SCARS, MARKS & TATTOOS
FOR PERSON IDENTIFICATION
IMAGES THAT SPEAK A THOUSAND WORDS
Surveillance cameras cannot provide a suspect’s name or address, but they can give you a ‘human license plate’ in the form of a tattoo. Victims and witnesses often remember distinctive tattoos and other marks, even when they recall little else. This means SMTs can play a significant part in person identification. However, they also pose challenges for the law enforcement officers that have to process them. In this brochure, WCC presents the solution for efficient and effective SMT management.

**What tattoos can tell you**

Scars, Marks, and Tattoos (SMTs) can identify individuals despite changes in physical appearance caused by aging, weight changes, or drug addiction. SMTs can also reinforce identifications that were based on other parameters.

Tattoos are of particular interest, and therefore the main focus of this brochure, for three reasons.

1. **They are increasingly common**: one in five U.S. adults has at least one tattoo. The number is even higher for delinquents.
2. **They are fairly permanent**: because the pigment sits so deep in the skin, tattoos are hard to remove, and usually not even erased by burns.
3. **They often hold information** about the person: for example, a gang tattoo can provide information about time spent in prison, criminal history, and affiliations.

Clearly, SMTs are a vital investigative tool; both for narrowing down the possible identities of victims and suspects, and when other identification methods fail. Effective SMT management helps ensure that nothing falls through the cracks.

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**Heroin trafficking in Amsterdam, the Netherlands. Home invasion in Vancouver, Canada. Armed robberies in Illinois, Texas, and Wisconsin. Statutory rape in Oklahoma, a fatal shooting in California, murder in Florida. What do all these cases have in common? Just one thing: tattoos were instrumental in solving them.**
Challenges and consequences

Three main challenges stand in the way of using SMTs effectively.

1. Inadequate classification
   The current standard for describing SMTs in a structured manner, ANSI/NIST-ITL 1-2011, has several limitations. The most critical are:
   
   » The standard uses over 70 class and subclass labels to describe tattoos, most of them very generic. This means they fail to capture the tattoo’s full semantic information. For example, the class “FLAG” contains only six subclasses: American, State, Nazi, Confederate, British, and Miscellaneous. Clearly, “FLAG - Miscellaneous” could describe any of a vast number of quite dissimilar tattoos.
   
   » Label assignment is manual. That makes it tedious and time-consuming, but also subjective and error-prone. Law enforcement maintains millions of images. Often, these are of complex tattoos containing multiple objects from different classes. That means the same tattoo could be filed under completely different labels. For example, a stylized clown face could be labeled as ‘human’, ‘abstract’, or ‘symbol’ by different officers. Figure 1 shows three examples of inconsistent assignment of ANSI/NIST classes to near-duplicate tattoo images.

2. Inadequate image quality
   When labels are too varied and subjective for searching and matching, images are the second-best alternative. To obtain accurate matches, photos of SMTs should be high-quality. Unfortunately, inadequate photography equipment and techniques often result in low-resolution or badly-lit images which impair effective matching.

3. Inadequate automation
   There are no systematized databases dedicated to SMTs yet. Searching and matching through massive amounts of images uses up a tremendous amount of resources. It becomes extra challenging when SMT images are stored from disparate and legacy databases, and even more so when the search-and-match process is done manually. The 2015 NIST report Tattoo Recognition Technology – Outcomes and Recommendations confirms that automated image recognition needs further improving.

Because of these three stumbling blocks, too many SMT searches fail. Law enforcement cannot afford to overlook information: missing a piece of the puzzle can make or break an investigation.

But processing all available information does take time. Often, this slows down investigations and creates far reaching issues including but not limited to:

» stressed workforce
» lack of public trust
» budget overruns
What is the target to aim for?

Law enforcement officers need technology and tools that help them process and organize complex information. These tools must be economical, efficient, and user-friendly. Every search should produce matches, even when working with low-resolution or partial images, tattoos assigned with multiple keywords, and disparate or legacy databases. The result of SMT searches should be high-quality identities that law enforcement can trust as investigative leads.

WCC ELISE for SMT management

Collecting SMT data is a wasted effort if the information they hold is not accessible. WCC provides the means to put that information at your fingertips. WCC’s software platform ELISE performs thorough searches using structured data (SMT location on the body), unstructured data (keywords, ANSI/NIST labels), or SMT images. Most importantly, it can do all of these searches simultaneously to optimize results.

Search on keyword

Currently, the most common approach to matching tattoos is keyword-based. But keywords can be incomplete or misspelled. ELISE uses affinity matching on keywords and ANSI/NIST labels to find similar tattoos. For example, it will match “Birds” to “Cardinal”, “Hawk”, and so on.

ELISE uses fuzzy logic to compensate for data-entry errors like typos. When letters are accidentally omitted or transposed, or the wrong key is hit by mistake, ELISE will still find the best matches. For example, it knows that misspelled keywords such as “SYMBL” and “SYMBOK” were intended as “SYMBOL”.

