R E P O R T R E S U M E S

ED 019 809 40 EC 002 550

AN EXPLORATORY STUDY OF THE DEVELOPMENT AND UTILIZATION OF A GRADE TWO BRAILLE TRANSLATOR FOR THE HONEYWELL 222 HIGH SPEED BRAILLE PRINTER. FINAL REPORT.

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REPORT NUMBER BR-6-8925 PUB DATE 30 AUG 67
GRANT OEG-4-7-008925-0500
EDRS PRICE MF-$0.25 HC-$0.88 20P.

DESCRIPTORS- *EXCEPTIONAL CHILD RESEARCH, *VISUALLY HANDICAPPED, *BRAILLE, MACHINE TRANSLATION, COMPUTERS, INSTRUCTIONAL MATERIALS, SURVEYS, COMPUTER PROGRAMS, TECHNOLOGY, PRINTING, INPUT OUTPUT, BLIND, GRADE TWO BRAILLE, HONEYWELL SERIES 200 SYSTEM,

IN ORDER TO EXPLORE THE TECHNICAL AND PRACTICAL PROBLEMS INVOLVED IN BRINGING THE HONEYWELL MODEL 222 MODIFIED BRAILLE PRINTER TO FULL UTILIZATION, THREE OBJECTIVES WERE DEVELOPED--(1) EXPLORATION OF THE PROBLEMS RELATED TO THE DEVELOPMENT OF A TRANSLATOR SYSTEM, (2) EXPLORATION OF A SYSTEM FOR DIRECT INPUT OF GRADE TWO BRAILLE SO THAT THE ADVANTAGES OF AUTOMATION COULD BE PARTIALLY REALIZED, AND (3) EXPLORATION OF THE NEEDS OF TEACHERS OF THE VISUALLY HANDICAPPED FOR BRAILLED MATERIALS. A TRANSLATOR SYSTEM WAS DEVELOPED FOR THE HONEYWELL PRINTER WHICH CONSIDERED BOTH ITS SOFTWARE AND HARDWARE COMPONENTS THAT COULD BE MADE OPERATIONAL IN 1 1/2 YEARS. COST ESTIMATES FOR A FULL SCALE TRANSLATOR WERE ALSO OBTAINED. A PROGRAM OF DIRECT INPUT OF GRADE TWO BRAILLE WAS COMPLETED, AND THE POSSIBILITY OF USING REMOTE EQUIPMENT WAS EXPLORED. HOWEVER, IT WAS NOT POSSIBLE TO TEST THE PROGRAM. A SURVEY OF THE NEEDS OF TEACHERS OF THE BLIND IN CALIFORNIA REVEALED THAT THE DEMAND FOR GENERALLY AVAILABLE TEXTS IS LESS THAN FOR MATERIALS THAT ARE NOT IN SUFFICIENT DEMAND TO JUSTIFY MASS PRODUCTION (SUPPLEMENTARY TEXTS, SPECIAL INFORMATION PAMPHLETS, RECREATIONAL READING MATERIALS, ETC.). SUCH MATERIALS ARE APPROPRIATE FOR USE WITH THE HONEYWELL PRINTER. SUGGESTIONS ARE MADE FOR THE FUTURE DEVELOPMENT OF THE TRANSLATOR. TRANSPARENCIES FOR USE WITH DIRECT INPUT GRADE TWO BRAILLE ARE INCLUDED. A BIBLIOGRAPHY CONTAINS SEVEN ITEMS. (RS)

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U.S. DEPARTMENT OF
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An Exploratory Study of the Development and Utilization of a Grade Two Braille Translator for the Honeywell 222 High Speed Braille Printer

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Los Angeles, California

August 30, 1967

The research reported herein was performed pursuant to a grant with the Office of Education, U.S. Department of Health, Education, and Welfare. Contractors undertaking such projects under Government sponsorship are encouraged to express freely their professional judgment in the conduct of the project. Points of view or opinions stated do not, therefore, necessarily represent official Office of Education position or policy.

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Summary

The purpose of this study was to explore the technical and practical problems involved in bringing the Honeywell Model 222 Modified Braille Printer to full utilization. The system for producing Grade 1. Braille has been described by Horne (5,6). The systems problem confronting the investigator was to make a determination as to how the equipment could be used to produce Grade 2. Braille without the services of a trained translator.

