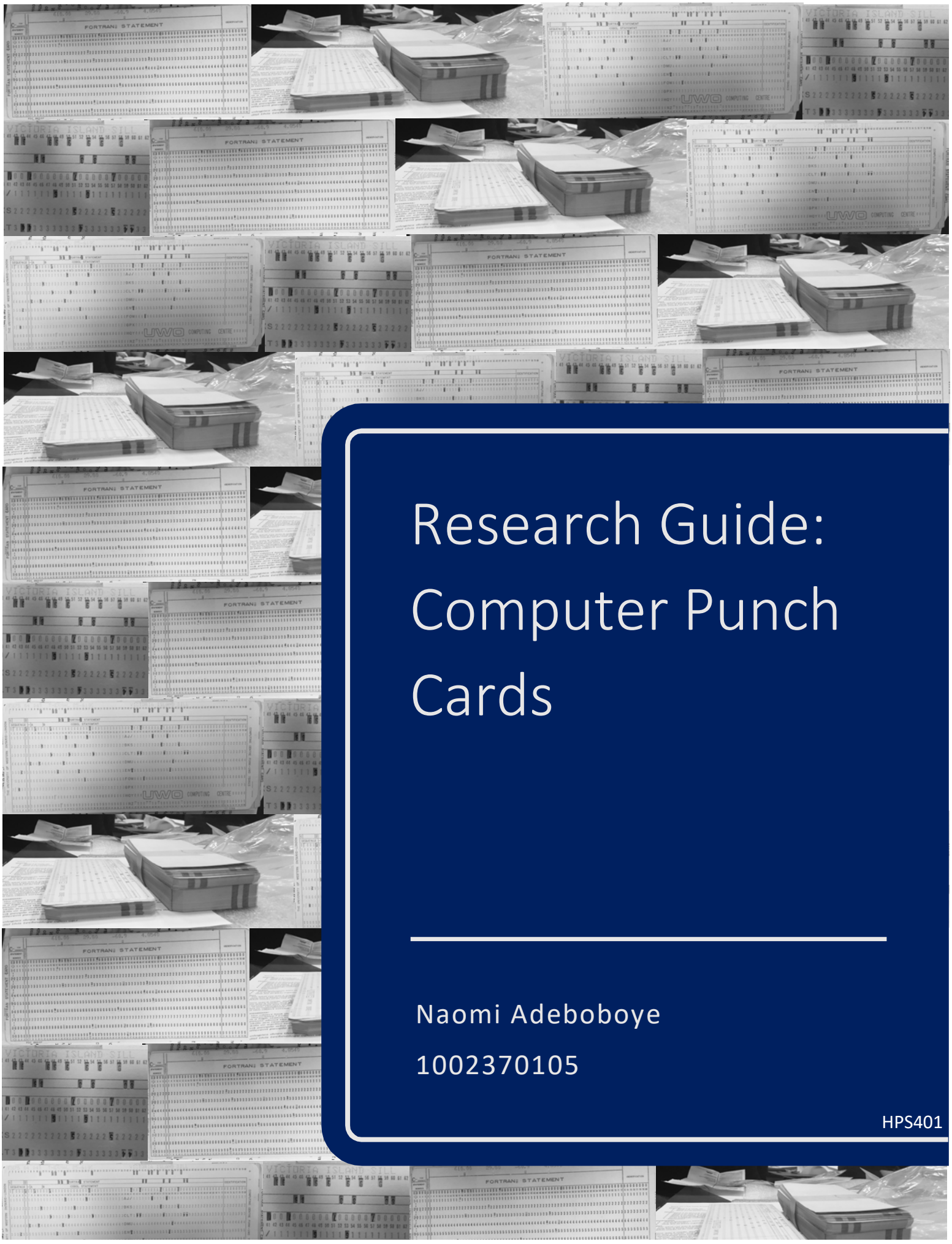

Research Guide: Computer Punch Cards

Naomi Adeboboye

1002370105

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Introduction

The purpose of the following guide is to provide future researchers a strong foundation for their inquiries and research pertaining to this artifactual item in the University of Toronto's Collection (UTSIC). This set of cards was recently added to the UTSIC. Before their acquisition, these computer punch cards were being used as metric spacers to level experimental equipment in a physics laboratory here at the university; a true testament to how easily these cards could be repurposed in versatile ways after the media itself became obsolete.