Search on color

Tattoo images usually have a dominant color. These colors are standardized according to ANSI/NIST as well. But colors can be subjective or hard to tell apart. And tattoos can fade with time. Through affinity matching, ELISE makes sure that a slight miscoding of a color – for example, blue instead of gray – will still yield all possible matches. Similarity scores are calculated from tables that hold near-equivalent words, names, or concepts, as seen in figure 2.

<table>
<thead>
<tr>
<th>Color Equivalencies</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blue</td>
</tr>
<tr>
<td>Blue</td>
</tr>
<tr>
<td>Gray</td>
</tr>
<tr>
<td>Black</td>
</tr>
</tbody>
</table>

Figure 2: Color equivalencies
Search on tattoo location
WCC collaborated with the medical faculty of Leiden University to define a standardized interface for indicating SMT location: a clickable map of the human body. The clickable map shown in figure 3 was inspired by this interface.

ELISE’s fuzzy-matching capability makes it possible to find matches in the proximity of the indicated locations on the body. In addition, ELISE can simultaneously search on multiple criteria besides location, such as tattoo image, gender, and facial features.

Figure 3: Clickable map for tattoo location
Among the millions of unique tattoo images maintained by law enforcement agencies, many contain multiple objects and have large intra-class variability. ELISE addresses this by using "repeating groups" wherein a single tattoo can be described as consisting of multiple objects and possessing multiple descriptions.

For example, a suspect has a large tattoo comprising roses, leaves, and branches. This tattoo runs from her shoulder down to her wrist. Two witnesses describe the tattoo. Witness A says the suspect has a swirly tattoo covering her entire left arm, and Witness B says the tattoo has blue roses with green leaves. Based on these descriptions, the tattoo is categorized under different ANSI/NIST labels, respectively: "ABSTRACT" – "Sleeve", and "PLANT" – "Blue Flowers", "Drawings of Flowers", and "Rose". Due to its size, the tattoo is photographed in sections. Despite these different labels and segmented images, ELISE can still pull up meaningful matches, including the tattoo image shown above.

Combining classification and search approaches to improve results is possible via ELISE. In fact, it is highly recommended – especially in light of the 2015 NIST report outlining the current challenges in automated tattoo image recognition. ELISE is unique because it enables users to combine different search methods and modalities. Given the as yet unresolved limitations of automated image matching, this is currently the most effective way to match SMTs. Of course, as third-party automated tattoo algorithms become more viable and available, WCC can easily integrate these into the SMT search methodology.

With its fuzzy logic, innovative interface, consistent input, and full compliance with ANSI/NIST standards, WCC ELISE is a comprehensive solution for effective SMT management.
WCC improves police operations

In most police departments, SMT matching consumes too much time, money, and manpower. Officers get bogged down in needlessly complicated search processes. They are frustrated by manual errors and delayed by procedural roadblocks. Worst of all, they miss out on important information that could help them prevent and solve crimes.

Entering SMT data and search queries should be effortless. Technology should not be a drain on resources, but an asset. Law enforcement agencies need a consistent processing framework that yields conclusive and actionable results.

WCC’s ELISE provides such a framework. Through it, searching and matching becomes more automated and integrated into the work process. Since ELISE can work with structured and unstructured data – even simultaneously – it delivers potential matches even where there used to be none.

The way forward

With WCC ELISE, searching SMTs results in valuable information that police officers can actually use in their investigations. Person identification with SMTs becomes more accurate and less time-consuming. The resources freed up can be spent on police work rather than procedure.

Of course, soft biometrics like SMTs are just one part of the solution. In addition to SMT matching, WCC offers a range of powerful solutions and services to meet the needs of law enforcement. WCC’s ELISE not only enhances law enforcement capabilities, but also helps them progress and evolve into more modern and flexible systems. Among ELISE’s many benefits are efficient data migration and legacy database management, multimodal fusion (combining biographic and biometric data), and advanced name matching capabilities.

WCC enables governments and law enforcement agencies to leave no stone unturned as they prevent and solve crimes to keep citizens safe.
About WCC

WCC Smart Search & Match is the world’s leading supplier of search and match software solutions and services. Founded in 1996, WCC focuses on two specific solution areas: Identity matching and Employment matching. Its ELISE software platform excels in these areas because it searches and matches data in a unique way that yields more meaningful results than any other software. ELISE is designed to search through vast amounts of data from various sources and return relevant results in under a second. It will search and match data in almost any form, using advanced algorithms, contextual knowledge, and other proprietary expertise. The data can be exact or inexact, structured or unstructured, private or public, and combine multiple modalities, both biographic and biometric.

WCC’s long-term experience in developing and supporting employment and identity matching solutions makes it an expert in these fields. WCC understands the business of its customers and knows how to optimize the effectiveness of searching and matching.

WCC’s primary customers are government organizations and large enterprises worldwide. In Identity matching, WCC supplies solutions for border management, justice & public safety, and civil identity. In Employment matching, WCC supplies solutions to public employment services, staffing companies and large enterprises for their corporate HR.

WCC is headquartered in Utrecht, the Netherlands, and also has offices in the USA.