force
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      - Mass/weight, force
      - Dimensional
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      - Dimensional
    - The types of measurements collected
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      - Purpose
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    - Microscopes
    - Measuring Devices
      - Mass/weight, force
      - Dimensional
    - The types of measurements collected
      - Purpose
      - Possible issues
Microscopes

- Stereomicroscope
  “An optical instrument, which provides three dimensional viewing of an object through paired objectives and eyepieces. Some models share a common main objective”  
  AFTE Glossary, 5th Edition
Microscopes

- Stereomicroscope
Microscopes

- Stereomicroscope
  - Provides magnification
Microscopes

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  - Provides magnification
  - Provides stereoscopic view
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  - Provides stereoscopic view
  - Allows for less restricted manipulation of items
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  - May be used in conjunction with standard measuring devices
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  - Provides magnification
  - Provides stereoscopic view
  - Allows for less restricted manipulation of items
  - May be used in conjunction with standard measuring devices
  - Bridges the gap between visual examination of items and the use of the comparison microscope
Microscopes

- Stereomicroscope
  - Greenough
Microscopes

- Stereomicroscope
  - Greenough
    - Two identical optical systems slightly offset to create the stereoscopic effect
Microscopes

- Stereomicroscope
  - Greenough
    - Two identical optical systems slightly offset to create the stereoscopic effect
  - Rugged
Microscopes

- Stereomicroscope
  - Greenough
    - Two identical optical systems slightly offset to create the stereoscopic effect
  - Rugged
  - Compact
Microscopes

- Stereomicroscope
  - Greenough
    - Two identical optical systems slightly offset to create the stereoscopic effect
    - Rugged
    - Compact
    - Relatively inexpensive
Microscopes

Stereomicroscope

- Common Main Objective (CMO)

Image courtesy of Nikon’s MicroscopyU
Microscopes

- Stereomicroscope
  - Common Main Objective (CMO)
    - Single, large diameter objective lens
Microscopes

Stereomicroscope

- Common Main Objective (CMO)
  - Single, large diameter objective lens
  - Collimated light path
  - Accessories can be introduced into the infinity space with little to no image aberrations

Image courtesy of Nikon’s MicroscopyU
Microscopes

- **Stereomicroscope**
  - **Common Main Objective (CMO)**
    - Single, large diameter objective lens
    - Collimated light path
      - Accessories can be introduced into the infinity space with little to no image aberrations
    - Can cost several times as much as a Greenough-type
Comparison of CMO and Greenough Stereomicroscope Designs

![Comparison of CMO and Greenough Stereomicroscope Designs](image.png)

**Figure 4**

- Eyepiece
- Prism
- Objective
- Stage
- Base

Image courtesy of Nikon’s MicroscopyU
Microscopes

- Comparison Microscope
  “Essentially two microscopes connected to an optical bridge which allows the viewer to observe two objects simultaneously with the same degree of magnification. This instrument can have a monocular or binocular eyepiece. Sometimes referred to as a COMPARISON MACROSCOPE.”

AFTE Glossary, 5th Edition
Microscopes

- Comparison Microscope
Microscopes

- Comparison Microscope
Microscopes

- Comparison Microscope
  - Instrument by which fired ammunition components are directly compared to one another
Bullets Fired from the Same Barrel
Cartridge Cases Fired in the Same Firearm
Microscopes

- **Comparison Microscope**
  - Instrument by which fired ammunition components are directly compared to one another
  - Has remained largely unchanged since it’s introduction
Microscopes

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    - Objectives typically range from .5x to 4x
    - Total magnification from 2.5x to 40x
  - May be used in conjunction with standard measuring devices
Measuring Devices – Weight/Mass, Force

- Powder Balance
Measuring Devices – Weight/Mass, Force

- Powder Balance
- Mass of bullet
Measuring Devices – Weight/Mass, Force

- Powder Balance
  - Mass of bullet
  - Aid in caliber determination
Measuring Devices – Weight/Mass, Force

- Powder Balance
  - Mass of bullet
    - Aid in caliber determination
  - Mass of powder
Measuring Devices – Weight/Mass, Force

- Powder Balance
  - Mass of bullet
    - Aid in caliber determination
  - Mass of powder
    - Downloading cartridges
Measuring Devices – Weight/Mass, Force

- Powder Balance
  - Mass of bullet
    - Aid in caliber determination
  - Mass of powder
    - Downloading cartridges
    - Reloaded/handloaded cartridges
Measuring Devices – Weight/Mass, Force

- Trigger Pull
Measuring Devices – Weight/Mass, Force

- Trigger Pull
  - An indication of how much force needs to be applied to the trigger of a firearm to cause it to fire
Measuring Devices – Weight/Mass, Force

