

TECHNICAL NOTE

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Cracking the Code: A Decode Strategy for the International Business Machines Punch Cards of Korean War Soldiers

ABSTRACT: During the Korean War, International Business Machines (IBM) punch cards were created for every individual involved in military combat. Each card contained all pertinent personal information about the individual and was utilized to keep track of all soldiers involved. However, at present, all of the information known about these punch cards reveals only their format and their significance; there is little to no information on how these cards were created or how to interpret the information contained without the aid of the computer system used during the war. Today, it is believed there is no one available to explain this computerized system, nor do the original computers exist. This decode strategy is the result of an attempt to decipher the information on these cards through the use of all available medical and dental records for each individual examined. By cross-referencing the relevant personal information with the known format of the cards, a basic guess-and-check method was utilized. After examining hundreds of IBM punch cards, however, it has become clear that the punch card method of recording information was not infallible. In some cases, there are gaps of information on cards where there are data recorded on personal records; in others, information is punched incorrectly onto the cards, perhaps as the result of a transcription error. Taken all together, it is clear that the information contained on each individual's card should be taken solely as another form of personal documentation.

KEYWORDS: forensic science, forensic anthropology, forensic odontology, forensic computerization, Korean War, human identification, IBM, Electrical Accounting Machines (EAMs), punch cards, Central Identification Laboratory (CIL)

Herman Hollerith created the first electro-mechanical punch card system using 3" × 5" cards, a vat of mercury, and pins (1). Later, the statistician left his position at the Census Bureau and founded his own company, which came to be known later as the International Business Machines, or IBM (1). Since its initial invention, the electro-mechanical punch card system had been improved to the point where, by World War II (2), the military turned to Hollerith's creation as a quick and efficient means of keeping track of its personnel, particularly during wartime.

The machine used in this process came to be known as the Electronic Accounting Machine (EAM), which was used in conjunction with other machines, such as the Key punch, the Verifier, the Sorter, and the Collator (2). This assembly line of machines was utilized to separate the punch cards based on how a person would have wanted the cards sorted, that is, alphabetically or by map sheet location.

Currently, there are approximately 8600 individuals on record at the Central Identification Laboratory (CIL) as casualties of the Korean War (1950–1953), most of whom have punch cards included in their military records. However, after the war, these

cards were not used as a source of further information on the soldiers, as the machinery used to interpret them had been lost and there was no known way of understanding what was encoded.

The intent of this article is to present a possible means of reading these lost soldiers' punch cards; hopefully, this will enable more of our nation's heroes to be identified and brought home. The author has posited that the information contained in these cards will allow researchers to better understand what kind of information they have and what they can do with it. Unfortunately, it appears that the cards should only be referenced on a general level as there are areas where the punch cards and the actual information in the serviceman's folder are conflicting, such as in the dental section.

Methods

Unfortunately, there was no precise method of figuring out how information was encoded on the individuals' punch cards other than to read through all of the material on hand. From there, any given information was duly recorded and noted; the information was then compared with the punches available on the cards. Making an educated guess and testing the hypothesis through trial and error deciphered anything that was not explicitly given in the reference texts (2). However, there were two variables in particular that needed to be taken into consideration during the decoding process.

The first variable involved the appearance of the punch cards themselves. According to the information on file at the CIL, punch cards of the Korean War era looked similar as in Fig. 1.

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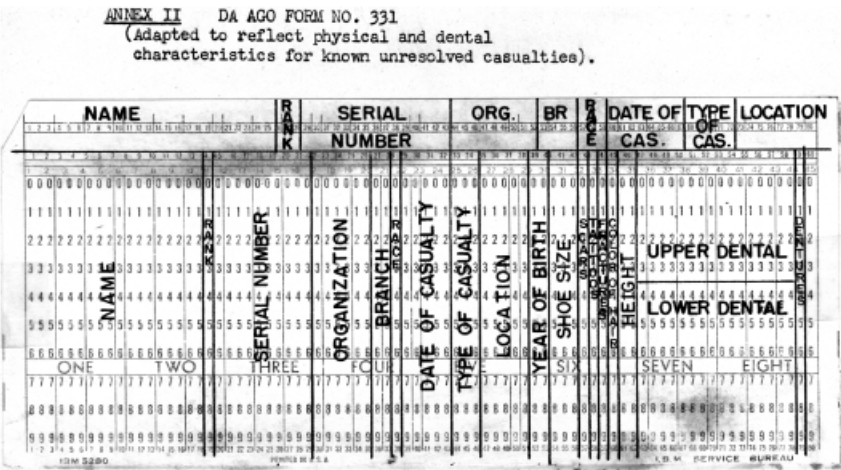


FIG. 1—Korean War punch card template.

