surfaces, such as wood, styrofoam, or granular surfaces, usually present difficulties, although useful prints can often obtained from such surfaces. Latent prints have even been successfully lifted from the bodies of human victims.

**Impression (Plastic) Prints.** When someone touches a soft, pliable surface, such as clay, putty, wax, or wet paint, they may leave behind an impression of the ridge pattern of their fingers. These patterns are often clearly visible to the unaided eye. An example is shown in Figure 7.2.26 where fingerprints can occasionally be observed break-in robberies in the window putty.

![Figure 7.2.26. Plastic fingerprints in window putty](http://images.meredith.com/diy/images/2009/01/l_SDW_034_12.jpg)

Interestingly, other mammals also have fingerprints similar to those found in humans. Monkeys, apes and even koala bears show fingerprints (Fig. 7.2.27).

**PRESERVING VISUALIZED FINGERPRINTS**

Once a fingerprint has been found, developed and visualized, it is important to preserve and record the evidence. Typically, once the visualization is completed, the prints are photographed to form a permanent record. It is often desirable, however, to preserve the fingerprint intact for later study and storage. Several techniques have been developed over the years to “lift” fingerprints from the surfaces on which they are originally found.

![Figure 7.2.27. Comparison between human and other mammal fingerprints: (Left) human, (Center) Koala, and (right) chimpanzee](http://www.odec.ca/projects/2004/fren4j0/public_html/animal_fingerprints.htm)

One very common methods used for “lifting” fingerprints uses cellophane tape that is carefully placed over the print and then rubbed to ensure that the adhesive on the tape is in full contact with the print (Figures 7.2.28). The tape is then slowly peeled away from the surface and applied to a card for permanent storage. One advantage of cellophane tape method is that the tape
can bend to conform to an irregular surface. Additionally, it is inexpensive, easy to use, and presents the fingerprint as it originally appears, rather than reversed. A variety of other techniques have been developed, such as casting and rubber lifting, and may be the methods of choice depending on the surface with the fingerprints. 7.2.29.

As mentioned above, prints can be successfully lifted and preserved even on human skin, as shown in Figure 7.2.29.

**LEGAL CHALLENGES TO FINGERPRINT EVIDENCE**

Fingerprint evidence has been used in courtroom proceedings for personal identification for over a century, with the first US murder conviction based on fingerprint identification evidence occurring in 1911. The matching of latent prints often not only determines who made the prints but they may also be used to indicate where that person has been, for example at the crime scene.

Recently, however, use of fingerprint information in court has come under intense scrutiny. Most of these challenges have come from questioning the accuracy rate of the examiners, the average accuracy rate of the profession, and even the scientific underpinnings of the technique. The Editor or Science, Donald Kennedy” recently wrote in an editorial that fingerprint evidence “is unverified by statistical models of ... variation or by consistent data on error rates.” The bottom line question is, of course, does fingerprint evidence and testimony meet acceptable evidence standards.

Often, the main issue in fingerprint evidence courtroom use is whether fingerprint examiners can accurately determine the identity of a latent print found at a crime scene. This partially arises because latent prints are often incomplete, the average size of a latent print from a crime scene is only 22% of that of a reference print. Latent prints may also be distorted by the surface upon which they are found and the method of contact, adding further uncertainty to the comparison between two prints. It is certainly true that fingerprint testimony is not completely infallible and an unquestioned reliance on this evidence cannot be justified. But it is generally believe that the problems lie mainly with the testimony of identity itself and not the basic premise that fingerprints are both a unique and permanent records of a person’s identity.

But, errors in analysis do occur. A recent estimate places the error rate at about 0.8%, or a little less than one in one-hundred comparisons, while another investigation placed the error rate much higher. There have also been, however, several highly prominent recent cases of mistaken identity using fingerprints. One of these cases involved the Portland, Oregon lawyer, Brandon Mayfield, whose file prints were matched with...
fingerprints obtained from the 2004 Madrid, Spain railcar bombing. Experts matched Mayfield’s fingerprints with those from Madrid, with the FBI calling the match "100 percent positive" and an "absolutely incontrovertible match". Mayfield was jailed for two weeks based upon this evidence before the Spanish National Police examiners showed the error in the analysis and he was released and exonerated.

Nonetheless, fingerprint evidence remains a powerful investigatory and courtroom technique that is generally relied upon as scientifically valid, reliable and trustworthy when applied in a rigorous manner. It has withstood significant Daubert challenges so far and remains an important part of forensic investigations and courtroom proceedings.

