Unusual, Genius and Stupid Tactics for More Fingerprint and Face Identifications

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*On 30 June 2022 this on-line PDF was updated with some new URLs for INTERPOL documents and other links.

Alternate Title for This Presentation:

Additional Steps to Solve More Current Cases, and Some Cold Cases, with Fingerprint and Face Evidence

This presentation does NOT purport to represent the position or opinion of any component of the US Government or any employer or organization with which the speaker is or has been affiliated.

THIS PRESENTATION IS UNCLASSIFIED

Presenter's Short Bio

- Has worked in the human identification field for the past 46 years, including 36 years' service in three different US Government organizations.

- Has routinely interfaced with government laboratories on six continents, and lived/worked more than seven years as a forensic scientist in Asia and Europe.

Presenter's Short Bio (Cont.)

- Job titles have included:
  - Fingerprint Examiner (tenprint) (FBI)
  - City Police Officer/CSI/LP Examiner (TN and NC)
  - Military Police Officer/PFC/SP4 (Army)
  - State Police LP Program Supervisor (Illinois)
  - Special Agent/Criminal Investigator/CW5 (Army)
  - Chief of Intel for Worldwide Army Law Enforcement
  - Intelligence Officer (Army & US Government)
  - Sr. Research Scientist & QA Mgr (US Government)
  - County Sheriff's Office Forensic Lead (Illinois)

Presenter's Short Bio (Cont.)

- Certified Latent Print Examiner (IAI)
- Fellow of the Chartered Society of Forensic Sciences (Formerly The Fingerprint Society)
- Certified Biometrics Professional (IEEE)
- Decades of membership in IAI, LPCB, MAFS, ASCLD-LAB PRC, multiple SWGs, OSAC…
- His loving wife says he belongs to everything but the human race

Presenter's Short Bio (Continued)

- No personal success has ever been just my accomplishment…
- Each time, I leveraged information, training and other kindnesses shared with me directly or indirectly by other experts and organizations.

No Agency Can Do Everything in Every Case

Processes/examinations/searches are planned in an attempt to best satisfy three goals:

- Accuracy
- Thoroughness
- Timely Support

…with frequent compromises in thoroughness to help balance the other two goals.

Example of "Acceptable Compromise" in Thoroughness

- Latent Print Certification Examination (or similar journeyman-level testing) often permits missing as much as 15% of the possible matches (e.g., 10 correct idents out of 12 possible idents with zero erroneous idents) during a six-hour (or longer) proctored test.
- Okay to sacrifice thoroughness within acceptable accuracy and timeliness parameters.

Sacrificing FP Thoroughness to Solve More Cases

- Some latent print matches will always be missed in AFIS searches.

- Whether you request, 3, 5, 20 or 99, there will always be those rare cases where the perpetrator's print would have come up in the candidate list had you searched one candidate deeper.

- The goal is finding the optimal thoroughness sacrifice (relative to accuracy and timely support) which best serves justice and society overall.

Sacrificing FP Thoroughness to Solve More Cases (Cont.)

- Reducing candidates returned for latent print searches by half (e.g., 20 to 10) may increase cases solved annually by over 50% when it enables review of 100% more latent print search results (double AFIS candidate list review completion).

- *This is especially important* if your agency seeks to improve thoroughness through periodic relaunching of latent prints.

Sacrificing FP Thoroughness to Solve More Cases (Cont.)

- FBI Latent Print Unit Efficiencies (as of June 2017):
  - Only required to check the top three candidates for LP to TP searches (because >95% of hits are in the top 3)
  - Typically spend little time marking up latent print minutiae and instead launch LFIS (image only) searches the vast majority of the time.
  - Encode minutiae (typically with minimal markup format) only when latent prints have checkered, spotted, or other background interference inhibiting LFIS searching.

Sacrificing FP Thoroughness to Solve More Cases (Cont.)

For latent-to-latent (ULF database) searches, FBI latent print examiners are required to request ten candidates, but are only required to check down the candidate list until they have two obviously different-appearing (not even close to a match) candidates.

Sacrificing FP Thoroughness to Solve More Cases (Cont.)

Because of the way NGI now works, many FBI latent print examiners now do NOT register unidentified latent prints in the ULF if the impression has less than 11 or 12 minutiae. The reason they no longer typically register latents with fewer minutiae is that for minimal latent prints, NGI continuously spits out close but non-ident candidates wasting a lot of their time.

Solve More Cases by Retraining Officers

- During periodic life cycle forensic training, teach that natural latent prints are NOT oily and just dusting will destroy and/or miss most latent prints.

- Teach them to practice taking close-up (fill-the-frame) images of small coins (e.g., US dime) until they are skillful at that task.

Solve More Cases by Retraining Officers (Cont.)

- Teach them that a strong flashlight will often find more latent prints on smooth, nonporous surfaces than a brush and powder.

- Teach them the "huff" (AKA "hut") method of breathing on a surface to add moisture before dusting (then dust as soon as the fog disappears).

Solve More Cases by Retraining Officers (Cont.)

- Teach them to ALWAYS photograph before lifting.

- Teach direct reflection, transmitted and oblique lighting.

- Teach them to submit all images and all lifts, whenever they see any ridge detail in either an image or lift.

Solve More Cases by Retraining Officers (Cont.)

- Teach them to include a scale (or just a coin or their business card if they have no scale handy) to permit sizing and geometric distortion correction.

- Give positive feedback to officers through their supervisors for latent print harvesting successes.

Thoroughness in Digital Imaging

- Do NOT confuse the SWGFAST (OSAC) guidelines mandating SWGIT processes to periodically test image capture accuracy as the normal course of business for all latent print casework.

- SWGFAST permits using images captured at less than 1K or 500 ppi and with no scales - you just need to document why (e.g., the images were the only ones captured).

Thoroughness in Digital Imaging (Cont.)

- The preamble of SWGFAST's Standard for Friction Ridge Impression Digital Imaging (Latent/Tenprint) states, "These standards do not extend to image requirements for automated fingerprint identification systems (AFIS)."

- Thus for AFIS-related processes you have great freedom.

Thoroughness in Digital Imaging (Cont.)

- Additional identifiable ridge detail can often be harvested through digital photography or scanning cold case specimens, especially latent print lifts.

- If only photographs (paper and film negatives) are available, scan the negatives because high-contrast filters in the darkroom were normally used (reducing radiometric resolution).

Thoroughness in Digital Imaging (Cont.)

- Simple digital image processes including histogram equalization, edge enhancement, HDR processes, and pseudo-color assignment can reveal previously undetected ridge detail.