However, the punch cards contained in many of the lost soldiers' folders looked as in Fig. 2.

It appears that, apart from outward appearance, there was no significant difference in the way the information was recorded onto the cards.

The second variable lay in the information itself. For the most part, the personal information pertaining to each individual is as complete as possible; however, making a positive identification requires definitive and accurate personal information. The dental records of soldiers during this time are rather sparse and not consistently documented, allowing for different or misinterpretations of the dental information. The medical records were quite copious for most of the soldiers, but unfortunately, there is no category that singles out this type of information. This inconsistency and ambiguity in the actual records makes it difficult for any punch card decode strategy to be completely accurate and foolproof.

What follows is the current working decode strategy of the IBM punch cards used for soldiers of the Korean War.

Decode Strategy

Name (Columns 1–18)—The individual's name appears to have been encoded by following this pattern:

Base	1	2	3	4	5	6	7	8	9
X	A	B	C	D	E	F	G	H	I
0	J	K	L	M	N	O	P	Q	R
	S	T	U	V	W	X	Y	Z	

A Base punch was found on the base line beneath all typed information on the punch card; an X punch was found in the margin between the Base punch and the 0 punch. Most names were coded last name, first name, middle name/initial with one blank column between each until the individual's name was entered completely. If an individual's full name contained more letters than columns, as much of the name was coded for as possible.

It is important to note that all following letters of the punch cards follow this same alphanumeric code.

Rank (Column 19)—In the cases of the Air Force, Army, and Marine Corps, the same basic idea was used to encode the ranks of their men:

	Air Force		Army
7	A2C	7	Pvt E-2
6	A1C	6	Pfc E-3
5	SSgt	5	Cpl E-4
4	TSgt	4	Sgt E-5
3	MSgt	3	Sfc E-6
Base 7	2nd Lt	1	MSgt
Base 6	1st Lt	0 7	WOJG
Base 5	Capt	Base 7	2nd Lt
Base 4	Maj	Base 6	1st Lt
Base 3	Lt Col	Base 5	Capt
Base 2	Col	Base 4	Maj
		Base 3	Lt Col
		Base 2	Col

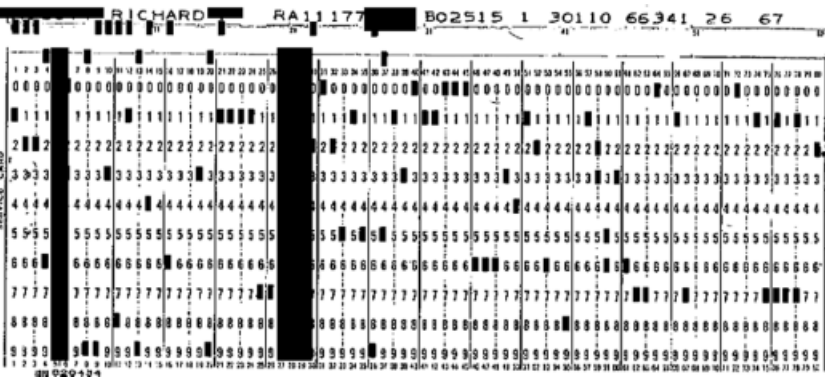


FIG. 2—Korean War punch card.

and

Marines	
8	Pvt
7	Pfc
6	Cpl
5	Sgt
4	SSgt
3	TSgt
1	MSgt
Base 7	2nd Lt
Base 6	1st Lt
Base 5	Capt
Base 4	Maj
Base 3	Lt Col
Base 2	Col

Omissions of rank punch indicate that no individual was recorded on punch cards as having a specific rank. Neither the Air Force nor the Army or Marines record a rank for a 2 punch; this logic has not yet been understood. The Army also recorded a Warrant Officer Junior Guard with a double punch of 0 and 7, but it is not clear why or how this code was selected for this rank.

In the case of the Navy, the general idea of coding for rank was similar, but there were some discrepancies between numbering and ranks.

	Navy
No punch	All ranks lower than AN
1	AN
Base 7	ENS
Base 6	LTJG
Base 5	LT
Base 4	LCDR
Base 3	CDR

It is not clear why several Navy ranks are not punched and why they are not obviously differentiated on the individuals' punch cards. It is also not immediately obvious why punch numbers 2 through 7 and Base 2 have not been observed for the Navy individuals; perhaps Base 2 may have been used for those who attained the rank of CAPT, although individuals of such rank were not observed. Omissions of rank punch indicate that no individual was recorded on punch cards as having a specific rank.