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  - A large portion of the community represents this in terms of pounds
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    • Weight is an easier term for most jurors to understand
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    - Relatively easy to determine if the firearm is in the “normal” range
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  - Some agencies may use this information to form a conclusion with regards to accidental/unintentional shooting cases
Measuring Devices – Weight/Mass, Force

- Arsenal weights
Measuring Devices – Weight/Mass, Force

- Arsenal weights
  - Increasing amounts of weight added until trigger releases sear
Measuring Devices – Weight/Mass, Force

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  - Increasing amounts of weight added until trigger releases sear
  - Repeated to determine consistency
Measuring Devices – Weight/Mass, Force

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Measuring Devices – Weight/Mass, Force

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- Gives results on a par with the firearms manufacturing industry
- Momentum not considered in results
Measuring Devices – Weight/Mass, Force

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  - Increasing amounts of weight added until trigger releases sear
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- Gives results on a par with the firearms manufacturing industry
- Momentum not considered in results
- Poor technique yields poor results
Measuring Devices – Weight/Mass, Force

- Spring gauge
Measuring Devices – Weight/Mass, Force

- Spring gauge
  - Increasing amounts of pressure applied until trigger releases sear
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  - Repeated to determine consistency
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- Poor technique yields poor results
Measuring Devices – Weight/Mass, Force

- Force gauge
Measuring Devices – Weight/Mass, Force

- Force gauge
- Automated models that recognize when the trigger “breaks”
Measuring Devices – Weight/Mass, Force

- Force gauge
- Automated models that recognize when the trigger “breaks”
- Measurements given in Joules or Inch-Pound Force
Measuring Devices - Dimensional

- Rulers, Tape Measures, Machinist’s Scales, etc.
Measuring Devices - Dimensional

- Rulers, Tape Measures, Machinist’s Scales, etc.
  - Used for simple, straight-line dimensions on firearms and attachments
Measuring Devices - Dimensional

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  - Used for simple, straight-line dimensions on firearms and attachments
    - Overall length of firearms
Measuring Devices - Dimensional

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  - Used for simple, straight-line dimensions on firearms and attachments
    - Overall length of firearms
    - Barrel length of firearms
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  - May be inexpensive, simple devices
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  - Should be certified and traceable to a NIST standard
    - Used for critical measurements
Measuring Devices - Dimensional

- Barrel Length and Overall Length
  - The term "short-barreled shotgun" means a shotgun having one or more barrels less than eighteen inches in length and any weapon made from a shotgun (whether by alteration, modification, or otherwise) if such weapon as modified has an overall length of less than twenty-six inches.
Measuring Devices - Dimensional

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  - The term "short-barreled rifle" means a rifle having one or more barrels less than sixteen inches in length and any weapon made from a rifle (whether by alteration, modification, or otherwise) if such weapon, as modified, has an overall length of less than twenty-six inches.
Measuring Devices - Dimensional

- Barrel Length and Overall Length
Measuring Devices - Dimensional

- Barrel Length and Overall Length
  - An example of a “critical measurement”
Measuring Devices - Dimensional

- Barrel Length and Overall Length
  - An example of a “critical measurement”
  - One of the few measurements that is included in the report
Measuring Devices - Dimensional

- Barrel Length and Overall Length
  - An example of a “critical measurement”
  - One of the few measurements that is included in the report
  - Additional charges may be leveled based on the measurements collected and reported
Measuring Devices - Dimensional

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  - One of the few measurements that is included in the report
  - Additional charges may be leveled based on the measurements collected and reported
    - Use of certified measuring devices
Measuring Devices - Dimensional

- Barrel Length and Overall Length
  - An example of a “critical measurement”
  - One of the few measurements that is included in the report
  - Additional charges may be leveled based on the measurements collected and reported
    - Use of certified measuring devices
    - Calculation of Measurement Uncertainty
Measuring Devices - Dimensional

- Micrometer
Measuring Devices - Dimensional

- Micrometer
  - Used for dimensional measurements on fired evidence
Measuring Devices - Dimensional

- Micrometer
  - Used for dimensional measurements on fired evidence
  - Determining caliber for cartridge cases with inadequate/misleading headstamp markings
Measuring Devices - Dimensional

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  - Determining caliber for cartridge cases with inadequate/misleading headstamp markings
  - Caliber of fired bullets
Measuring Devices - Dimensional

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  - Determining caliber for cartridge cases with inadequate/misleading headstamp markings
  - Caliber of fired bullets
    - Diameter of bearing surface
Measuring Devices - Dimensional