- ULW's image processing capabilities are simple and strong. They can often detect new ridge detail quickly. For starters, many LP examiners combine binary, difference of Gaussian, and local histogram equalization filters on faint or overly dark impressions (think bin-dif-loc).

Sample Before and After Image Processing
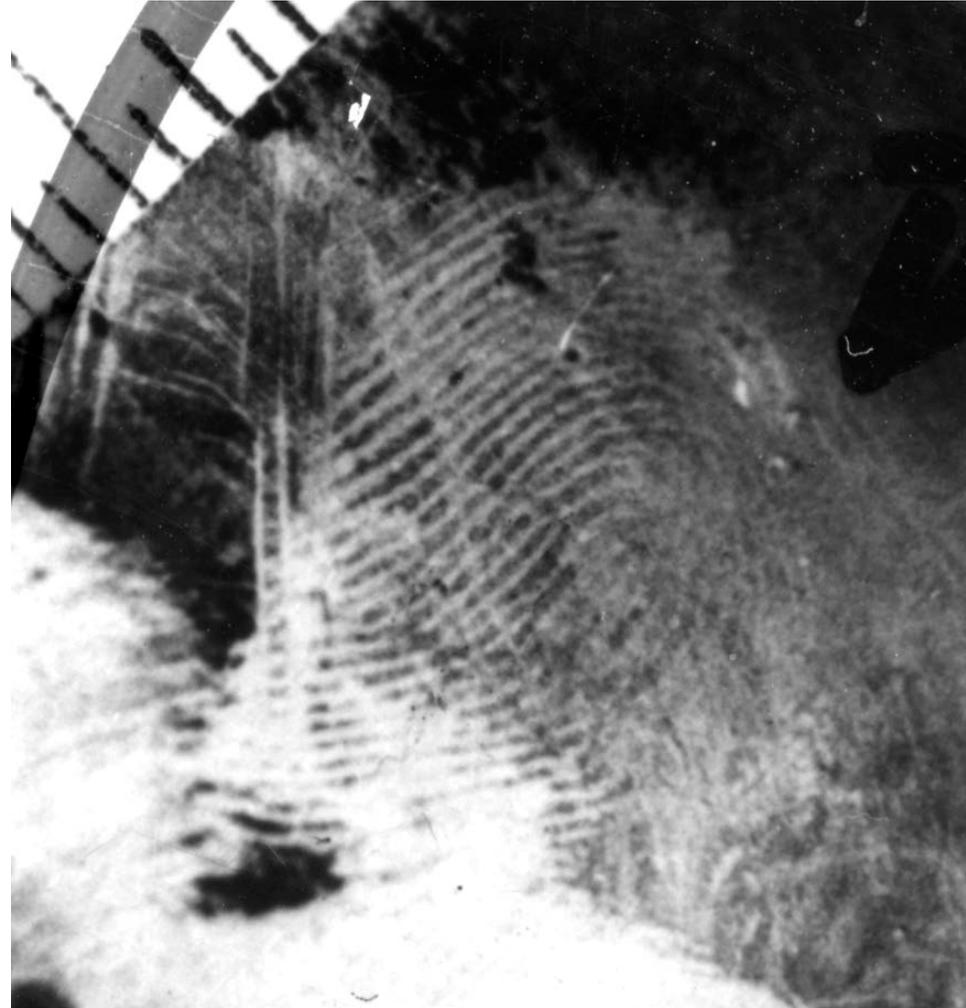
Thoroughness in Digital Imaging (Cont.)

The presenter's experience with federal and state labs found fingerprint spatial resolution (image size) errors happen as often as 5% in the absence of systematic QA review… and as frequently as 20% when images are transferred between agencies (especially by well-meaning investigators).

Thoroughness in Digital Imaging (Cont.)

- The image meta-data values for pixels per inch (ppi), file names ending with 1Kppi, and other descriptors are often inaccurate.

- Most AFIS algorithms can handle 10 to 20% ppi variance without missing latents having "enough" (i.e., many) corresponding minutiae, but the matching score can sometimes nose dive to cause a miss, especially if greater than 20% variance.

Thoroughness in Digital Imaging (Cont.)

- Pay attention to pixel horizontal and vertical values in LP images.

- View image file size and dimension lists (latents and tenprints) to see obvious anomalies.