Pre-research Evaluation of the Artifact

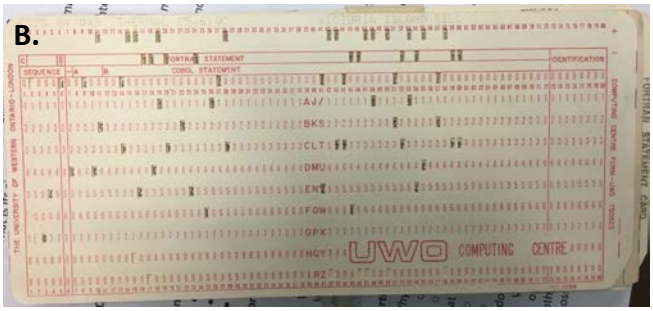
First Impressions

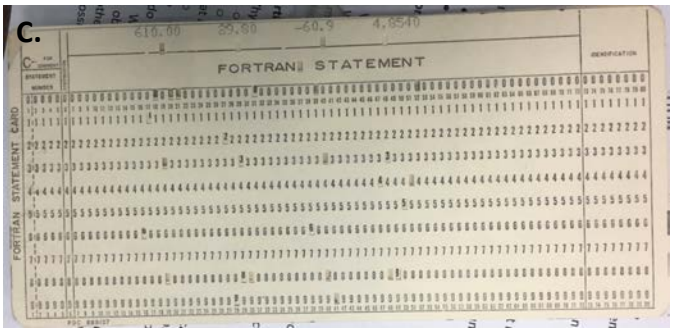
The artifact of interest for this guide is depicted in a series of photos in Figure 1. Upon receiving the artifact, one could make a number of visual observations. This artifact seemed to be a set of cards made of paper; some were bundled together using masking tape (Fig 1 A,E,F), others were loose for observation (Fig 1 B-D, G-H). The cards were intact with slight weathering around the edges indicating they had been well used at some point but appeared to be in relatively good condition as there were no major rips and all the printed information on the cards was still clear and readable. The cards were not uniform in appearance, indicating that perhaps different cards were used to relay different information. A brief excerpt was provided for this artifact stating that they were most previously used as metric spacers, to level equipment in physics laboratories, which is likely why the two stacks of taped cards had the words '1.0 cm' and '2.0 cm' written on them in pencil(Fig 1 E, F). These numbers likely indicated to their users the height of each stack of cards.

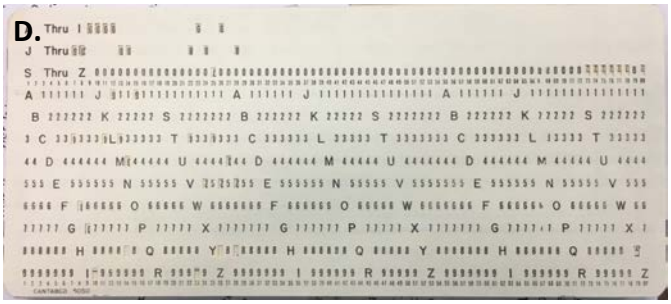
Guiding Research Questions

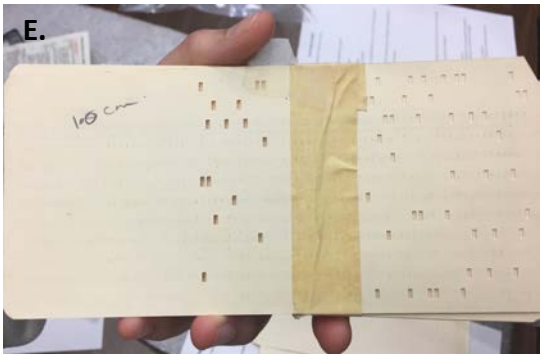
There were a number of questions I initially asked to guide the research:

1. How did this object survive throughout time?
2. How might people using this object think of it? What is its significance?
3. Is this a complete set of cards?
4. What machines and other technologies are required alongside these cards?
5. How might one understand the markings found on these cards?
6. What were these cards used for?