It is important to note that ranks in all four branches of the military have changed over time and therefore not all ranks can be confidently accounted for at present.

Serial Number (Columns 20–29)—In most serial numbers, there is at least one letter before the actual numbers are coded that go as follows:

AF	Air Force (Enlisted)	MA	Marines (Enlisted)
AO	Air Force (Officers)	MO	Marines (Officers)
RA	Army (Enlisted)	NA	Navy (Enlisted)
O	Army (Officers)	NO	Navy (Officers)
US	Draftees (4)	ER	Enlisted Reserve (4)

However, not all serial numbers contain these letters and it is not clear why the letters were not recorded. It is particularly ambiguous for those individuals who had clear identification of the military organization they belonged to and their rank at the time of postulated death.

All columns were used to record the individual's serial number; blank columns were left between any letters used and the ensuing numerical digits to ensure that all 10 columns were utilized.

Organization (Columns 30–35)—This section has been somewhat ambiguous; it appears that the organization is representative of the company or unit that the individual was assigned to in the military. Observations indicate consistency in how companies

were recorded, i.e., AO = A Company, as well as battalions or cavalries since the same numbers were used for the same division. However, the method that was used to determine how the code was created is still being questioned.

Branch (Columns 36–37)—Branch was punched according to what type of duty an individual was assigned. So far, the ones that have been observed are:

IN	Infantry	AT	Artillery
HQ	Headquarters	MD	Medic
EN	Engineer	NA	Navy
AR	Army	MA	Marine
AF	Air Force	MC	Marine Corps
TK	Tank	TC	Transport Cargo

It is assumed that there were probably more branches coded for as there were numerous duties and tasks performed, but these were the ones encountered during the study. The interpretations of the two letters punched on the cards were inferred by the information that was given for the soldier's branch on his 371 form.

Race (Column 38)—Race was coded as follows (2):

1	White
2	Negroid
3	Chinese
4	Japanese
5	Malayan
6	American Indian
7	Filipino
8	Puerto Rican White
9	Others
10	Puerto Rican Colored

It appears that "Others" was the category for those of Mexican descent as the individuals with a 9 punch had "Mexican" listed under the race category of their 371 forms.

Date of Casualty (Columns 39–43)—The individual's date of casualty is recorded as day, month, year. However, only the last digit of the casualty year is recorded; it has been conjectured that only the last digit was thought crucial as it was obvious when the Korean War had occurred, and therefore only the last digit was important as the year would have been 195[x] in any case.

In the case of those who were missing in action (MIA) and thought to be killed, their date of casualty was recorded as 1 year and 1 day after the date they were presumed to be missing.

Type of Casualty (Columns 44–46)—The only two types that were seen were 006 and 001, meaning MIA and Killed in Action (KIA), respectively. Numbers 601 and 609 were also seen on the punch cards, but as far as observations allowed, these two 600 numbers appear to have been errors in punching.

Location (Columns 47–51)—This was otherwise referred to as the "place of casualty (2)" and corresponded to either the assumed place of death or an actual eyewitness observation. It correlates to the map sheet location of death according to the "L751 series of topographic maps of Korea published by the U.S. Army Map Service during the Korean War (3)." The first four digits are standard, while the fifth corresponds to the quadrant and is actually read as a Roman numeral.

Year of Birth (Columns 52–53)—The year of birth is recorded as the last two digits of the individual's year of birth.

Shoe Size (Columns 54–56)—This piece of information was not recorded very often; it is not clear why it was not used as frequently as others. It appears to have used all of the columns possible, starting with a blank column if only two columns were needed to code the information. The first number is the actual shoe size of the individual, followed by the width, which is A, B, C, D,

or E, coded by 1, 2, 3, 4, and 5, respectively (2). However, it is noted that shoe sizes were also punched according to a person's best guess. In other words, if an individual was recorded as having shoe size 8½ E, the ½ was denoted either as a Base 8 punch in the same column, an 8 and 5 punched in the same column, or the ½ was ignored completely. The same can be said for sizes such as 8EE; sometimes, the second E was noted and in other cases it was not.