- In ULW, use the image resolution verification tool to detect frequent 500 vs. 1000 ppi errors
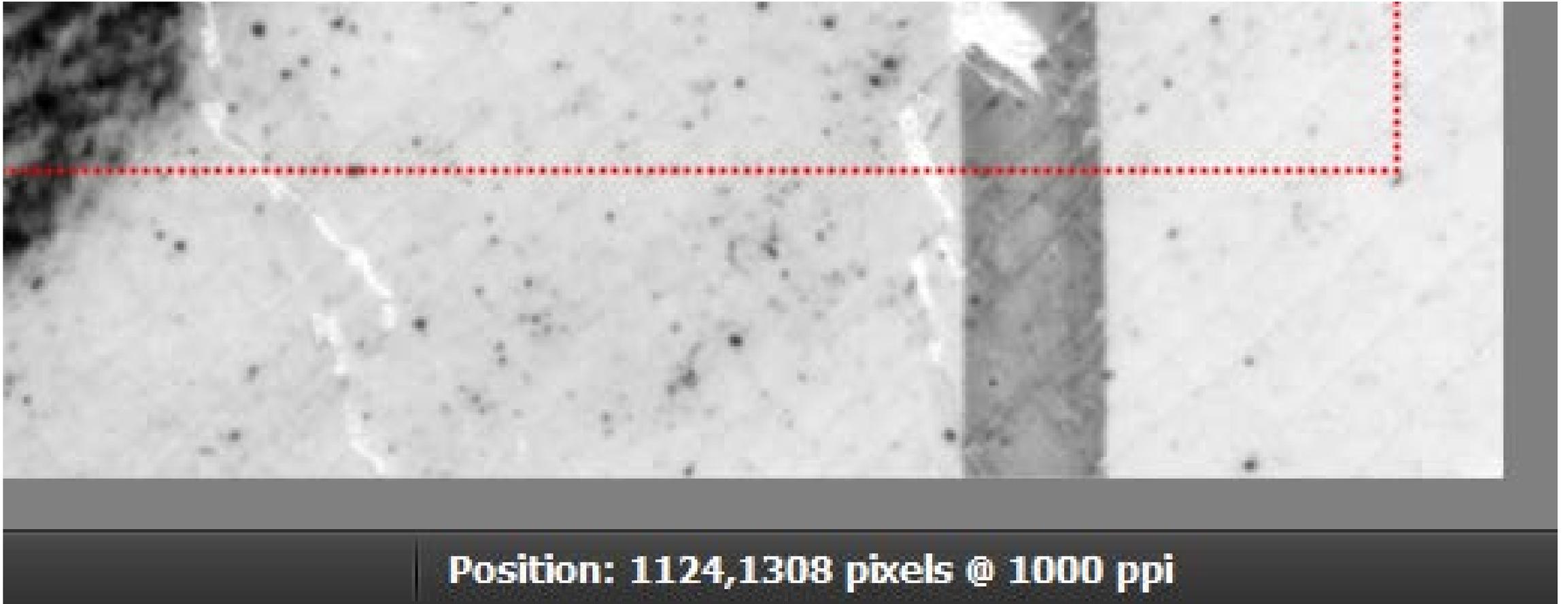
In ULW's Menu, Select Image -> Verify Resolution
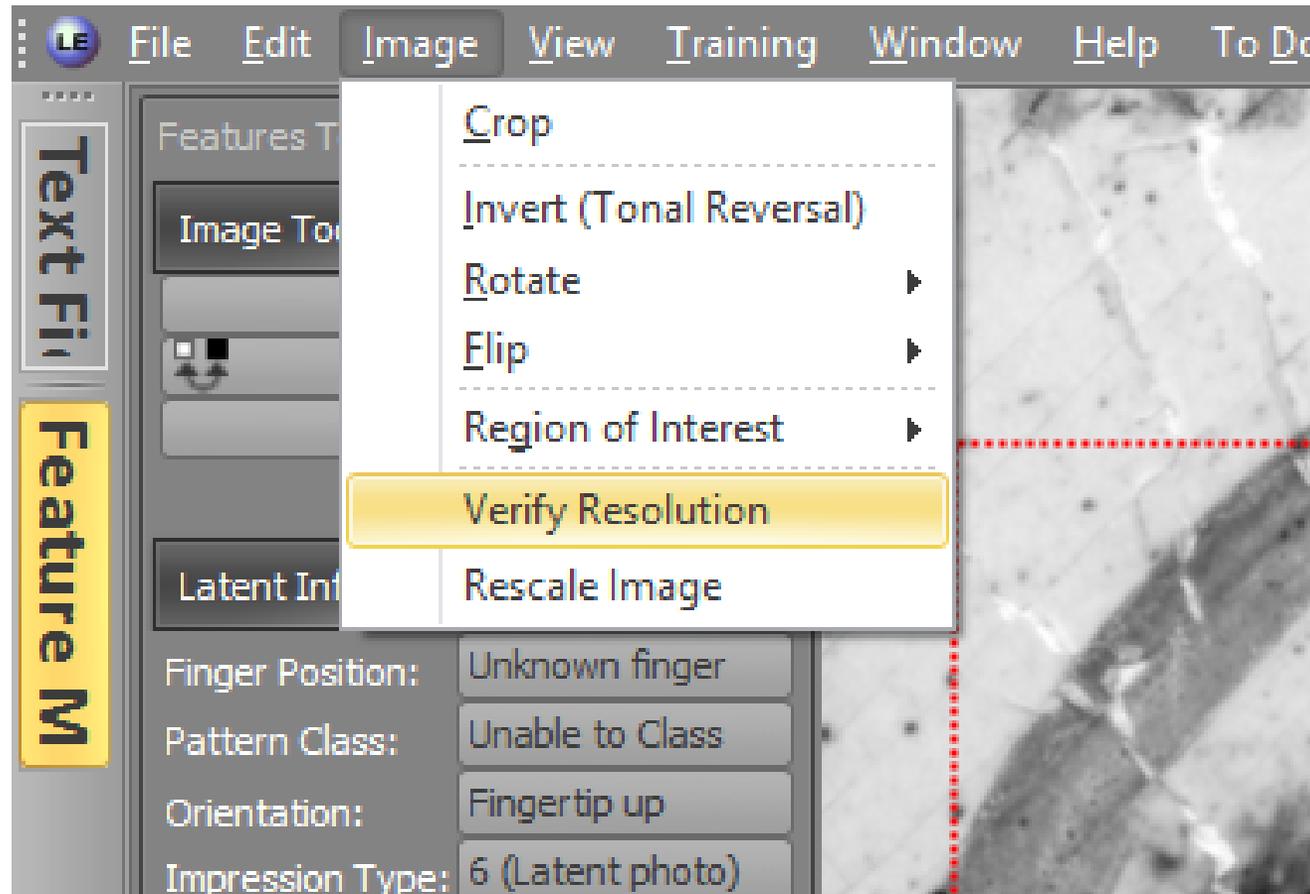
Then compare your latent print to the resulting pop-up window with sample 500 and 1000 ppi ridge detail
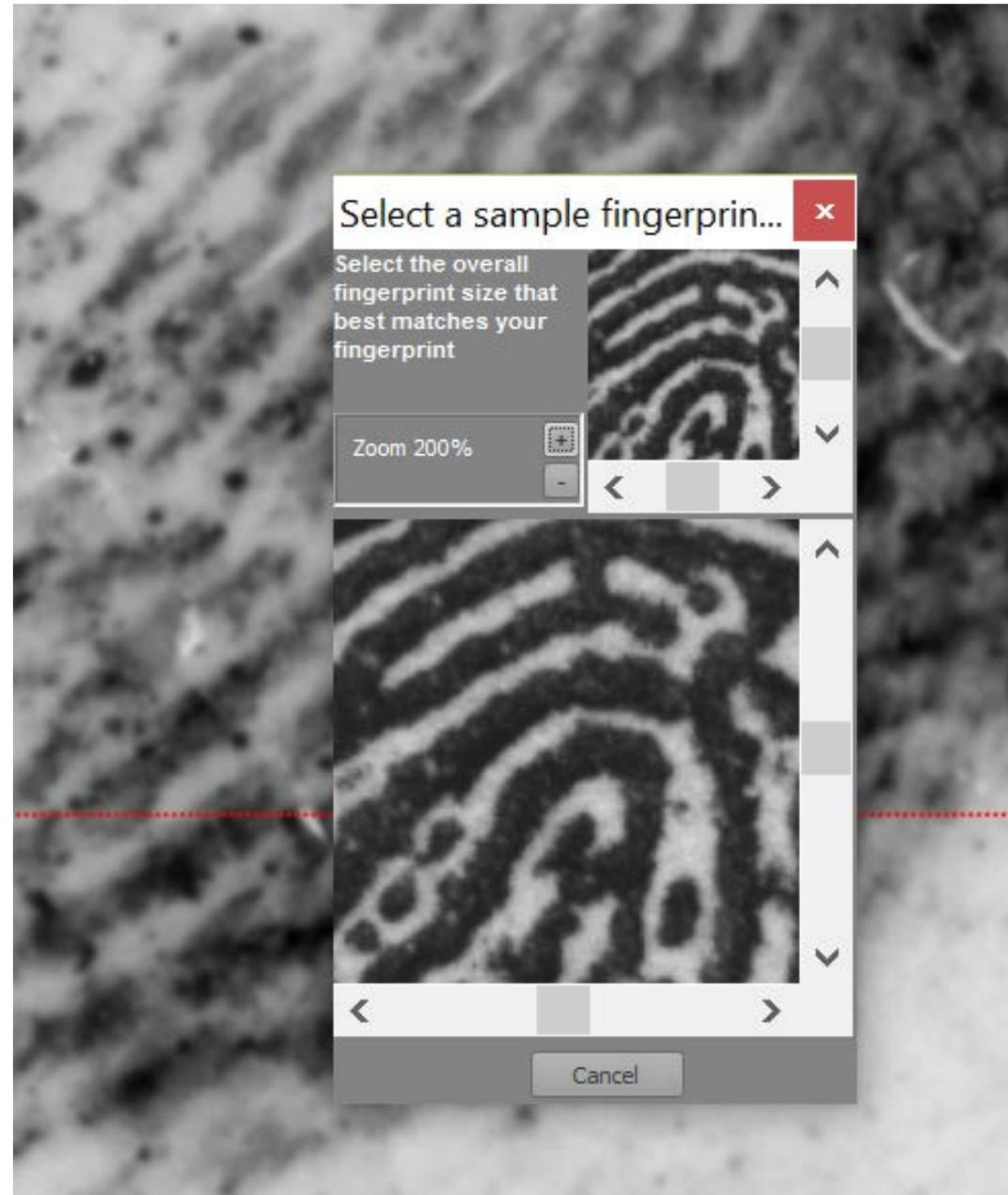
Hovering the Cursor in the Bottom Right Corner in ULW Shows Horizontal and Vertical Pixel Counts