Three areas of inquiry were developed. These were (1) exploration of the problems related to the development of a translator system, (2) exploration of a system for direct input of Grade 2. Braille so that the advantages of automation could be partially realized, and (3) exploration of the needs of teachers of the visually handicapped for Brailled materials should the Honeywell system be brought to full operational capacity. All three objectives were realized. It should be pointed out, however, that the statements in the proposal regarding the development of a model translator system were naive. It was determined that the development of a model translator would require the time and hardware needs necessary for the development of a full scale operational model. Neither the funding of the project nor the project personnel were adequate to achieve this goal.

Hardware and software needs for the translation program were identified. Cost estimates for a full scale translator have also been obtained. Provided sufficient funds were available and provided that the necessary systems personnel could be obtained, the system could be operational in about a year and a half.

The program for direct input of Grade 2. Braille was completed. Though transcribers were not trained to use it, it was felt that minimal time to become acquainted with keypunch or remote equipment would be required. The possibility of using remote equipment was explored. However, limited funds prevented testing. Experience gained at the University of Southern California in merging IBM Datatext equipment with the Honeywell 200 System has demonstrated the feasibility of using such a system in the Braille Program.

The survey of teacher needs was restricted to California inasmuch as the large majority of users in the immediate geographic area would be in California. All teachers of the blind were sent questionaires regarding their needs for Brailled materials. Eighty-two per cent of the teachers responded. Their responses suggested that the rationale for developing a system such as the Honeywell 222 is justified. The prime needs of teachers are not for the generally available texts. Rather, the needs are for materials which are

not in sufficient demand to justify mass production. That is, they are interested in obtaining secondary level textbooks, supplimentary texts, special assignments, general and special information pamphlets, recreational reading materials, tests, etc.

The major recommendation of the study is to develop the translator. This will require obtaining sufficient funds to do the following:

(1) Obtain more storage for the system as presently constituted at the University of Southern California
(2) Make some slight modifications in the printer
(3) Obtain the services of persons such as the Shack Associates to do the systems work.
(4) Test the use of remote input system

Introduction

A major problem in the production of Brailled materials is a marketing problem. The fact that approximately ten per cent of the 400,000 legally blind people in the United States reads Braille and the additional fact that about 33,000 of these use Braille actively must be taken into consideration. That this is a relatively small number of people with a wide variety of reading needs must be taken into consideration when trying to determine the marketing feasibility of developing automated systems for producing Braille. Louis Goldish (3) has estimated that the active market for Brailled materials in the next ten years will be approximately 50,000 readers. In addition, as blindness becomes increasingly an old age problem, the demand for Brailled materials will drop. When considering the costs and profits, it is difficult to see the private sector of the economy becoming interested in the reading problems of the blind. The problem is further complicated by the fact that the demand for Brailled materials is extremely varied. The greatest demand is in the areas of elementary and secondary textbooks as well as college textbooks and current reading material.

The Federal Government has long recognized the problems of obtaining a wide variety of embossed materials for a limited number of consumers. Certainly, this is a difficult assignment to fulfill in a profit motivated economy. The

American Printing House for the Blind has attempted, with the help of Federal funding, to provide for the reading needs of the blind for many years. Though the Printing House has done a yeoman job, there is still considerable difficulty taking care of the extreme variety and the limited instances of needs for reading materials. While it is relatively easy to obtain standard readers for the elementary school, it is difficult to obtain a book for one blind student who may perhaps be the only person who would need such a book. The general educational tendency to integrate the blind student in the regular class has compounded the problem. The resource teacher who must work with these students has a considerable problem supplying the blind student with the variety of reading materials which might be used in any one of the several integrated classes in which the student might be enrolled. This might include textbooks which are not embossed by the American Printing House, a marketing bulletin being used in the class, or a current events magazine.

Efforts are underway to speed up the output of the American Printing House for the Blind. Since the IBM 709 Computer System was installed at the Printing House, it is possible to obtain more embossed materials through the use of automation. Since 1964, 182 titles in 427 Braille volumes have been produced using the 709 System. These volumes consist of literary works, one textbook series, and some magazines. Though Haynes (4) reports that unlimited volumes can be produced by the 709 System, the process involves problems both from the production and from the storage standpoint. The need to store the many plates necessary for large scale production is significant. In addition, it would seem that efficiency would dictate that only materials which have a wide demand could be produced economically.