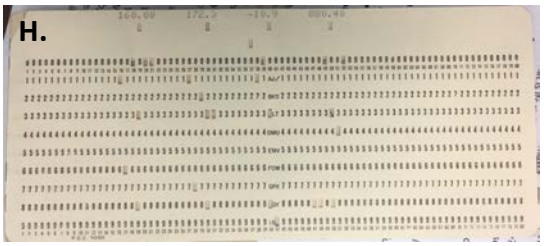


Figure 1 A series of photos of our artifact of interest **A.** The complete set of cards belonging to this collection **B.** A card that appears to have been initially belonged to a set from the University of Western Ontario **C.** Likely a data card that would have been used to program with the language FORTRAN **D.** A general purpose punch card **E.** The first stack of cards bound together with tape for use as metric spacers. The height of this stack written in pencil on the top left corner of the card **F.** The second stack of cards bound together; the height of this stack is written underneath the tap binding it together **G.** A job card that would precede any other cards being fed into the card reader; this card would state what job needs to be done and by whom **H.** Another general purpose punch card, likely used for programming.

Findings

Throughout the research process a number of sources were assessed that may provide further insight on this artifact. The following section of the guide presents the sources that were consulted in order to produce an accurate interpretation of these computer punch cards and answer the guiding questions.

Websites

I began my search on the online search engine google (https://www.google.com), as I felt this would provide me with the best general understanding of these items and would answer some questions that I may not be able to find within an academic paper. Below I have listed the websites consulted, within chronological order of how I accessed them, as well as the key words searched in order to come across each set of websites.

Key search words: History of FORTRAN

The words 'FORTRAN' were printed on a number of cards so I thought this would be a fair place to begin my search. The following sources provided me a bit of background information on how FORTRAN works so that I was able to begin to understand what some of these cards may actually have been used for:

History of FORTRAN Language. (2019). Retrieved from Live Physics: http://www.livephysics.com/computational-physics/fortran/history-fortran-language/

This source provided me a very brief history on FORTRAN, what this language was and the possibilities that it began for the programming world.

FORTRAN. (2014, May). Retrieved from Beans The Magazine for Kids, Code, and Computer Science: https://www.kidscodecs.com/fortran/

As this link lead me to a computer science magazine geared towards children, it provided me with a very fundamental understanding of what a programming language was, how FORTRAN came to be, how this language worked and how it was used.

Key search words: Is FORTRAN an assembly language

Information Systems Technician Training Series, Module 2 - Computer Systems. (n.d.). Retrieved from Integrated Publishing: http://informationtechniciantraining.tpub.com/14223/css/Assembly-Languages-81.htm

After consulting a number of sources on the history of FORTRAN words like 'assembly language' continued to pop up casually within the text without much reference to what an assembly language actually was. I used these key words to search in order to be able to distinguish between the several different types of programming language that existed. Computers are only able to understand information in 0s and 1s, a binary language called machine language. This

language was very complicated and hard for many to understand at face value therefore a number of other assembly languages were created. These languages essentially use mnemonics to symbolize key operations, allowing the programs to be more user friendly. This web page discusses the main assembly languages that are used; something interesting I learned is that it seems different languages are often created for different types of tasks. For example, there is a business oriented language named COBOL. FORTRAN is math and science based language and there are also languages that are useful for teaching and general purpose tasks.

Key search words: FORTRAN Cards

Mills, D. L. (n.d.). *Anatomy of a Hollerith Card.* Retrieved from https://www.eecis.udel.edu/~mills/gallery/gallery9.html

I began searching with these next key words in an attempt to better understand the cards themselves. This search yielded the website above that was very helpful in providing the basic knowledge of how many rows and columns were found on each card, how individuals would prepare the cards and subsequently how they would be read.

Computer programming in the punched card era. (2016). Retrieved from Wikipedia: https://en.wikipedia.org/wiki/Computer_programming_in_the_punched_card_era

The notable information I took away from the source was mainly its mention of the machinery used in order for the cards to be prepared, read and even copied. This included a key punch used to punch the appropriate holes into the card and a verifier which was used to check for punching errors. Also, machines that would be able to reproduce decks and main frame computers that the cards would be fed into; punch cards would provide the instructions for these computers so they would know how to analyze any data cards that were to follow the instruction set. As well, card sorters machines were available that could help to reorganize a disorganized set of cards. Additionally, within the references section of this link I came to the next link presented below.

IBM Punch Cards. (2013). Retrieved from Columbia University Computing History: http://www.columbia.edu/cu/computinghistory/cards.html

This webpage is of particular importance because it provided relevant links to information on the history of punch cards and the machines and equipment they depended on. It also provided a link to a useful article on the culture associated with computer punch cards (see *Articles* section).This is the point my research where I began to understand versatile nature of punch cards in general and how they were used for a lot more than just programming.