Position: 1124,1308 pixels @ 1000 ppi

Tenprint PPI Anomalies in Dimensions

Type	Size	Dimensions
TIF File	21,757 KB	8100 x 10100
TIF File	21,757 KB	8100 x 10100
TIF File	16,790 KB	8100 x 10100
TIF File	16,790 KB	8100 x 10100
TIF File	2,466 KB	1296 x 1944
TIF File	2,466 KB	1296 x 1944
TIF File	2,466 KB	1296 x 1944
TIF File	2,466 KB	1296 x 1944
TIF File	2,466 KB	1296 x 1944
TIF File	601 KB	629 x 968
TIF File	601 KB	629 x 968

Tenprint PPI Anomalies in EFTS File Size

- Remember that the devil is in the numbers.

- 500 ppi EFTS/EBTS tenprint files of rolled and flats from paper cards compressed at 15:1 (wsq) average 666 Kb in size without mugshots.

- Learn the average file size of LFFS/LFIS and EFTS/EBTS files generated by your agency to help detect anomalies.

Investigators Often Put Scales on a Non-1:1 Photo

- Checking the ppi using a scale in a photo often gives false values... especially for cold cases involving paper photos... or cases transferred between agencies (which can involve paper photos or printouts which were imaged with a scale lying on the printout or paper photo).

Latent Spatial Resolution

- At 500 ppi, the AVERAGE pixel count from the middle of one ridge to the middle of an adjacent ridge for an adult is 11 pixels.

- At 1000 ppi, the AVERAGE pixel count from the middle of one ridge to the middle of an adjacent ridge for an adult is 22 pixels.
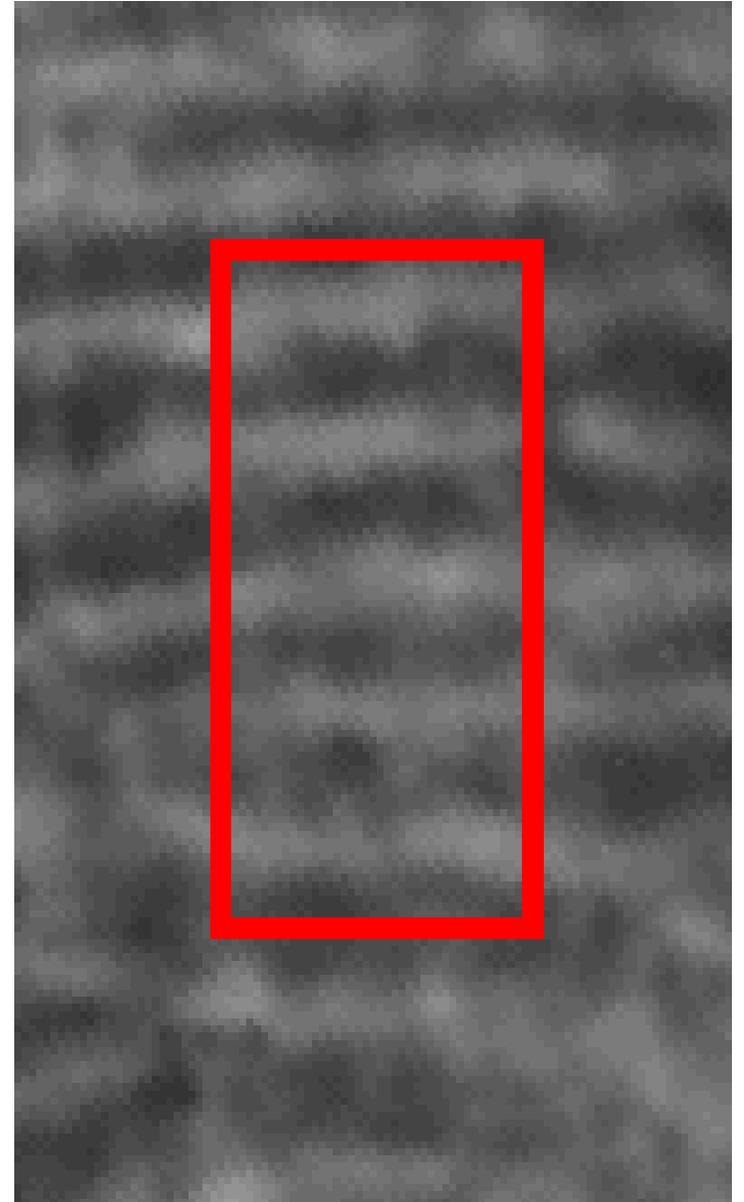
Latent Spatial Resolution (Cont.)