The problem of meeting individual needs or the needs of small groups of blind persons is currently being met by teachers transcribing materials for the students, engaging the services of a professional transcriber, or through the work of volunteer transcriber groups. In addition many materials are available through records and tapes. These procedures, though better than nothing, can not help but have a significant time-lag built in. The effects of this range all the way from those resulting in always getting materials late to those resulting from never getting the materials.

The fact that the American Printing House for the Blind is the only agency which produces Brailled materials on a large scale basis creates some problems. These are in the areas of limitations imposed by mass production and those imposed by the necessity of transporting materials from one place to the entire country and back again. These problems might be resolved by having other facilities in different parts of the country which have a similar production potential. If this is to be done by a local agency or by private industry, then certain problems must be resolved. Goldish (3) has commented on this. "In the Braille business, we have no profits that we can afford to lose" and further, "it is necessary to consider costs, uses, probable market, maintainance, reliability, and probable impact on the market of automated embossing equipment before trying to put it into production." In view of the description of the potential market for the next ten years, it is unlikely that private industry will move very rapidly into the field of the production of Brailled materials. This observation coupled with the above observation that the large scale card-to-plate system utilized by the American Printing House for Blind is best adapted for producing materials on a large scale basis, it is not likely that reading materials with limited demand will be readily available.

It would appear that a partial solution to the problem lies in economics. That is, finding an economically feasible system for producing embossed materials. This is necessary whether one is thinking in terms of private industry producing Brailled materials or whether one is thinking in terms of a school system or a Federal agency such as the Veterans Administration producing its own embossed materials. Economic feasibility lies in the development of high speed small computers which can emboss directly- that is, produce Brailled materials in much the same manner as a printing press produces ink print materials. Such a system would require a minimum of set up time, eliminate the need for large storage facilities for plates, eliminate the need for large storage facilities for produced materials (since one would not have to produce more copies than required on a particular order. Inasmuch as the material is stored on magnetic tapes, and subsequent copies can be made on demand), and provide for maximal variation in demand. Direct embossing would also make it possible to utilize some of the remote input systems which have been and are being developed. It would appear that production would most profitably be directed toward the short pamphlet, the newsette, the magazine, tests, and similar materials. Books could be produced by such a system, but the economic and time problems of producing multiple copies of books would require additional investigation.

It is proposed that the modified version of the Model 222 printer and the Honeywell Series 200 Computer is the basic hardware unit for meeting the requirements discussed above. This unit produces Braille comparable in quality to that produced by conventional means at a rate of 250 to 300 Braille lines per minute. The speed of production, the fact that the Braille is produced directly, and the potential for utilization of remote input systems make it possible for units of this sort to operate within the marketing parameters discussed by Goldish.

The purpose of this study was to explore the problems to be encountered in producing Grade 2. Braille with the Honeywell system. The major problems were those involved in determining the hardware and software requirements for a translation system which would enable a person who does not know Braille to input into the system. Other problems looked into included developing a system for input when the person operating the equipment knows Grade 2. Braille, considering the various choices of remote equipment which might be used with the Honeywell System, and determining the needs of the field which might be best met with a system such as Honeywell.

The Translator System

There are two areas for exploration when planning a translator system. These areas are the software system and the hardware system. For convenience, these will be discussed separately.

Software System - The system envisioned for the Honeywell Series 200 translation operation consists of three distinct programs. The first program is one which reads into the computer the material which is to be translated. The second program is the actual translation program. This program is one which must develop and maintain the dictionary of Braille terms with their English meaning and rules for use. In addition, it must contain the instructions for the computer so that translations can be made. The third program is for the purpose of controlling output. The system is divided into three distinct parts for very definite reasons. The most important reason is that it allows a certain degree of independence. Output and input devices can be modified as hardware is improved without changing the translation program. Again, if changes in the rules for Brailling come about, it is possible to modify the translation program without changing the input or output systems.

An additional advantage of the three-part system lies in making it available for research. It is possible to collect data at any point within the translation process. It is therefore possible to monitor the translation process as well as provide important data to linguists who are interested in word structures or frequencies in the English language. Since the input portion of the program provides output in the form of statistical analysis. This is possible at this point since no translation has taken place yet. The data is still, for all practical purposes, in its original form. In like fashion, data can be taken off immediately at the end of the translation part of the system. This may be of value to the student who would analyze the structure of Braille. Indeed, such a facility would make it possible to evaluate the appropriateness of existing rules of Braille transcribing. This may be useful with respect to the development of a more useful system of Braille.