Key search words: Types of Computer Punch Cards

On google images I now began to look for links to websites that would hopefully talk about punch cards that looked similar to mine and provide me a bit of insight on why some our set look different from others.

Scott, J. (2016, July). *A COLLECTION OF PUNCHED CARDS* . Retrieved from http://www.jkmscott.net/data/Punched%20Cards.html

This link was particularly helpful as it provided photos and explanations of the different types of punch cards an individual may come across. This allowed me to determine that some of the cards within this set were general purpose cards (Fig 1D) and confirmed that others were made specifically for the program FORTRAN (Fig 1 B, C). It also provided information on some of the detailed characters on the face of the card and allowed me to determine that the printed information in the bottom margin of our cards was the manufacturer and form number. As seen in Figure 2 it appears there would be three main manufacturers that the cards of this set would have been made by: CDC, PDC and CANTABCO.

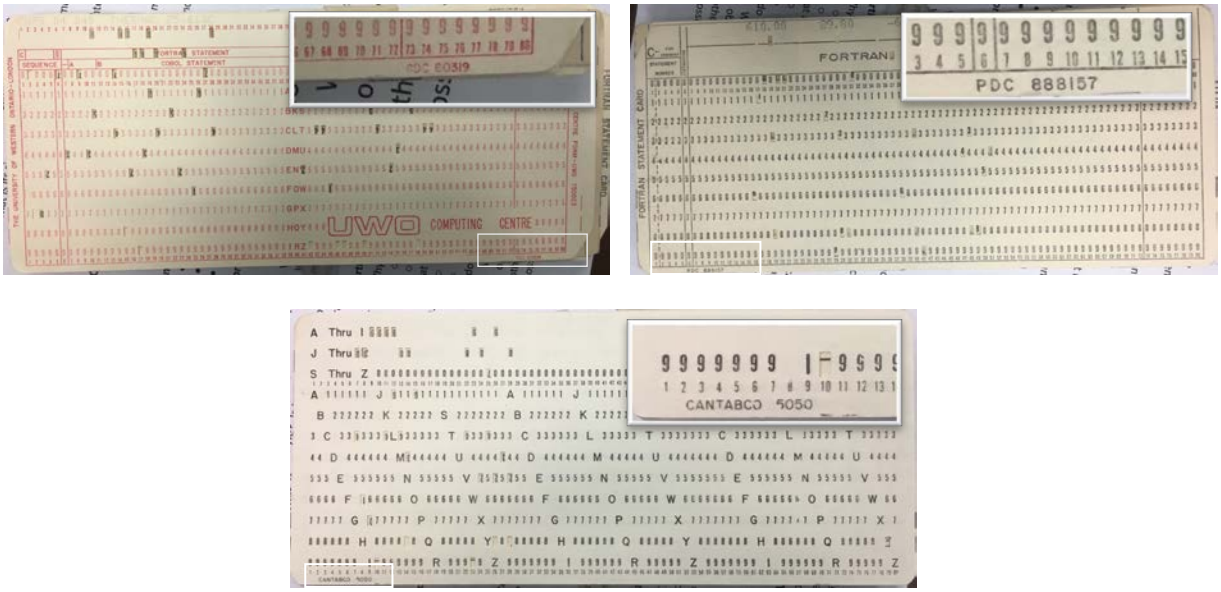


Figure 2 Photos of three cards from the set of interest that are all hypothesized to be made by different manufacturers, given the distinct markings in the bottom margin of each card. The white boxed area of each card has been blown up so that the proposed manufacturer name and number are more visible.

Key search words: CDC FORTRAN 63 Cards

I searched the label found in the bottom margin of one of my cards (CDC 60319) in the hope that this would provide me with the full name of this 'CDC' company represented by an acronym. And perhaps also provide me with an idea of what the numbers beside the manufacturer name represented, but both to no avail. I then tried to get more specific and added the name a popular model of the FORTRAN language system (FORTRAN 63) to the previous search words and that search yielded the following source below. This demonstrated that CDC stood for Control Data Corporation, which is a super computing company that also manufactures punch cards. Therefore, at least a fraction of these cards were produced by this

manufacturer. Searches of the other manufacturer acronyms did not yield any successful results.