- Choose "normal" looking ridges to measure if part of the latent appears to have wider or narrower ridges or furrows due to pressure distortion, etc. Ridges near the distal-medial joint (at the base of a finger) may also be wider than other ridges in a fingerprint.
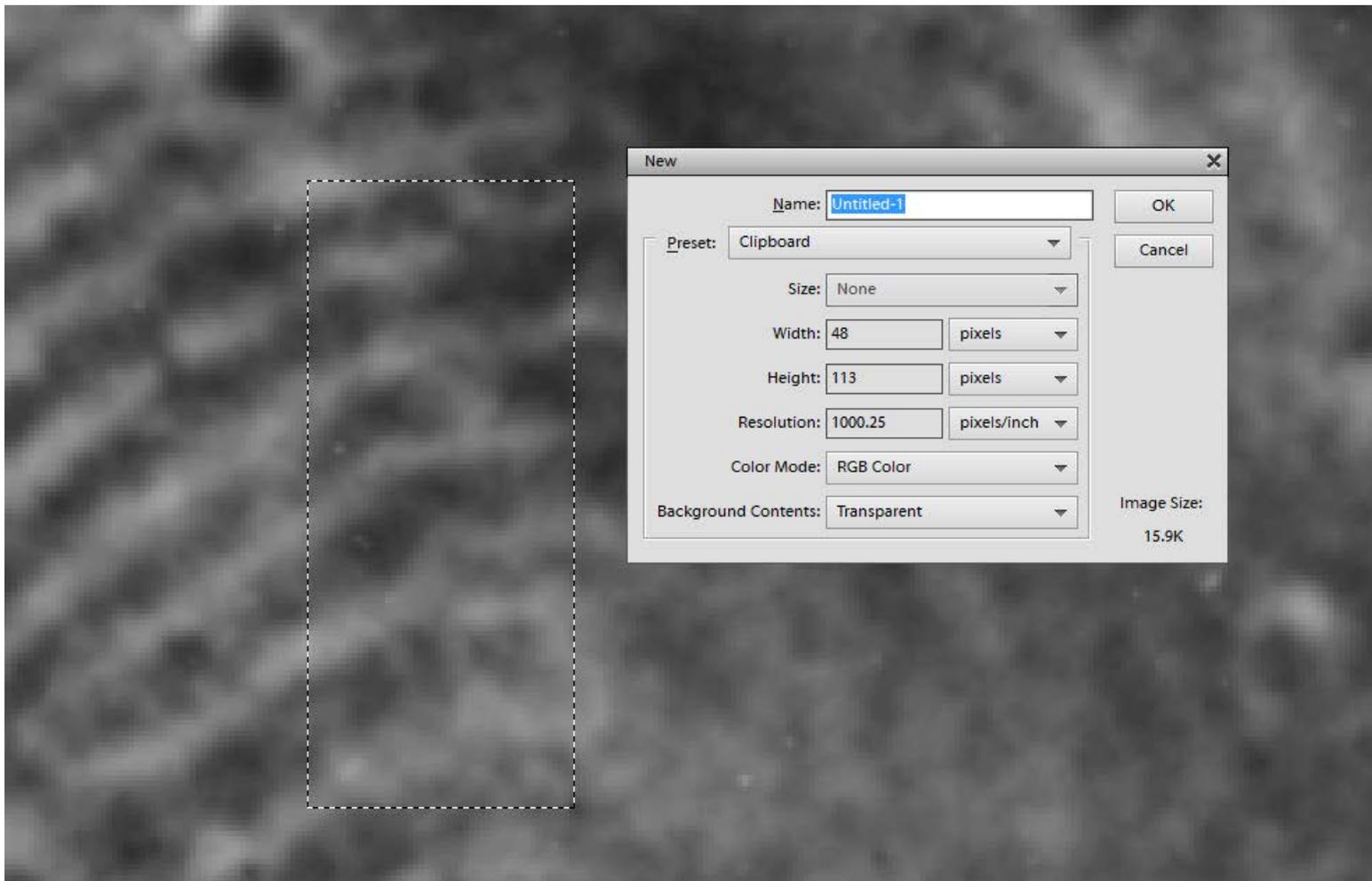
Latent Spatial Resolution (Cont.)

- You will seldom find exactly 11 pixels at 500 ppi or exactly 22 pixels at 1000 ppi. Thumbs tend to have larger ridges, whereas ring and little fingers have smaller ridges.

- You are looking for something "ballpark" close… not one-fourth or four-times the expected 11 or 22 value.

Start in the middle of a ridge, cross five furrows and stop in the middle of a ridge, then copy and paste the selection to see the pixel count without having to manually count (press control-c, then control-n in Photoshop).
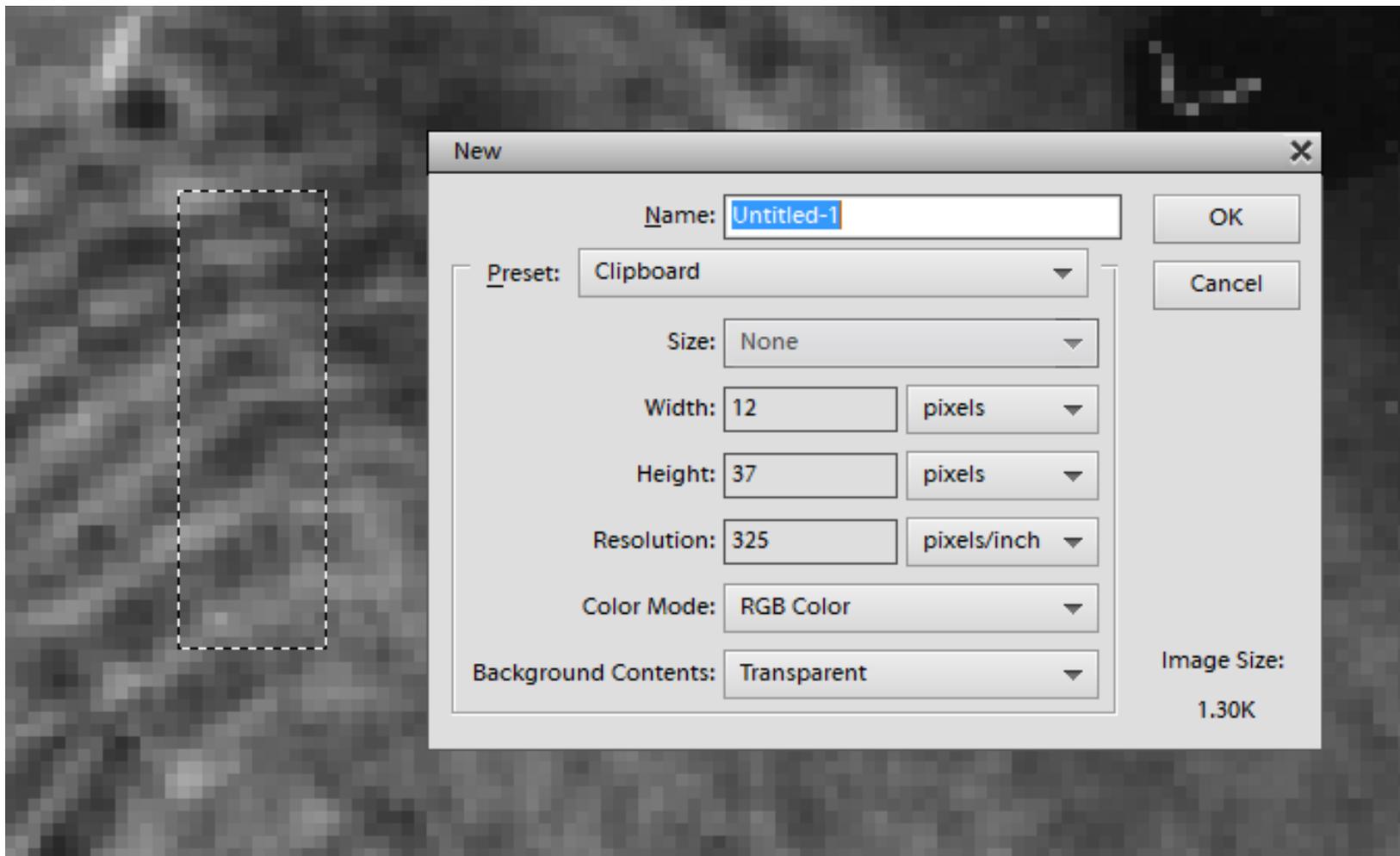
Latent Spatial Resolution (Cont.)