- Micrometer
  - Used for dimensional measurements on fired evidence
  - Determining caliber for cartridge cases with inadequate/misleading headstamp markings
  - Caliber of fired bullets
    - Diameter of bearing surface
    - Width of land and groove impressions
Measuring Devices - Dimensional

- **Micrometer**
  - Used for dimensional measurements on fired evidence
  - Determining caliber for cartridge cases with inadequate/misleading headstamp markings
  - Caliber of fired bullets
    - Diameter of bearing surface
    - Width of land and groove impressions
    - When used in conjunction with stereo or comparison microscope
Measuring Devices - Dimensional

- **Micrometer**
  - Used for dimensional measurements on fired evidence
    - Determining caliber for cartridge cases with inadequate/misleading headstamp markings
  - Caliber of fired bullets
    - Diameter of bearing surface
    - Width of land and groove impressions
      - When used in conjunction with stereo or comparison microscope
  - Various levels of quality and readout
Measuring Devices - Dimensional

- Micrometer
  - Used for dimensional measurements on fired evidence
  - Determining caliber for cartridge cases with inadequate/misleading headstamp markings
  - Caliber of fired bullets
    - Diameter of bearing surface
    - Width of land and groove impressions
      - When used in conjunction with stereo or comparison microscope
  - Various levels of quality and readout
  - Typically are periodically checked against a NIST certified gauge block
Measuring Devices - Dimensional

- Caliper
Measuring Devices - Dimensional

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    - Caliber of fired bullets
      - Diameter of bearing surface
      - Width of land and groove impressions
        - When used in conjunction with stereo or comparison microscope
  - Various levels of quality and readout
  - Typically are periodically checked against a NIST certified gauge block
Measuring Devices - Dimensional

- Reticules
Measuring Devices - Dimensional

- Reticules
  - Employed as a component of a stereo or comparison microscope
Measuring Devices - Dimensional

- Reticules
  - Employed as a component of a stereo or comparison microscope
  - Used for small scale dimensional measurements on fired evidence
Measuring Devices - Dimensional

- Reticules
  - Employed as a component of a stereo or comparison microscope
  - Used for small scale dimensional measurements on fired evidence
  - Caliber of fired bullets
Measuring Devices - Dimensional

- Reticules
  - Employed as a component of a stereo or comparison microscope
  - Used for small scale dimensional measurements on fired evidence
    - Caliber of fired bullets
    - Diameter of bearing surface
Measuring Devices - Dimensional

• Reticules
  • Employed as a component of a stereo or comparison microscope
  • Used for small scale dimensional measurements on fired evidence
    • Caliber of fired bullets
      • Diameter of bearing surface
      • Width of land and groove impressions
Measuring Devices - Dimensional

- Reticules
  - Employed as a component of a stereo or comparison microscope
  - Used for small scale dimensional measurements on fired evidence
    - Caliber of fired bullets
      - Diameter of bearing surface
      - Width of land and groove impressions
  - Ocular with etched division lines
Measuring Devices - Dimensional

- Reticules
  - Employed as a component of a stereo or comparison microscope
  - Used for small scale dimensional measurements on fired evidence
    - Caliber of fired bullets
      - Diameter of bearing surface
      - Width of land and groove impressions
  - Ocular with etched division lines
  - Filar micrometer
Measuring Devices - Dimensional

- Reticules
  - Employed as a component of a stereo or comparison microscope
  - Used for small scale dimensional measurements on fired evidence
    - Caliber of fired bullets
      - Diameter of bearing surface
      - Width of land and groove impressions
  - Ocular with etched division lines
- Filar micrometer
- Digital camera software
Measuring Devices - Dimensional

- **Reticules**
  - Employed as a component of a stereo or comparison microscope
  - Used for small scale dimensional measurements on fired evidence
    - Caliber of fired bullets
      - Diameter of bearing surface
      - Width of land and groove impressions
  - Ocular with etched division lines
- **Filar micrometer**
- **Digital camera software**
- **All of these methods should be performance checked regularly against a certified stage micrometer**
Measuring Devices - Dimensional

- MP6 Measuring Projector
Measuring Devices - Dimensional

- MP6 Measuring Projector
- Used for dimensional measurements on fired evidence
Measuring Devices - Dimensional

- MP6 Measuring Projector
  - Used for dimensional measurements on fired evidence
  - Caliber of fired bullets
Measure Devices - Dimensional

- MP6 Measuring Projector
  - Used for dimensional measurements on fired evidence
  - Caliber of fired bullets
    - Diameter of bearing surface
Measuring Devices - Dimensional