Full text of "cdc :: cyber :: lang :: fortran :: 60483000C Fortran Extended Version 4 to Fortran Version 5 Conversion Aid Program Version 1 Reference Mar83". (n.d.). Retrieved from https://archive.org/stream/bitsavers_cdccyberlaortranExtendedVersion4toFortranVersion5C_3131033/60483000C_Fortran_Extended_Version_4_to_Fortran_Version_5_Conversion_Aid_Program_Version_1_Reference_Mar83_djvu.txt

Key search words: Labelled Programming Punch Card

I then continued in an attempt to find out what the other markings on the cards meant. After typing in the search word above on google images I came across a photo that lead me to this website.

Punched Cards. (2013). Retrieved from Applied Mathematics: University of Washington: http://staff.washington.edu/rjl/uwhpsc-coursera/punchcard.html

In retrospect, I found this post on the University of Washington's website to be quite interesting in the light of the video of Professor Brailsford (See *Videos* section). In the video when talking about the importance of having a set of cards in order, he discussed short cuts and tricks individuals would use to ensure their set was in the right order without having to go through each individual card numerically. In one of the photos provided on this webpage we see an example of this first hand, as individuals have written words and drawn lines across their sets of cards. Aside from being able to use this to label their card set, it was also used as an insurance mechanism, as if the cards were disorganized the drawn line or text would not match up correctly, indicating that some cards were out of order.

Key search words: How to Read a Computer Punch Card

Read Your Own Punch Cards. (2017). Retrieved from The Craft of Coding: https://craftofcoding.wordpress.com/2017/01/28/read-your-own-punch-cards/

This blog provided a very short and simple explanation on how to read what has been punched onto a punch card. This helped foster a greater understanding of how I could interpret what was written on my punch cards. This blog provides a legend so that one could figure out the characters represented by each combination of punched holes in a single column. They also shed light on the fact that the information punched onto the card, also know as its statement, is actually printed at the top of a finished card in human readable form. I would assume this accessibility feature made computing significantly easier, by being able to see the exact input one was providing to the machines. This also likely made it more easy to detect mistakes made in the instructions, just by being able to read them over before a run.

Videos

The following section presents a series of videos found with the search engine Youtube. I found these to be particularly informative about the punch cards and their use in a variety of different disciplines.

Key search words: Computer Punch Cards History

Computer Punch Cards Historical Overview - IBM Remington Rand UNIVAC - History Archives, # CH-0093. (2016). Retrieved from Youtube: https://www.youtube.com/watch?v=kKJxzay85Vk

This video speaks about the history of computer punch cards and how their popular uses changed overtime. This video also touches on the two major companies in the punch card tabulating machine industry and the timeline of their competition. This allowed me to have a greater understanding of the versatility of punch cards and also provided me with a visual representation of what punch cards for purposes other than computer programming looked like. I also began to appreciate that in a computing era, computers were not the only machines that punch cards could be used to do calculations with; electric calculating machines also existed. I would assume these machines would have less range of capability than a computer but would be still be effective a for quick and easy way to carry out simple calculations.

Punch Card Programming- Computerphile. (2013). Retrieved from Youtube: https://www.youtube.com/watch?v=KG2M4ttzBnY

This video provided me with basic knowledge of how the cards would have been compiled to perform a programming job. In this video Professor Brailsford from the University of Nottingham provides a brief outline of how characters are punched into the card, how characters punched are actually presented on the card in human readable form, and finally what different prompts provided by the card would instruct the computers to do. This was very insightful in terms of understanding more about the markings on the cards. He also spoke about ways that individuals would be able to tell if cards were in the correct order. For example, the chiseled corner that is present on our artifact of interest is a protective mechanism, that essentially allows the individual managing the set to know that all the cards are in the right direction simply by making sure the beveled edges of each card match up. This is one of the few methods that were discussed for ensuring that cards were in the right order, as this was something that was important and necessary for a program to work properly.

Articles

Following the broad internet search on the topic, I took to a more academic source to look for articles that would be helpful in gaining a deeper understanding of the punch cards within the context of their academic and social influence. The main search engine used to accomplish this was University of Toronto's Libraries website; http://onesearch.library.utoronto.ca/.

Key search words: Computer Punch Card Programming

Agar, J. (2006). What Difference Did Computers Make? *Social Studies of Science*, 869-907.