Good (113 pixels across 5 ridges at 1000 ppi)

Latent Spatial Resolution (Cont.)

Bad (37 pixels across 5 ridges at 1000 ppi)

Latent Spatial Resolution (Cont.)

- If the ppi is far from 500 or 1000 (or completely unknown) you can often achieve AFIS accuracy by resizing the image to average 11 or 22 pixels across five furrows.

- Cold case children's latent prints (e.g., finger-painting or other latent prints collected from an abduction investigation decades ago) will NOT hit against the adult's prints today without resizing.

Post-Super Glue Fuming

- Cyanoacrylate-developed ridge detail is nearly permanent on specimens and can enable the harvesting of additional cold case latent prints years/decades later.

- If only visible light and dusting powder were used, there is an excellent chance to detect additional impressions using luminescent dye stains (R6G is one of the best, but others also work well).

Post-Super Glue Fuming (Cont.)

- Powder "rubbing" (different from dusting for prints) should be the last step, but is also one of the most overlooked steps. Expect additional identifiable latent prints at least 5% of the time if powder rubbing was not done in a cold case.

- RUVIS can be valuable for finding previously undetected latent prints on cold cases where only visible light, dye stains, and powders (including powder rubbing) were used.

AFIS Thoroughness

- Re-launching latent prints periodically will detect many idents impossible when only relying on daily TP/LP searches (AKA ULMs).

- If you have a local AFIS to supplement your state's giant AFIS, you may be able to leverage it to achieve hits difficult (or outside your budget) using systems tailored to support large-scale daily tenprint throughput.

AFIS Thoroughness (Cont.)

- For suspects from serial murders/rapes, launch each of their 20 rolled and flat record prints as LP-LP searches. This has proven especially valuable in some EU labs for solving additional cold cases.

- Leverage tenprint examiners, office administrative/clerical workers, or summer hires to help with periodic latent print re-launch activities.

AFIS Thoroughness (Cont.)

- In your next AFIS rebuild, consider leveraging "double-dipping" to data mine suspects hundreds of SRL candidates deep for multiple LPs from the same crime.

- Do not manually compare the top 500 or 1000, etc., best matches for each print.

- Instead, use correlation logic to lead you to identifications otherwise impossible to detect.
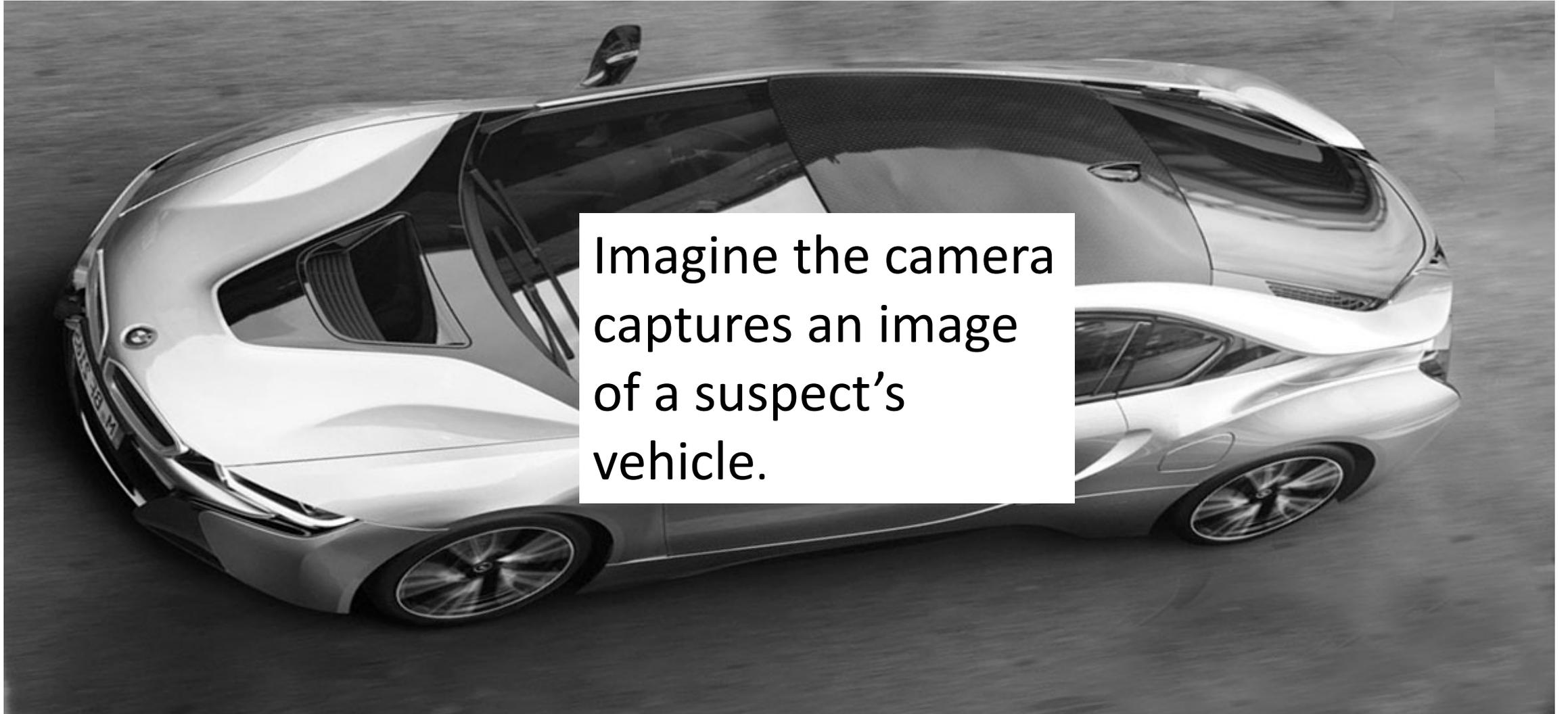
AFIS Thoroughness (Cont.)