The overall translation system is seen as consisting of three parts - one for input, one for translation, and one for output. Though the three parts are locked together as parts of a system, they nevertheless function independently with the advantages listed above.

Input Considerations - Information being fed into the system being considered is read in and broken into words. The term word has a specific meaning in the computer world and does not refer to a word in the sense of written or spoken language. Words are stored as separate units ready to be translated into Braille. Other information such as carriage control, line positioning, headings, etc. is also stored through this program. It will be noted that two types of information are being stored. These will be used in two different portions of the overall system. One sort of information will be used in the translation portion of the program and the other will be used in the output part.

Translator Considerations - This portion of the program is responsible for the correct rendition of language into Braille. Essentially, this program consists of the directions to the computer for taking a single word from the input program, scan the dictionary stored in the computer, make the proper contractions, and send the proper signal to the output portion of the program. This is a rather involved process in that the program is not simply a look up system in which matching Braille symbols are found for specific English words. Rather, Braille is written in accordance with a strict set of rules which governs the manner in which a given word will be contracted. The translator must check a set of rules stored with each entry in its dictionary to be certain that the contraction selected is legal in a particular context.

The complexity of the problem can be illustrated by an example of translating one contraction. The letters BLE are combined to form a contraction represented by a single Braille character. The rules for Braille say that the contraction may not be used at the beginning of a word. A rule to this effect is stored in the computer. When the word BLEMISH is entered into the computer, the contraction for BLE is not used since the rule that BLE is not to be contracted at the beginning of a word is already in the dictionary. Suppose, now, that the word UNBLEMISH is entered into the computer. The program will translate the BLE portion in contracted form. This is an illegal contraction. A second rule must be entered into the dictionary to the effect that BLE is not contracted if it follows a prefix. On the other hand, if the word GOBLET were entered into the computer, the BLE portion could be contracted. The same is true of the BLE in STUMBLED. The rule that BLE can be contracted if it appears in the middle or at the end of a word must be entered into the dictionary. The program of course, would have to provide alternate systems if the translator looks up a contraction and discovers that the contraction is not legal.

The problem becomes extremely complex when one considers the large variety of Braille contractions and the different considerations for their use. The same sort of system must also serve for the rules of punctuation, special form, etc.

In addition to the complexities of contraction and proper form, the system must also provide for updating. It is necessary to update the dictionary both with respect to new rules for transcribing as well as new words. Since there is a great likelihood that both of these eventualities will be realized, it is most important that it be possible to modify the translator part of the system without the necessity of making changes in either the input or output portions of the system. If it were necessary to modify either or both the input and output systems everytime new words or rules were introduced, the expense of computerization would be increased.

Output Considerations - This portion of the program is very much like the input part except that its function is to take material from the translator and put it in readable form. In this case, instructions are written for the Honeywell 222 Modified Braille Printer. The basic program for this operation is operational. It is only necessary to activate it from the translator program (to be written). It is programmed with respect to number of characters per line, margins, pagination, etc.

Hardware System - The Honeywell equipment configuration should be considered. Previous systems have been written for older computers. Though efficient, such systems have been unable to take advantage of advancements in the "state of the art" which are available in the Honeywell Series 200 System. The refinement and compactness in solid state circuitry of the 200 greatly increases the speed of operation. Also, with the realization of present interest in many translation situations (for example, Russion into English), the 200 system has been designed accordingly. Many data manipulation operations involved in translation have been built into the circuitry. This eliminates much time consuming programming activity.

A major difficulty in implimenting the proposal objective of trying to develop a translator program was lack of computer storage for both the input and translator portions of the program. This deficiency is not characteristic of the Honeywell Series 200 System. Rather, the equipment at the Computer Science Laboratory at the University of Southern California is limited in storage. More storage can be obtained by adding units. The 16K unit at the University is simply not large encough to take care of the demands of a Braille production system. Estimates by Schack Associates (7), who have had considerable experience in designing Braille Systems, place additional storage needs at a minimum of 8K and 16K as ideal. For maximal efficiency, 32K storage would be required to meet the storage needs of the three portions of the system.