Scars, Tattoos, and Fractures (Columns 57, 58, and 59)—As with shoe size, the individual's scars, tattoos, and fractures were hardly ever recorded accurately on their punch cards. It is posited that as each individual had a quite comprehensive medical record and the punch cards were meant for concise information presentation that these columns were often left blank or punched as a 1; if one really needed this information, they only needed to find the individual's medical records. However, if used, the code read (2):

Scars, Tattoos, and Fractures

1	No report
2	Right arm
3	Left arm
4	Torso
5	Right leg
6	Left leg
7	Head

Color of Hair (Column 60)—As with shoe size, scars, tattoos, and fractures, color of hair was not recorded very often either. It is posited that this information was also obtained through viewing the comprehensive medical records of the individual. If used, the code read as follows (2):

1	No report
2	Red
3	Brown
4	Blonde
5	Gray
6	Black
7	None

However, there are individuals in which color of hair has been recorded but when compared with the medical records, the punch card information is incorrect. The reason for this is not known.

Height (Columns 61–62)—The individual's height is recorded in inches on the punch card. However, as with hair color, there has been conflicting information recorded on the punch card when compared with the medical records. In the case of height, however, there are also discrepancies recorded within the medical records; hence, it is difficult to determine which data set is truly accurate.

Upper Dental (Columns 63–78, punches 0–3)—Based on looking at several individuals' dental records, it appears that the punch cards recorded the following information:

Base	Restoration
X	Crowns
0	Carious
1	Missing (does not seem to differentiate between extracted and unerupted)
2	Nonrestorable (includes carious and impacted)
3	Bridgework

It appears that the punches used to record the condition of the upper teeth mirror the punches used to record the condition of the lower teeth.

As the dental records are rather sparse and it is often questionable as to which set of records were actually used to create the punch cards, this code is a hypothesis at best.

Lower Dental (Columns 63–78, Punches 4–9)—Based on looking at several individuals' dental records, it appears that the punch cards recorded the following information:

4	Restoration
5	Crowns
6	Carious
7	Missing (does not seem to differentiate between extracted and unerupted)
8	Nonrestorable (includes carious and impacted)
9	Bridgework

However, as the dental records are rather sparse and it is often questionable as to which set of records were actually used to create the punch cards, this code is a strategy at best.

Dentures (Column 79)—The code for dentures was given as follows (2):

X	Denture, full upper
0	Denture, full lower
1	Denture, partial upper
2	Denture, partial lower

If there was no punch indicated, it was assumed and confirmed through observation of dental records that the individual did not have dentures.

Confirmed POW (Column 80)—According to General Hastings of the Adjutant General Statistical Accounting Section, column 80 reflected the confirmed POWs (5). It appears that there were two punches that were used: a 1 and a 2 punch. The 2 punch was used consistently throughout the four services to denote a confirmed POW but the 1 punch was more ambiguous. Only the Air Force used it in conjunction with a 2 punch, and appears to mean that the individual was a potential POW but there was no evidence to confirm the suspicion.

Results

A random sample population of 100 individuals was taken and analyzed based on their punch cards, 371 forms, and dental and medical records to see how well all of the information correlated with one another (Table 1). It should be noted that some of the information is sparse despite the potential ease with which such information could be gathered (e.g., shoe size). A second separate

TABLE 1—Random sample population (100 individuals).

	% Correct	% Incorrect	% Ambiguous	% Blank
Name	94	5	1	0
Rank	92	6	2	0
Serial number	99	1	0	0
Organization	66	9	16	6
Branch	93	2	0	5
Race	97	3	0	0
Date of casualty	96	4	0	0
Type of casualty	92	5	1	2
Location	87	1	12	0
Year of birth	99	1	0	0
Shoe size	37	7	45	11
Scars	89	7	3	1
Tattoos	95	1	3	1
Fractures	90	5	5	0
Color of hair	94	2	1	3
Height	65	1	1	33
Approximate dental accuracy	95*			

*Will be addressed.

TABLE 2—*Individuals with column 80 punch observed.*

	% Correct	% Incorrect
Confirmed POW punched	~ 26	~ 74

TABLE 3—*Random sample among those with column 80 punch.*

	% Correct	% Incorrect
Confirmed POW punched	1	32

random set of 100 individuals was analyzed based on the fact that some sort of punch had been made under column 80 to discern the accuracy of POW accounting (Table 2). Nearly three fourths of all soldiers to be denoted as prisoners of war were classified incorrectly. A third set of 100 individuals was analyzed, again with the intent of discerning the accuracy of POW accounting; however, this time a third random set of 100 individuals was chosen, with column 80 as the focus of analysis (Table 3). Of those denoted as prisoners of war, only one person was a confirmed POW. All results are listed as percentages in each respective group.