Imagine a High Resolution Camera Above an Intersection

AFIS Thoroughness (Cont.)

Imagine the camera captures an image of a suspect's vehicle.

AFIS Thoroughness (Cont.)

- Capturing a fraction of the license plate, a fraction of the dashboard VIN number, and a fraction of the inspection decal number means little based on each piece of information, because each may correspond with thousands of vehicles.

- Considered jointly however, the single vehicle having all three partial numbers has just won the lottery.

AFIS Thoroughness (Cont.)

- With the double-dipping concept, the same person's left index finger in candidate list positions 288, 472 and 162 (for example) for three latent prints from one crime scene means nothing... maybe his/her left index finger is similar to the true donor's right thumb.

- However, if two or three DIFFERENT fingers from the same person appear in the top 500 candidates (etc.) from one crime – he/she just won the lottery and is worth manually comparing to the latent prints.

AFIS Thoroughness (Cont.)

Be sure to search state/national/regional and international AFIS databases. DHS' huge AFIS databases are often overlooked, but contain over 100 million foreign persons and your agency may request latent print searches for serious cases.

Fingerprint Repositories to Search

- FBI CJIS' Next Generation Identification (NGI)
  - Much greater accuracy than prior IAFIS software
  - Automatically Searches Criminal and Civil Prints
  - NGI Latent Fingerprint Feature Searches (LFFS) include simultaneous automatic Latent Fingerprint Image Searches (LFIS) with scores merged to improve LFFS candidate lists

Fingerprint Repositories to Search (Cont.)

- Local AFIS
- Your State AFIS
- Other Local AFIS
- Other States' AFIS
- Regional AFIS Databases such as WIN, NCR, NOVARIS

Fingerprint Repositories to Search (Cont.)

- Department of Homeland Security (DHS has one of America's largest AFIS database... with visa applicants, legal and illegal immigrants, and more)
  - Any US law enforcement agency may submit latent prints
  - Only major cases (serious crimes)
  - Submit 500 or 1000 ppi TIF or JPG images
  - DHS request cover sheet is online at onin.com/dhscvrsht

Fingerprint Repositories to Search (Cont.)

- Email image, cover sheet and case details from official law enforcement email account to lpu@dhs.gov

    afis@dhs.gov (ten print)

    lpu@dhs.gov (latent print)

- DHS Biometric Support Centers (BSC) Contact:

    DHS BSC West, phone 858-609-2609, fax 858-609-2600

    DHS BSC East, phone 202-298-5199

Fingerprint Repositories to Search (Cont.)

- Interpol
  - Due to email filtering, US local/state law enforcement agencies CANNOT submit images via regular agency email.
  - Send request and images via FBI LEO.gov or via other US gov't email accounts to
    usncb.state.mailbox@usdoj.gov
  - Obtain FBI LEO.gov accounts (now called LEEP) from www.cjis.gov

Fingerprint Repositories to Search (Cont.)

- For US Law Enforcement, FBI LEO (LEEP) accounts have the added advantage of Teleporter file sharing.

- Teleporter meets all FBI security requirements and works for individual files up to 5 GB in size.

- For example, send a link to Interpol authorizing them to download a file(s) within the next seven days, or to upload files during the next 24 hours.

Fingerprint Repositories to Search (Cont.)

- Interpol
  - Washington DC Interpol office phone 202-616-3900
    Additional details for contact are online at
    https://www.justice.gov/interpol-washington/services-law-enforcement-agencies

    Interpol fingerprint transmission guidelines are at
    https://www.interpol.int/content/download/7191/file/EN_FP%20Crime%20Scene%20Marks.pdf
    and at
    https://www.interpol.int/content/download/7189/file/EN_FP%20transmission.pdf

(The above two INTERPOL links were updated in this on-line PDF file on 30 June 2022.)

Fingerprint Repositories to Search (Cont.)

Department of Justice
INTERPOL/USNCB   US Interpol phone 202-616-3900
145 N Street, N.E.
Washington, DC 2002

     or

Secretariat General
Fingerprint Unit
Identification Branch OIPC INTERPOL
200 Quai Charles de Gaulle
69006 Lyon France

Fingerprint Repositories to Search (Cont.)

- Other US and Foreign Databases
  - Forensic organization restricted access membership rosters are your outreach phonebooks for other law enforcement/government fingerprint and face repositories

AFIS Forensic Intelligence

Studies have shown latent prints considered "unsuitable" for ID by CLPEs can be searched in giant databases (over 50 million persons) as lights out LFIS searches ...and those prints will sometimes provide a ground truth match in the number one candidate position.

AFIS Forensic Intelligence (Cont.)

- In 2017, launching searches of unsuitable (for identification) five-point latent prints from a crime scene may produce an investigative lead… (e.g., insufficient for ID, but top hit in NGI just happens to live in the same town as the victim).

- And, if two different fingers of the same person show up in the top twenty candidates of a large database – they just won the lottery (i.e., a mini-version of the double-dipping concept).

AFIS Forensic Intelligence (Cont.)

- In the future, there **WILL BE** probability models approved by the relevant scientific community, including statisticians and metrologists, to provide the numerical probability a person may have made small latent prints (e.g., possessing as few as five level 2 features in consecutive friction ridge detail… and maybe fewer features in some latent prints when exceptional rarity is present).