In addition to these considerations, other aspects of the hardware situation were explored. Though the translator can operate adequately with the machine card-magnetic tape input system now in effect, it would seem that some of the new equipment and systems now available might be profitably used if the production of Braille by the Honeywell primter were used maximally in producing the sorts of material for which it seems best suited. These input systems are the various systems developed for remote input. The teletype, teletypesetter, and Datatext are several possibilities. One that looks promising is the IBM Datatext System.

Computer operations with the IRUS Program being used by the IMCSE at U.S.C. have demonstrated the feasibility of using Datatext for remote input of Braille materials. It is possible to place a datatext unit in a facility which has large demand for transcribing. The input is taken care of by the Datatext sending information to an IBM 360 Computer. This information in turn is put on a tape at 560 BPI and run through a conversion program for the Honeywell 200. The tape is then placed on the Honeywell and the translation and brailling completed. The merging procedure is now routine with the IRUS program.

As has been suggested, it would be highly desireable to have some sort of remote system in order to take full advantage of the speed facet of the Honeywell system. This advantage, it will be recalled, was that the Honeywell system provides for rapid immediate output. This makes possible the production of short newsletters, bulletins, and the production of examinations.

It is anticipated that greater speed and efficiency will be possible in the near future. The system as it stands at the University of Southern California, is a tape driven system. It is anticipated that disk drive will be soon available.

Manual Production of Grade 2 Braille

The Honeywell 222 Modified Braille Printer will produce Grade 2. Braille which is put into the computer (Horne 5, 6). Instead of English being the input, the English is transcribed by a trained transcriber and the input is Grade 2. Braille. This is accomplished by the computer taking in machine cards in accordance with the proper use of the rules of Braille transcribing. It can be argued that this is no improvement over existing systems in that the services of a transcriber are still required. The objection is a valid one. However, if one is interested in rapidly making multiple copies, if one is interested in storing "copies" for future use in convenient form, or if one is interested in a remote input system, this manual system has much to speak for it.

The keypunch machine is programmed to the computer in such a way that the keys have specific meanings in Braille rather than ink-print. The transcriber's first task is to become familiar with the keypunch machine and the use of the keys as Braille symbols. This is accomplished by the use of transparencies which are designed as overlays. Three are required to present the entire system. The first transparency shows the keyboard as it is usually used. The second transparency shows Grade 1. Braille symbols and lower key contractions. The third transparency shows Nemeth Code symbols and upper key contractions. All other symbols can be made by using these keys and the multiple punch key. Thus, the dot configuration for AND can be made by punching the multiple punch key, the "X" key, and the "L" key. These transparencies are presented in the Appendix of this report.

Though the system has been developed, its efficiency has not been tested. It is not known how long one can expect a transcriber to become efficient in its use. It is

felt that a transcriber who is also a typist could learn to use the keypunch rather rapidly. The transparencies discussed above were designed so that all three could be presented at the same time so that the transcriber could have a quick reference to the entire keyboard at one glance. Unfortunately, the reproductions of the original for inclusion in this report are not accurate, so that they do not line up as they should in actual practice.

Inasmuch as there is a likelihood that one might use a remote system, and inasmuch as the remote would have a different configuration than the keypunch, it is felt that there is probably little value in spending a great deal of time training transcribers on the keypunch. Should either the remote or the translator prove to be too expensive to develop and install, one could always fall back on the manual input system described here.

Need for Braille Materials

An effort was made to determine the needs for brailled materials by teachers of the visually handicapped in Californis. Since California has the greatest number of teachers of the Blind in the western part of the United States (the most likely service region for a system such as that envisioned in this report), it was felt that these teachers would be representative of the geographic region. Lists of teachers of the Visually Handicapped produced by the State Department of Education were obtained (1,2). Questionaires were sent to all teachers listed as teaching blind children. Ten items were listed and teachers were requested to rank the items in terms of greatest need. These rankings were then counted and a mean rank computed. The mean ranks for the different sorts of embossed materials are presented in Table I. Eighty-two per cent of 145 teachers returned the questionaires.

