The Henry Classification System

International·Biometric·Group

R e s e a r c h   C o n s u l t i n g   I n t e g r a t i o n

Request for permission or further information should be addressed to:

International Biometric Group
One Battery Park Plaza
New York, NY 10004
(212) 809-9491

Table of Contents

Introduction

The Henry Classification System is a long-standing method by which fingerprints are sorted by physiological characteristics for one-to-many searching. Developed by Sir Edward Henry in the late 1800s for criminal investigations in British India, it was the basis of modern day AFIS classification methods up until the1990s. In recent years, the Henry Classification System has generally been replaced by ridge flow classification approaches.

History and Development of the Henry Classification System

Although fingerprint characteristics were studied as far back as the mid-1600s, the use of fingerprints as a means of identification did not occur until the mid-1800s. In roughly 1859, Sir William Herschel discovered that fingerprints remain stable over time and are unique across individuals; as Chief Magistrate of the Hooghly district in Jungipoor, India, in 1877 he was the first to institute the use of fingerprints and handprints as a means of identification, signing legal documents, and authenticating transactions. The fingerprint records collected at this time were used for one-to-one verification only; as a means in which records would be logically filed and searched had not yet been invented.

In 1880, Dr. Henry Faulds wrote to Sir Charles Darwin, explaining a system for classifying fingerprints, asking for his assistance in their development. Darwin was unable to assist Dr. Faulds, but agreed to forward the letter to his cousin, Sir Francis Galton. Dr. Henry Faulds and Sir Francis Galton did not engage in much correspondence, but in the following decade, they devised very similar fingerprint classification systems. It is unclear whom to credit for the classification system. However, we do know that Dr. Henry Faulds was the first European to publish the notion of scientific use of fingerprints in the identification of criminals. In 1892, Sir Francis Galton published his highly influential book, *Finger Prints* in which he described his classification system that include three main fingerprint patterns - loops, whorls and arches.

At the time, the alternative to fingerprints was Bertillonage, also known as Anthropometry. Developed by Alphonse Bertillon in 1879, Bertillonage consists of a meticulous method of measuring body parts for the use of identifying criminals. In1892, the British Indian police force adopted Anthropometry. Two years later, Sir Edward Henry, Inspector General of the Bengal Police in India became interested in the use of fingerprints for the use of criminal identification. Influenced by Sir Galton's *Finger Prints*, the men corresponded regularly in 1894; and in January of 1896, Sir Henry ordered the Bengali Police to collect prisoners' fingerprints in addition to their anthropometric measurements. Expanding on Sir Galton's classification system, Sir Henry developed the Henry Classification System between the years1896 to 1897. The Henry Classification System was to find worldwide acceptance within a few years.

In 1887 a commission was established to compare Anthropometry to the Henry Classification System. As the results were overwhelmingly in favor of fingerprints, fingerprinting was introduced to British India by the Governor General, and in 1900, replaced Anthropometry. Also in 1900, Sir Henry was sent to Natal, South Africa to assist in the reorganization of the local police force and establish a fingerprint bureau. His efforts in South Africa were highly successful; and in 1901 Sir Henry returned to Britain and was appointed Assistant Commissioner of Scotland Yard, head of the Criminal Investigation Department. In the same year, the first UK fingerprint bureau was established at Scotland Yard. (Harling 1996) (Met) (Early)

Explanation of the Henry Classification System

The Henry Classification System allows for logical categorization of ten-print fingerprint records into primary groupings based on fingerprint pattern types. This system reduces the effort necessary to search large numbers of fingerprint records by classifying fingerprint records according to gross physiological characteristics. Subsequent searches (manual or automated) utilizing granular characteristics such as minutiae are greatly simplified.

The Henry Classification System assigns each finger a number according to the order in which is it located in the hand, beginning with the right thumb as number 1 and ending with the left pinky as number 10. The system also assigns a numerical value to fingers that contain a whorl pattern; fingers 1 and 2 each have a value of 16, fingers 3 and 4 have a value of 8, and so on, with the final two fingers having a value of 1. Fingers with a non-whorl pattern, such as an arch or loop pattern, have a value of zero. (Harling 1996). Images of various fingerprint patterns are illustrated below:

Arch   Loop   Whorl
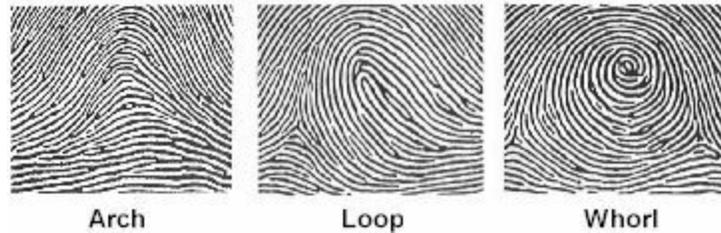
(Fingerprints)

In accordance to the Henry Classification System, finger numbers and finger values are assigned as following:

	L Pinky	L Ring	L Middle	L Index	L Thumb	R Thumb	R Index	R Middle	R Ring	R Pinky
Finger Number	10	9	8	7	6	1	2	3	4	5
Value (if Whorl)	1	1	2	2	4	16	16	8	8	4

The fingerprint record's primary grouping is determined by calculating the ratio of one plus the sum of the values of the whorl-patterned, *even*-numbered fingers; divided by one plus the sum of the values of the whorl-patterned, *odd*-numbered fingers (Harling 1996). This formula is represented below:

Henry Classification System Formula:	$\dfrac{1+ \text{(Sum of whorled, EVEN finger value)}}{1+ \text{(Sum of whorled, ODD finger value)}}$ = Primary Grouping Ratio