- MP6 Measuring Projector
  - Used for dimensional measurements on fired evidence
  - Caliber of fired bullets
    - Diameter of bearing surface
    - Width of land and groove impressions
Measuring Devices - Dimensional

- MP6 Measuring Projector
Measuring Devices - Dimensional

- MP6 Measuring Projector
  - Image of item is projected on a screen with a fixed anchor line
Measuring Devices - Dimensional

- MP6 Measuring Projector
  - Image of item is projected on a screen with a fixed anchor line
  - The stage is connected directly or indirectly to a measuring device
Fired Evidence

- Cartridge Cases
  - Inadequate headstamp
Fired Evidence

- Cartridge Cases
  - Inadequate headstamp
  - Misleading headstamp
Fired Evidence

- Cartridge Cases
Fired Evidence

- Cartridge Cases
  - Dimensional measurements taken
Fired Evidence

- Cartridge Cases
  - Dimensional measurements taken
    - Micrometer
Fired Evidence

- Cartridge Cases
  - Dimensional measurements taken
    - Micrometer
    - Caliper
Fired Evidence

- Cartridge Cases
  - Dimensional measurements taken
    - Micrometer
    - Caliper
  - Dimensions compared to published standards
Fired Evidence

- Cartridge Cases
  - Dimensional measurements taken
    - Micrometer
    - Caliper
  - Dimensions compared to published standards
    - Reloading manuals
Fired Evidence

- Cartridge Cases
  - Dimensional measurements taken
    - Micrometer
    - Caliper
  - Dimensions compared to published standards
    - Reloading manuals
    - Reference works (*Cartridges of the World*)
Fired Evidence

- Cartridge Cases
  - Dimensional measurements taken
    - Micrometer
    - Caliper
  - Dimensions compared to published standards
    - Reloading manuals
    - Reference works (*Cartridges of the World*)
    - Commercially available databases
Fired Evidence

- Cartridge Cases
Fired Evidence

- Cartridge Cases
  - Potential pitfalls
Fired Evidence

- Cartridge Cases
  - Potential pitfalls
    - Dimensional tolerances vary slightly by manufacturer
Fired Evidence

- Cartridge Cases
  - Potential pitfalls
    - Dimensional tolerances vary slightly by manufacturer
    - Due to obturation, dimensions of fired cartridge cases may vary slightly from unfired cartridges
Fired Evidence

- Cartridge Cases
  - Potential pitfalls
    - Dimensional tolerances vary slightly by manufacturer
    - Due to obturation, dimensions of fired cartridge cases may vary slightly from unfired cartridges
    - The “human factor”
Fired Evidence

- Cartridge Cases
  - Potential pitfalls
    - Dimensional tolerances vary slightly by manufacturer
    - Due to obturation, dimensions of fired cartridge cases may vary slightly from unfired cartridges
    - The “human factor”
      - Reading the device
Fired Evidence

- Cartridge Cases
  - Potential pitfalls
    - Dimensional tolerances vary slightly by manufacturer
    - Due to obturation, dimensions of fired cartridge cases may vary slightly from unfired cartridges
    - The “human factor”
      - Reading the device
      - Selecting the proper areas to measure
Fired Evidence

- Cartridge Cases
  - Potential pitfalls
    - Dimensional tolerances vary slightly by manufacturer
    - Due to obturation, dimensions of fired cartridge cases may vary slightly from unfired cartridges
    - The “human factor”
      - Reading the device
      - Selecting the proper areas to measure
      - Generally poor technique
Fired Evidence

- Bullets
  - Three class characteristics are mathematically linked to each other
Fired Evidence

- Bullets
  - Three class characteristics are mathematically linked to each other
    - Caliber – diameter of the bullet (D)
Fired Evidence

- Bullets
  - Three class characteristics are mathematically linked to each other
    - Caliber – diameter of the bullet (D)
    - Number of land and groove impressions (N)
Fired Evidence

- **Bullets**
  - Three class characteristics are mathematically linked to each other
    - Caliber – diameter of the bullet (D)
    - Number of land and groove impressions (N)
    - Width of the land and groove impressions (L, G)
Fired Evidence

- Bullets
  - Three class characteristics are mathematically linked to each other
    - Caliber – diameter of the bullet (D)
    - Number of land and groove impressions (N)
    - Width of the land and groove impressions (L, G)
  - If two are known, the third can be derived
    - \( D = \frac{(L + G) \cdot (N)}{\pi} \)
Fired Evidence

• Bullets
  • Example:
    • Damage to bearing surface preventing diameter measurement (D)
    • Measured land impression widths = .056” (L)
    • Measured groove impression widths = .122” (G)
    • Number of land and groove impressions = 6 (N)
Fired Evidence