Discussion

After analyzing a sample population of those soldiers with surviving punch cards, there are several glaring discrepancies in the method utilized in processing the required information. At this point, it is difficult to tell where errors were made during the punch card production, but the end results of these inconsistencies cast a shadow on the dependability of the card system.

The main purpose and goal of the punch card system was to establish "... associations of MIA and KIA unrecovered casualties of a conflict by making mechanical comparison of the physical and dental characteristics of the known casualties with the physical and dental characteristics of the remains of unknown decedents which have been obtained as a result of processing the unknown remains ..." (2) Both the physical and dental information recorded on the punch cards was taken from each serviceman's 371 form in order to further promote consistency in sources of personal information.

However, according to the information that was observed on the punch cards, the 371 form was not the only source for identifying characteristics; in four cases, the dental information was completely inconsistent with the 371 form and in one case the individual did not have a 371 form or its equivalent anywhere in his file. By not consistently referring to the same forms for information, it becomes difficult to validate the accuracy of a card that is supposed to lead investigators to the correct identification of unknown remains. In order to figure out consistently how the dental information was observed and recorded, it is necessary to go through all of the dental records available in an individual's file and compile all of the information into a comprehensive picture of the dentition.

It is acknowledged that the Standing Operating Procedure 3 (SOP 3) states that dental information from all sources was culminated into a punch card format; however, it also states that dental information could also be interpreted differently based on different records and thus as many different punch cards were made for as many different interpretations that were possible. One would therefore expect numerous punch cards to be found at least

occasionally in some servicemen's files; unfortunately, there were no such occurrences during this study and any additional punch cards found were duplicate pairs. It is possible that these other cards were somehow lost or even destroyed at some point between the end of the Korean War and the present, but without being able to find different cards for the same individual, this is pure speculation.

In further looking at the information gleaned from this study, it also becomes apparent that the main goal of the punch card system may not have been as successfully attained as previously thought. In recording "Type of Casualty," 8% of the sample population was recorded either incorrectly, ambiguously, or was left blank; when 8% is translated to the entire group of 8600 servicemen, a potential 688 soldiers may have been misfiled or overlooked in the sorting process prior to positive identifications. Depending on the perspective one has, a 92% accuracy may be outstanding when trying to keep track of that many people as a group; however, if looking at this from the 8% perspective, the possible outcomes may be devastating.

By cross-referencing the information contained in the SOP 3 and the results from this study, other discrepancies have been noted. In the SOP 3, there are several decks that punch cards were sorted into; one deck was known as the work deck, which was arranged according to the month and year of casualty. Based on this study's results, as many as 344 soldiers could have been overlooked in the punch card sorting process on their date of casualty alone. A second deck arranged by Laundry Mark sequence was utilized; however, in viewing several hundred files, the Laundry Mark sequence was not readily observed and therefore it is not completely understood. A third deck was arranged alphabetically for those who required several cards to record conflicting dental information; again, no such cards were seen and therefore nothing can be said definitively on the subject. A fourth deck was arranged according to map sheet location; in this case, 13% or 1118 soldiers may have been misfiled and thrown out of the potential matches pile. However, in all cases that were observed in the random sample set, map sheet location had to have been obtained from material other than the 371 form as the location was given as a general area of loss as opposed to an actual map sheet location. In some cases, the only information given for "Location" on the 371 form was "Out at sea." Further study is required to correlate how the L750 map series from the Korean War era and the modern map series system match one another. A fifth deck was used as back-up in the event that cards became unusable for any reason; a sixth deck was known as the POW deck, which contained the cards of those prisoners of war who were known to be captured. The sixth deck is one that raises many questions when viewed in relation to the results of this study.

Two different sets of 100 individuals were examined in relation to Column 80, denoting confirmed POW status. The first set of 100 soldiers was chosen based on the appearance of a punch in the last column whereas the second set of 100 was chosen at random. Out of those who were supposedly confirmed prisoners of war, at least 74% were not. Among these 74%, it was ambiguous at best as to why those soldiers were said to be confirmed prisoners. It is possible that there is some information that was not recorded or was not kept in the files, but with information on the status of American soldiers as important as this, it is hard to believe that individuals would be noted as prisoners when nothing of the sort was known. However, it does appear in some situations where the status of the missing individual is completely uncertain and anything was possible, the cards erred on the side of caution and denoted those people as prisoners of war. At the same time,