It will be noted that the rankings differ somewhat for the different levels at which teachers work. While required textbooks were the greatest need for secondary teachers, these ranked only fifth or sixth for elementary teachers. It would seem that existing supplies are adequate for the elementary teacher; but this is not so for the high school teacher. This finding may reflect the sort of problem discussed in the introduction of this report. That is the demands of the secondary school are more varied and less in number for single items. On the other hand, both levels are equally concerned about supplimentary texts. This is perhaps another reflection of the marketing and production

Table I

Mean Rank Preference of California Teachers of the Visually Handicapped for Computer Produced Braille Materials When Teachers are Classified by Level and Type of Teaching Assignment

Type of Material	Mean Rank Preference					
	All Teachers	Senior High School	Junior High School	Elem-Sec. (Itinerant)	Elementary (Itinerant)	Elementary
Textbooks (required)	2	1	1	1	6.5	5
Textbooks (supplimental)	1	2	2	2	1	1
Popular Magazines	7	7	7	7	6.5	7
Professional Magazines	9	9	8.5	8	9.5	10
News Magazines	6	5	6	6	5	6
Special Assignments	3	3	3	3	2	3
Special Lectures	8	8	8.5	10	8	8
General and Special Information Pamphlets	4	4	4.5	5	3	4
Recreational Reading Materials	5	6	4	4	4	2
Syllabi	10	10	3	9	9.5	9

problem already discussed. It is possible that the high speed small computer with directing printing potential can supply partial relief for this problem. The secondary and supplimentary textbook needs are more individual in nature and therefore not as easily mass-produced.

It will be noted that special assignments and recreational materials were next most frequently mentioned as difficult to deal with. Part of this situation is traced to the increasing integration of blind students in the regular classroom and the use of a resource teacher or room to take care of the specific problems which are related to the fact that the child is blind. These teachers have a rather monumental task of supplying embossed materials to their charges so that they can keep up with the regular class routine. Though the teacher does a good deal of transcribing, and though some resource teachers are fortunate to have transcriber groups to aid in preparing the materials, the availability of a computer which translates ink print into Braille would be very useful to this group of teachers.

Some teachers supplied information which was not requested; but which was nevertheless valuable. A major suggestion was the need for the production of achievement tests (classroom primarily). The general consensus was that a computer system such as that described in this report would be highly desireable.

One additional comment might be added relative to the use of the Honeywell System in California. The state has ten regional data processing centers throughout the state for the purpose of accumulating and processing pupil personnel data. These centers are all equipped with Honeywell Series 200 computers. This makes it possible to place an input and translator program on any of the computers, take up the output at the end of the translator program, and send to the University of Southern California Center (where the printer is located), activate the output part of the system and produce Braille. This might be more convenient and economical than sending all materials tc the University for input, translation, and output. It would certainly make the use of remote systems more economical in areas which are great distances from the University.

The survey suggests that teachers of the blind still have many unmet needs for materials, and that the materials most needed appear to be those which the Honeywell system can best produce.

Recommendations

1. The suggestions in this study should be implemented with a full scale program.
2. The full scale program would involve the exploration of new input media, the consideration of linguistic studies, and the writing of a program along the lines of the one discussed in this report for translating ink-print into Braille (Grade 2.).
3. The acquisition of the necessary hardware for testing the program - this is chiefly in the area of storage. 16 additional K storage is recommended.
4. Estimated costs of developing a new program would approximate $50,000. The major costs would break down as follows.

    (a) $4800 for rental of additional computer storage @ $200.00 per 8K per month.
    (b) $30,000 for writing programs for the three systems discussed in this report.
    (c) The remaining funds would be needed for computer time, personnel other than the systems people, supplies, etc.

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6. Horne, B. Memorandum BH #4. (Honeywell Internal Company Correspondence) "Input to the Honeywell Brailler," October 7, 1965.