This paper discusses the impact that the computer has on science upon its introduction to practice. One claim I found to be particularly interesting was that computers were often developed within practices where the theoretical basis for computing had already been

established. Therefore, it was not like computing was entirely a new feat within itself, but rather a way for theory to finally become practice. Moreover, this paper discussed how punch cards offered increased speed and accuracy of computing when compared to methods used just before them. They also discussed how electronic computers following the punch cards, were able to increase the efficiency to an even great scale than the cards were able to. Interestingly, at one point this paper described punch card computing as a process that combined human, machine and method. The fact of the matter was that although in some cases people viewed punch cards and computing as a way to dehumanize tasks, humans were still very much needed in order to carry out computational tasks with punched cards.

Garner, R. (2013). STARS: EARLY POPULAR COMPUTERS, 1950–1970. *Proceedings of the IEEE* , 2134-2140.

This paper identifies punch card equipment as one of the oldest forms of a popular computer. The different changes this machinery underwent was discussed as well as costs of such machinery and its accompanying cards. This assisted in my research as it allowed me to have an idea of just how costly this equipment could be. Within the context of small businesses, punched card data processing could cost companies up to $2500 per month which is around $20000 when adjusted for inflation. This demonstrates that the machinery and often the sheer cost of having to buy millions of cards per year was truly expensive. With this being one of the earlier and less expensive ways to complete these automated computational tasks it allows one to consider how it may have been inaccessible for most institutions to keep up with the current technologies and thus have to use machines like punch-card operated equipment well past their period of social and technological relevance.

Lubar, S. (1992). "Do Not Fold, Spindle or Mutilate": A Cultural History of the Punch Card. *Journal of American Culture*, 43-55.

This source was linked on the website cited above (*IBM Punch Cards*, 2013). This paper discusses a famous saying that was associated with punched cards and is still remembered to this very day, demonstrating the longevity of the culture associated with materials. The phrase discussed embodies the cultural legacy of punch cards and has been remembered and associated with this item even into the present age, where this medium is now obsolete. The saying discussed within the paper had a lot of negative weight to it, as people viewed punch cards as dehumanizing and tools of bureaucratic control. This allowed me to see one perspective of how people using these cards during the peak of their popularity, viewed this technology. It also provides an alternative perspective to the commonly expressed opinion that everyone believes new technology is always a ground breaking heaven sent that is built to change everyone's lives for the better. This is evidence that this was clearly not always the case, and truly shows the need to seek out multiple perspectives when analyzing how people viewed artifacts, as this allows a more holistic understanding of its relevance to society.

Primary Sources

After consulting archivist Marnee Gamble (marnee.gamble@utoronto.ca) at the University of Toronto Archives and Records Management Services, I was able to determine a number of

relevant primary sources to examine. All of the documents consulted in the archives pertaining to this artifact were in records of Dr. Patterson Hume. Dr. Hume was a technological pioneer at the U of T and is known as one of the co-founders of the Computer Science Department here at the university. The majority of the records kept for the late professor were related to programming language courses he taught.

University of Toronto Archives, *Continuity of Programmer Training in a Changing Machine Environment,*(1962), p. 2-4, B2007-0007/009 (04).

This short abstract outlines how technology was frequently changing in the 1950s and 60s and emphasized that as a result, curriculum had to be altered to remain accessible. This allowed frequent changes in equipment to be met with continuity within the concepts taught. This was interesting as it discussed the impact changing technologies had on education here at U of T and how these changes shaped teaching.

University of Toronto Archives, *Design as Controlled by External Function,*(1968), p. 1-1, B2007-0007/009 (04).

This is another document which was helpful for my overall understanding of how punch cards were used. This provided somewhat of a how-to-guide on software systems, listing all the technical components required for something like a punch card program to run on a mainframe computer.

University of Toronto Archives, *Introductory FORTRAN Course,* p. 1-16, B2007-0007/009 (06).

This document is part of an introductory guide to FORTRAN. This was particularly helpful as it allowed me to determine how the cards in a set should be appropriately ordered to successfully be read by the machine and in contrast allowing me to be able to classify the set at hand as rigorously disordered.

University of Toronto Archives, *FORTRAN II Lectures,* p. 1-4, B2007-0007/009 (07).

This is a lecture given from a series about FORTRAN. This provided me information about the process of using punch cards to program. He speaks about the memory capacity of the cards, how quickly they can be read as well as what is required to punch, read and process the cards.

People to contact

The following section is a list of people that I contacted during my research to gain helpful insights at several points along my journey.