• Bullets
  • Example:
    • Damage to bearing surface preventing diameter measurement (D)
    • Measured land impression widths = .056” (L)
    • Measured groove impression widths = .122” (G)
    • Number of land and groove impressions = 6 (N)
  • \[ D = \frac{(L + G) \times (N)}{\pi} \]
Fired Evidence

- Bullets
  - Example:
    - Damage to bearing surface preventing diameter measurement (D)
    - Measured land impression widths = .056” (L)
    - Measured groove impression widths = .122” (G)
    - Number of land and groove impressions = 6 (N)

- \[ D = \frac{(L + G) (N)}{\pi} \]
- \[ D = \frac{(.061” + .122”) (6)}{3.14159265} \]
Fired Evidence

- **Bullets**
  - Example:
    - Damage to bearing surface preventing diameter measurement (D)
    - Measured land impression widths = .056” (L)
    - Measured groove impression widths = .122” (G)
    - Number of land and groove impressions = 6 (N)
  
  \[
  D = \frac{(L + G) \cdot (N)}{\pi}
  \]
  
  \[
  D = \frac{(.061” + .122”) \cdot 6}{3.14159265}
  \]
  
  \[
  D = .349”
  \]
Fired Evidence

- Bullets
  - Diameter can be measured
    - Macroscopically using
      - Caliper
      - Micrometer
Fired Evidence

• Bullets
  • Diameter can be measured
    • Macroscopically using
      • Caliper
      • Micrometer
    • Under magnification using
      • Reticules
      • MP6 measuring projector
Fired Evidence

- Bullets
  - Land and groove impression widths can be measured
  - Under magnification using
Fired Evidence

- Bullets
  - Land and groove impression widths can be measured
    - Under magnification using
      - Reticules
Fired Evidence

• Bullets
  • Land and groove impression widths can be measured
    • Under magnification using
      • Reticules
      • MP6 measuring projector
Fired Evidence

- Bullets
  - Land and groove impression widths can be measured
    - Under magnification using
      - Reticules
      - MP6 measuring projector
      - Ruler
Fired Evidence

• Bullets
  • Land and groove impression widths can be measured
    • Under magnification using
      • Reticules
      • MP6 measuring projector
      • Ruler
      • Caliper (air gap)
Fired Evidence

- Bullets
  - Land and groove impression widths can be measured
    - Under magnification using
      - Reticules
      - MP6 measuring projector
      - Ruler
      - Caliper (air gap)
      - Micrometer (air gap)
Fired Evidence

- Bullets
Fired Evidence

- Bullets
  - Potential pitfalls
Fired Evidence

- Bullets
  - Potential pitfalls
  - Damage to bullet can cause distortion of dimensions
Fired Evidence

- Bullets
  - Potential pitfalls
    - Damage to bullet can cause distortion of dimensions
    - Poor shoulder definition
Fired Evidence

- Bullets
  - Potential pitfalls
    - Damage to bullet can cause distortion of dimensions
    - Poor shoulder definition
    - The “human factor”
Fired Evidence

- Bullets
  - Potential pitfalls
    - Damage to bullet can cause distortion of dimensions
    - Poor shoulder definition
    - The “human factor”
      - Reading the device
Fired Evidence

- Bullets
  - Potential pitfalls
    - Damage to bullet can cause distortion of dimensions
    - Poor shoulder definition
    - The “human factor”
      - Reading the device
      - Interpolation between division marks on reticules and rulers
Fired Evidence

- Bullets
  - Potential pitfalls
    - Damage to bullet can cause distortion of dimensions
    - Poor shoulder definition
    - The “human factor”
      - Reading the device
        - Interpolation between division marks on reticules and rulers
      - Selecting the correct anchor points on the shoulders
Fired Evidence

- Bullets

![Diagram showing groove and land impressions on a bullet]
Fired Evidence

- Bullets
  - Potential pitfalls
    - Damage to bullet can cause distortion of dimensions
    - Poor shoulder definition
    - The “human factor”
      - Reading the device
        - Interpolation between division marks on reticules and rulers
      - Selecting the correct anchor points on the shoulders
    - Generally poor technique
Conclusion

- Over the course of this discussion, an introduction to the basic instrumentation found within the modern Firearms Unit was presented.
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- This included a brief description of:
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- Microscopes
- Measuring Devices
Conclusion

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- This included a brief description of:
  - Microscopes
  - Measuring Devices
    - Mass/weight, force
Conclusion

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This included a brief description of:

- Microscopes
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  - The types of measurements collected
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    - Mass/weight, force
    - Dimensional
  - The types of measurements collected
    - Purpose
    - Possible issues