If, for example, an individual has a fingerprint record with a LWAALALWLA pattern series (the series begins with Finger 1, the right thumb and ending with Finger 10, the left pinky), the corresponding classification ratio would be 19:1. This example is calculated below:

	L Pinky	L Ring	L Middle	L Index	L Thumb	R Thumb	R Index	R Middle	R Ring	R Pinky

Finger Number	10	9	8	7	6	1	2	3	4	5
Value (if Whorl)	1	1	2	2	4	16	16	8	8	4
Pattern Type	**Arch**	**Loop**	***Whorl***	**Loop**	**Arch**	**Loop**	***Whorl***	**Arch**	**Arch**	**Loop**
Finger Value	**0**	**0**	***2***	**0**	**0**	**0**	**16**	**0**	**0**	**0**

Example: $\dfrac{1+ \text{(Sum of Even finger value)}}{1+ \text{(Sum of Odd finger value)}} = \dfrac{1+ (16 + 2)}{1 + (0)} = \boxed{\dfrac{19}{1}}$

Therefore, this individual belongs to the 19:1 primary group. If, for example, an individual does not have any whorl-patterned fingerprints, his or her classification ratio, or primary group, would be 1:1. If an individual has all ten fingerprints containing a whorl pattern, his or her classification ratio would be 31:31. The Henry Classification System allows for up to 1,024 primary groupings.

Impact on Current Biometric Systems

The Henry Classification System has been a highly influential force in the formation of current AFIS technology (Automated Fingerprint Identification System). When AFIS technology was first introduced, it was primarily envisioned used as a tool to expedite the manual searching of fingerprint records, eventually reducing matching time requirements from months to hours. At that time, most forensic hardcopy fingerprint files were sorted according to the Henry Classification System and the first AFIS solutions attempted to emulate the Henry process.

Up until the mid 1990s, it was not unusual for a state or city to continue to maintain its physical file of Henry-sorted fingerprint cards just in case a disaster occurred in the AFIS. As processing speeds, network throughput capacities, and system reliability increased, it was no longer necessary for automated fingerprint matching to mirror what had been the manual processes. AFIS began to classify fingerprints according to the distance between the core and delta, minutiae locations, and pattern type; the later being based on the Henry Classification System. Presently, there are some forensic AFIS solutions (e.g. state and local) that still employ a Henry Classification System based manual fingerprint filing. However, other than for legacy systems, the Henry Classification System is not essential for automated systems. (Carlton)

Newer Approaches to AFIS Matching

In the early 1980s, states and larger localities began acquiring AFIS systems; and by 1995, funded in part by the federal government, all states either had their own AFIS or had access to a regional system for automated fingerprint matching. Meanwhile, the Department of Justice and FBI continued to employ a manual fingerprint storage and retrieval system, lagging behind the rest of the law enforcement community until the development of IAFIS.

The Henry-based AFIS, although a significant improvement over manual systems, have several limitations. At that time, most forensic hardcopy fingerprint files were sorted according to the Henry Classification System and the first AFIS solutions attempted to emulate the Henry process – which some experts believe was a critical and costly mistake. Reasons for this belief include Henry's lengthy and convoluted finger pattern "definitions" that are extremely difficult to

translate successfully into a "computer definition", and the multiple sum classifications and references which do not lend themselves easily to automated classification procedures and are time consuming. Furthermore, the Henry-based AFIS solutions suffer from the same limitations as with the manual system – the system requires a trained technician to examine fingerprint records before being stored on AFIS and therefore not fully automated; the Henry Classification System only works if all ten fingerprints are available, thereby limiting its use in civil identification which normally includes only one or two fingerprints; and borderline pattern fingerprints may be stored incorrectly. These experts believe that when designing AFIS, the pattern definitions of the Henry system should have been discarded and instead relied on computer generated pattern type based on ridge flows direction or some other type of word topology, and that these patterns should be given designations such as 1.2.3.4. without any ties to the Henry system. Early fingerprint examiners would often disagree with the computer-generated Henry classification of given fingerprints and override the classification feature, thereby nullifying the benefits of an automated system. (Woodward)

These limitations led the FBI to overhaul the AFIS system in1989. By 1999 the IAFIS (Integrated AFIS) was released, projected to perform more than 80,000 searches once fully developed. Unlike AFIS, IAFIS does not employ the Henry Classification System or other binning logic. All IAFIS records are maintained in flat files and searches are based on ridgeline counting. IAFIS is able to perform more flexible searches, including not only fingerprint information, but other descriptive information as well. (AFIS) (Carlton)

In 2001, AFIS systems in four US states performed "completely 'lights-out' ten print to ten print AFIS identifications" (AFIS). "Lights-out" identifications mean that the entire process was performed without human intervention. These ten print to ten print matched were reported by the system to be positive identifications. To ensure accuracy, these "lights-out" identifications are subject to Quality Assurance/Quality Control inspections, particularly if the subject denies the identity match.

Resources

All links active as of July, 2003

http://www.ridgesandfurrows.homestead.com

Carlton, Dennis. International Biometric Group internal resources.

http://www.aucklandcitypolice.govt.nz/Specialists/Forensic_Services/fingerprints.htm

Harling Michael (1996). Origins of the New York State Bureau of Identification.
http://www.correctionhistory.org/html/chronicl/dcjs/html/nyidbur2.html

Metropolitan Police Service Centenary Fingerprint Bureau Press Pack.
http://www.met.police.uk/so/100years/centenary.doc

Woodward, Gary. AFIS expert – previously an Identification Technician, and a Manager/User/Implementer of initial AFIS systems.