**Palm and Footprint Evidence**

Fingers are not the only portions of our bodies covered with epidermal friction ridges. Ridges are also found on the palms of our hands and on the soles of our feet that display many of the important pattern characteristics that are so important in fingerprint analysis. While palm and foot ridge pattern analysis is less well developed relative to fingerprint analysis, the information derived from palm and footprint pattern analysis can still be very useful.

The patterns observed on our palms and feet not only contain patterns of friction ridges but also show complex patterns of flexion creases - places where the skin flexes or folds to cause breaks in the observed ridge patterns. The major creases are formed prenatally and are places where the epidermis and dermis of the skin are very firmly anchored together, necessary because of their rugged use. Generally, our palms show three prominent creases and numerous smaller creases (Figure 7.2.30). One major crease runs in our palms “underneath” our fingers, called the *distal transverse crease* (“distal” meaning farther from the main part of our body and “transverse” meaning that it runs perpendicular to the axis of our hands). A second crease runs parallel this first crease but closer to the trunk of our body and arms and is called the *proximal transverse crease* (“proximal” meaning closer). The final main crease runs along the boundary of our thumbs in the palm and is called the *radial transverse crease* (“radial” since it close to the radius bone not that it radiates). These three creases break the palm into three separate regions for more detailed analysis. In addition to these major creases, our palms and feet show many, many very fine, thin creases that break up the ridge lines (Figure 7.2.31).

---

**Figure 7.2.30.** Palm print regions and generalized ridge patterns (Anil K. Jain, Fellow, IEEE, and Jianjiang Feng (IEEE Trans. on PAMI).

**Figure 7.2.31.** Palmprint with many thin creases (L) and the ridge characteristics completed computationally by VeriFinger (R) (Anil K. Jain, Fellow, IEEE, and Jianjiang Feng (IEEE Trans. on PAMI).
The ridges in our palms contain sweat pores like the fingers but our palms ridges do not contain any hair or oil glands. Like fingerprints, however, the ridges on our palms and feet show a variety of fine minutiae features that can be classified, identified and located for analysis and comparison. These patterns provide a unique set of pattern features that can be used to identify the prints in a very similar fashion to that described earlier for fingerprints (both one-to-one and one-to-many processes). A typical fingerprint pattern contains about 100 minutiae features while a palmprint contains about 800 minutiae features. Palmprint identification will be an important component of the FBI’s new NGI system, since it is estimated that about 30% of prints recovered from crime scenes are palm and not fingerprints.

The patterns on our feet and hands appear to be persistent throughout life and form entirely unique patterns that are individual to each person, as are fingerprints. The use of palm and foot prints does, however, suffer from the same problems encountered in fingerprint use; incomplete images, poorly resolved features, and small recovered areas of the prints. Palm and foot prints carry the added difficulty of the numerous complex patterns of fine creases and lines interrupting the ridge patterns, cause difficulties in automated identification of the prints.

Nonetheless, analysis of our palms and foot ridge and crease patterns is expected to become increasingly important as we understand more about how to analyze these features.

EAR AND LIP PATTERN EVIDENCE (pinnascopy and cheiloscopy)

The use of lip marks and ear shape patterns has been proposed as another way of linking a biological feature to a particular person. In order for any technique to be employed, it must first be demonstrated that it provides unique information and that the information is permanent (does not change over time or easily changed by design).

Lips have been shown to contain many “elevations and depressions” along their surfaces (sometimes called grooves), although these do not have direct biological similarity to the ridges found in fingerprints (Figures 7.2.32 and 7.2.33). It was proposed as early as 1902 that the pattern formed by these groves could provide a means of personal identification. A number of methods for identifying lip marks features have been developed, although none has gained general acceptance.

![Figure 7.2.32. Typical pattern of grooves found on lips](http://www.cosmogirl.com/beauty/get-the-look/beauty-kiss-of-approval-0907).

![Figure 7.2.33. Examples of ear shapes](http://www.shef.ac.uk/dcs/research/groups/graphics/teaching/mscprojs).

A number of studies have been undertaken to determine whether cheiloscopy, the study of lip groves patterns, meets the requirements of scientific validity to define legal uniqueness and permanence. It has been used in several court proceedings with mixed admissibility. One study in
Japan measured the lip marks of over 1300 subject, including a number of identical twins, and found them uniquely different and followed several others for several years at noted that the patterns did not appear to change. The scientific validity of the technique remains, however, untested and a great deal of work is needed before this technique can find acceptable use in forensic investigations and courtroom proceedings.

In a similar fashion, the shapes of a person’s ears has shown significant variation and have been used to tie a particular person with a “found” earprint (pinnascopy), such as on a window, door, or mirror.