there was barely any distinction made between those who were confirmed prisoners of war and those who were possible prisoners. The only cases where there was some difference were in records of Air Force personnel; in two of 12 Air Force cases, there was either a 1 punch or a 1 and a 2 punched but the rest of the cases that were uncertain were not marked at all. The same kind of questions cropped up in the second population; according to the personal records and punch cards of the random 100 servicemen, 33 should have been marked in some manner. Of these 33, only one person was punched correctly. While it has not been determined exactly how many of the 8600 servicemen in the Korean War were prisoners of war, 32% being marked incorrectly is quite a staggering number of people. The percentages of individuals marked incorrectly with regard to capture POW status is astounding and calls into serious question the accuracy of positive identifications made based on those individuals who were thought to be prisoners of war; in other words, identifications may have been made on a population that excluded 99% of the total 8600 soldiers, leaving the number of those investigated at 86.

The idea of excluding individuals based on captured POW status was not the only way of eliminating unlikely individuals as matches for an unknown set of remains. Based on the information obtained on a given set of unknown remains, one could select for any characteristic observed and run the entire set of cards through the sorter. This process could be repeated any number of times until a small set of cards was left, which would then be further investigated in depth for possible matches to the remains (2).

For example, if the report of interment for a remains in question should indicate place of death to be on Map Sheet 6630-IV, the machine will be operated so that only those cards which show a similar location will drop into a separate pocket. If the characteristics of the remains indicate blond hair, white race and a height of over 6 feet, the number of separated cards may be further reduced by successively sorting for each of these characteristics. Similarly, the dental could be sorted to determine those having favorable dental characteristics (2).

To take the example individual described, we can start with a population size of 8600 individuals. Assuming that all of the information on all of the individuals' cards is correct, by process of elimination, one would have to only work with approximately 4434 individuals taking those four characteristics alone. In principle and theory, the punch card sorting system is a wonderful and efficient concept. However, in practice, not all of the information was correct on all of the cards as evidenced by none of the recorded data having 100% accuracy; with sections like "Organization," "Location," "Shoe Size," "Scars," and "Height" having less than 90% accuracy, there is a large margin of error, particularly when dealing with thousands of people.

It must be acknowledged that those records with reference to the punch card aspect of the Korean War are rather sparse as are many of the records of those who served our country during that conflict. During the course of this study, new information appeared concerning the codes that were used in producing the punch cards. A report written by General Hastings of the Adjutant General Statistical Accounting Section included how the alphabet was punched and the code used for the dental section. However, the information from General Hastings' report further confirmed the accuracy of the code proposed by this author. The General further clarified that Column 80 was used to note those of confirmed POW status and that half sizes for shoes were not used. Again, information was found to the contrary on both accounts; further in-depth analyses of two separate populations involving Column 80 were shown to be highly inaccurate. In the case of shoe sizes, there were two different ways of recording half sizes that was interpreted; in one, there were several that read Base 8

punch then a 5 punch, indicating a shoe size of $8\frac{1}{2}$ E. In a second case, there were several that read an 8 and a 5 punch in the same column, then a 5 punch in a different column, also indicating a shoe size of $8\frac{1}{2}$ E.

Conclusion

Imagine a soldier from the Korean War who is 24 years of age and stands about 5' 7" tall with brown hair and brown eyes. He is of Caucasian ancestry and was most likely a Private First Class in the Army. This man was probably in the infantry and may have just missed becoming a prisoner of war in the North Korean camps, but is nonetheless declared MIA to his family and friends as his whereabouts after a chaotic firefight are still unknown.

Enter the role of the IBM punch cards during the early 1950s. This system was one being utilized to match identifications to unknown remains recovered both during and after the Korean War. The punch card sorting process was probably relied upon quite heavily as there were thousands of servicemen who needed to be accounted for; however, in reviewing the codes used and the accuracy with which they were used in the punch card system, questions may logically arise as to the positive identifications made for unknown remains based on the closest possible matches to the observed or known character traits listed. If someone's card was punched incorrectly based on information used to eliminate nonmatches, how would this mistake be rectified later? Was it ever rectified? How many mistakes of this sort were made and would there be enough to stir unrest in the families of those who suffered a loss?

These are questions that may never be answered because of the scarcity and ambiguity of the surviving records of those involved in this foreign conflict. However, the purpose of this study was not to create alarm over the events of the early 1950s but to devise a decode strategy that may be used toward understanding how information was used and compiled in an effort to send more of our lost servicemen home. At the very least, it seems safe to use the information on the cards as a general guideline for future recovery efforts of these men.

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