Professor Michael A. Bauer (Western University)

Key search words: UWO Computing Centre

When I began my search, I tried determine the provenance of the cards that had more obvious clues on them, such as the one in Figure 1B. A striking hint for this card that was not

present on the others was the large writing across: “UWO Computing Centre”. I assumed UWO stood for University of Western Ontario and with the knowledge that this institution still exists I assumed that the search words above would yield promising results. ‘UWO Computing Centre’ was actually autocorrected to ‘UWO Computer Centre’ by my laptop and brought me to this link.

Contact List. (2019). Retrieved from Computer Science: Western Science: https://www.csd.uwo.ca/our_department/contact.html

This link brought me to a webpage with the contact information for the individuals heading the computer science department at Western. Initially, I reached out to the Department Chair Ms. Hanan Lutfiyya (hanan@csd.uwo.ca) sending her a photo of the punch card in Figure 1B and asking if she was aware of anyone who might have an idea of the connection between our school and theirs to determine how we may have acquired this card. Ms. Lutfiyya then pointed me in the direction of Professor Michael Bauer (bauer@uwo.ca).

During my correspondence with Professor Bauer I learned a number of things. Punch cards were likely used at the UWO within the same decades as U of T: 1960s to 1980s. These cards allowed a wide range of students and staff to be able to accessibly write computer programs at their school, also similar to U of T. He also provided me information on the key punches and card readers required to actually create and read the data on the cards. He assured me that vendors were able to print logos or company names on cards, which is likely how this card obtained its distinct its appearance. Also, that the UWO Computing Centre was now known as Western Technology Services, which operates the main administrative computers of the school. Finally, he was not exactly aware of the direct connection between the schools that could have allowed us to obtain this card but assured me that in this media’s prime, U of T had its own collection as well as multiple card readers around the campus, accessible to staff and students.

Professor David Bailey (University of Toronto)

Professor Bailey (dbailey@physics.utoronto.ca) is a professor at the University of Toronto in the department of physics. Professor Bailey’s contact was part of the information I was given when assigned this artifact. Through an in person interview he provided me with an understanding of the cards’ longevity here at the university. He also provided me with information on their provenance mentioning that they had been acquired from a storage cabinet in the McLennan Physics building (room 245) before they were used by a laboratory here as metric spacers and finally given to the UTSIC. One particularly interesting theme throughout our conversation was the ubiquitous nature of these punch cards, that Professor Bailey noted, was likely the reason they had stayed around the university so long after the media had become obsolete. Furthermore, after discussing what jobs the information on the cards may have been used for, he speculated that information on the card in Figure 1B, likely had temperatures on in that may have been readings from a geophysics study. Thus, he provided me with the name of one of his colleagues in the geophysics department that may have known a bit more about the use of these cards.

Professor Gordon West (University of Toronto)

Professor Gordon West (west@physics.utoronto.ca) is a colleague of Professor Bailey's whom I was redirected to. After reaching out by email he provided me with lots of history on the technological changes that have happened at the U of T over the last several decades and noted that punch card operated machines would have been used at the school roughly from 1965-1980. When it came to the data on our Figure 1B card he said that he was not certain but if he had to guess, the card was likely temperature measurements of boreholes made by Professor Allan Beck. Beck was a former professor at the Western University who did research with his students at a number of west coast sites. Given that the card is from UWO and that the card reads 'Victoria Island' preceding the temperature measurements, it seems that this is an extremely likely match of information. Therefore, although not fully confirmed, this conversation allowed us to build upon the provenance of one of the staple cards within this set.

Outstanding Questions

To conclude, the research conducted has allowed the observation of these computer punch cards from numerous perspectives. This allowed us to piece together a narrative for the cards and their rich history, within the school and society in general. Future researchers may want to explore the following questions in order to solidify this narrative even further:

1. Is there a possible way to date these cards and determine which exact years they were manufactured?
    a. This would provide a more focused idea of when the cards themselves may have been punched and used.
2. What does the form number on the bottom margin of the card represent? And who were the outstanding manufacturers?
    a. During my research I was able to find out valuable information about the markings found on the front of the card. One outstanding number I'm unsure of is the form number and its significance. Could this provide us a better idea of the exact type of card and therefore a better idea of what the data on the cards could be?
3. Is it possible to get in contact with professor Allan Beck in order to see if he has any knowledge of the cards, particularly the one depicted in Figure 1B?