AFIS Forensic Intelligence (Cont.)

Recommend *now* saving every latent print with **five or more** ridge endings or bifurcations in legible, consecutive ridge detail from murders and other serious offenses, especially those with no statute of limitations.

Unknown Latent Print Mirror Imaging

- Latent prints may be mirror imaged due to transfer (e.g., contaminated matrix transferred on a plastic bag).

- Latent prints on the sticky surface of tape may have been "lifted" when the tape was applied.

- Latent prints on car windows or plastic bags may have been photographed "through" the surface in a manner causing mirror imaging.

Unknown Latent Print Mirror Imaging (Cont.)

- Rubber lifter photos may or may not have been properly reversed. Markings on a paper photo in cold cases may be confused with markings on a rubber lifter and cause erroneous mirror imaging.

- With thin papers such as flash paper or cigarette rolling papers, it may be impossible to know which side was touched. They often need to be searched both ways.

Other Latent Print Processes

Pour an aqueous reddish dye solution (R6G has worked) over large, smooth concrete surfaces post-cyanoacrylate fuming. Then rinse, allow to dry, and view with LED or ALS in darkness (through orange glasses/goggles).

Other Latent Print Processes

Although it sounds stupid – this has been done:
Spray a clandestine drug lab with a coating of white powder from a fire extinguisher, then gently brush away the powder from latent prints on non-porous surfaces. In some cases, perpetrators may have already coated surfaces in an attempt to extinguish a fire before fire/police services arrive.

Other Latent Print Processes (Cont.)

The binarization enhancement tool in the FBI's free ULW software is often effective for enhancing poor quality connect-the-dot latent prints.

Another option is digital imaging distortion (Photoshop) to artificially "tilt" the latent-bearing surface (as if looking down rows of ridges) followed by re-sampling to correct geometric distortion.

Other Latent Print Processes (Cont.)

Because many police officers now use high-resolution mobile phone cameras for imaging evidence from minor crimes (e.g., low dollar loss burglaries, vehicle break-ins), they can use 3 x 5 card frames surrounding latent prints and "Tiny Scanner" phone apps to enable rapid (or instant) geometric distortion correction facilitating faster AFIS searching. They can use 5 x 7 or larger frames for palmprints or larger impression sets.

Other Latent Print Processes (Cont.)

- Hints listed in this presentation are a few of the frequently overlooked steps for harvesting additional latent prints from cold cases.
- There are numerous other steps which can be considered, especially additional porous surface, blood, and other specialized substrate and/or matrix processes.

Re-Think Burglary Case Resource Expenditures

- Although lacking the news media attention given to all murder cases, many burglars continue victimizing three or more families weekly until caught …sometimes progressing to robbery, assault, rape and/or murder when they encounter people in a home.

- Encourage management to allow you to work smarter, not harder, and expend more resources on solving as many burglaries as possible.

Every US Law Enforcement Agency Can Solve Cases with Facial Recognition Now

- So-called Positive ID involving automated facial recognition searches is very rare – investigative leads are the norm.

- When 60 pixels (and sometimes as few as 40 pixels) are present between the centers of the eye sockets, on faces with suitable pose/illumination/expression (PIE), a solve rate of at least 10% is common in facial recognition searches. Solve = follow-up investigation resulted in non-facial evidence sufficient to prosecute.

If Your AFIS/ABIS Lacks FR– Plan Now

- Local Facial Recognition systems often provide even more than 10% solve rate.

- Many agencies currently degrade standard mugshots by compression to as small as 25 Kb JPG files. It is typically simple to decrease compression to create 250 Kb JPG facial image files lacking severe compression artifacts detrimental to FR matching. Improve mugshot image quality now, not later.

Face Repositories to Search

FBI CJIS NGI Direct Submission Face Search

- Direct submission through your state's AFIS/ABIS
- Many state AFIS infrastructures do not yet facilitate NGI face transactions
- When direct NGI search is available – FBI CJIS' Universal Face Workstation software can be used to prepare searches and adjudicate search response candidate lists (similar to FBI Universal Latent Workstation software)

Face Repositories to Search (Cont.)

Next Generation Identification (NGI) FBI Office Search

- Request local FBI Office to open a "cooperative case" (if they balk, call CJIS' Face Services Unit at (304)625-FACE for assistance)

- When appropriate, request that faces are searched in NGI **and** other datasets of millions of faces the FBI can search… including 17 state DMVs (as of Sep 2017), US State Department Passport/Visa faces, US military collections and more.

- Search responses are typically a "possible match" investigative lead or no match found.

Other Face Repositories to Search (Cont.)

- State DMV face searches are available for criminal investigations in many (not all) US states.

- Other US State/Federal and Foreign Databases
  - Forensic organization membership rosters are your outreach phonebooks for other law enforcement/government face repositories

Facial Image Thoroughness

- Although less than 40% of persons imaged in most facial recognition (FR) automated databases (DMV, passport, visa photos, etc.) are wearing glasses, if your suspect is wearing glasses in the probe image, then typically 80% of the faces in the resulting candidate list will be wearing glasses.

- The true match can miss if the suspect wearing glasses is not also wearing glasses in their gallery image.

Facial Image Thoroughness (Cont.)

- Some agencies are unaware it is permissible to alter facial images to improve the chances for a successful match in facial recognition databases.

- Using Photoshop to remove glasses is a valuable way to identify persons who would otherwise be missed if their gallery image in a face database is without glasses.

Facial Image Thoroughness (Cont.)

- If the suspect is wearing dark sunglasses, FR algorithms will typically fail to generate a template for searching.

- Several agencies have successfully used Photoshop to remove dark sunglasses and then add unrelated eyes (of another person) to enable the FR algorithm to build a template and achieve successful matches in huge databases.

Facial Image Thoroughness (Cont.)

- Other pose, illumination, expression, printing (moiré pattern) and occlusion problems can be mitigated with Photoshop and other imaging software (Animetrics, etc.).

- Just as occurs with fingerprints, post-automated search comparisons (after considerable probe image manipulation) are made using the original image(s) collected and not using face images with artificially added eyes or other modifications.

FP and Face Horizontal/Vertical Ratio Errors

- Horizontal to Vertical ratio errors (often accompanied by ppi errors) are frequently introduced when images are shared/transferred between agencies.
- Facial images are especially prone to compression degradation, aspect ratio and other image anomaly problems during insertion in apparently normal or high-resolution wanted flyers, investigation reports, etc.

Think Outside the Box

This presentation only scratches the surface of things to consider for solving additional current and cold cases while balancing accuracy, thoroughness and timely support.

Questions?

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