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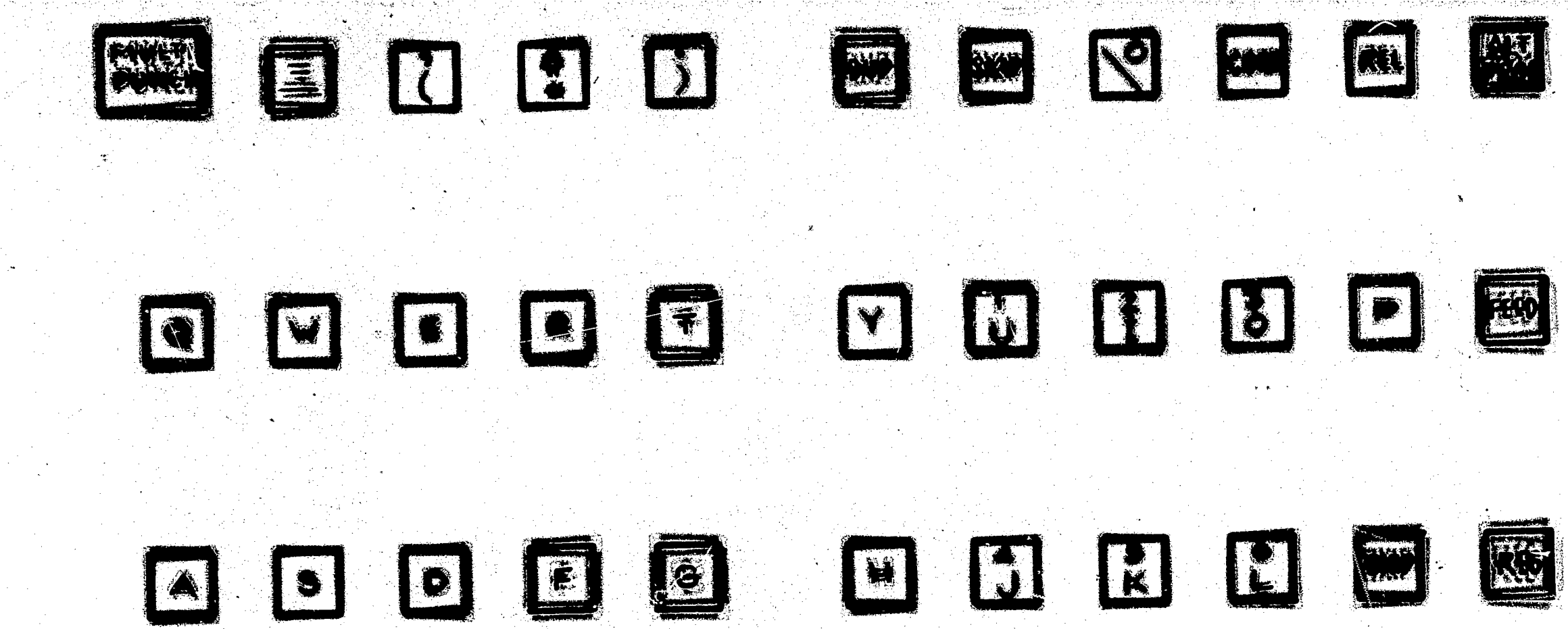
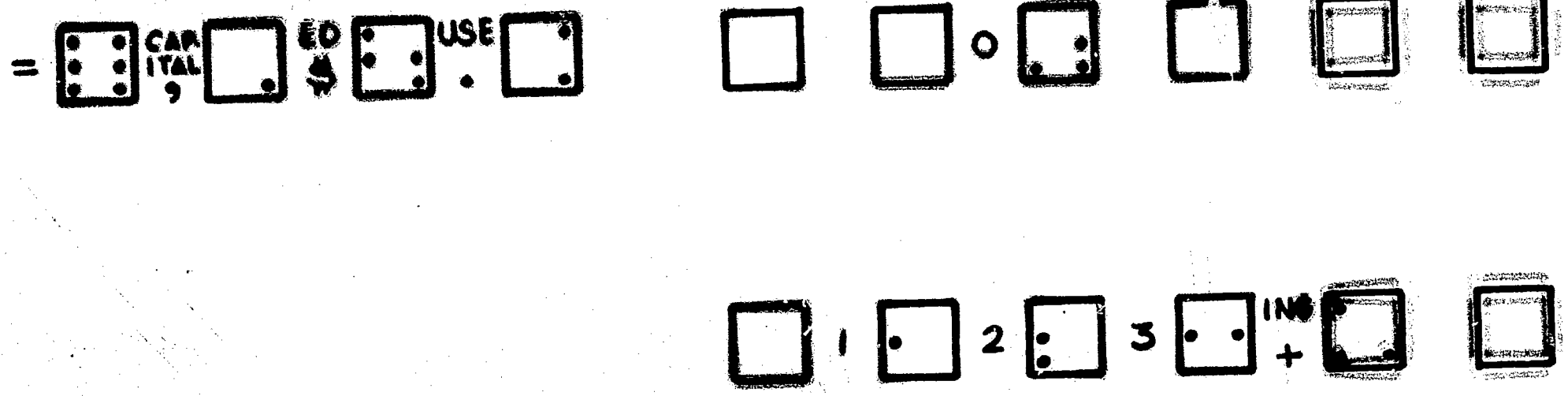
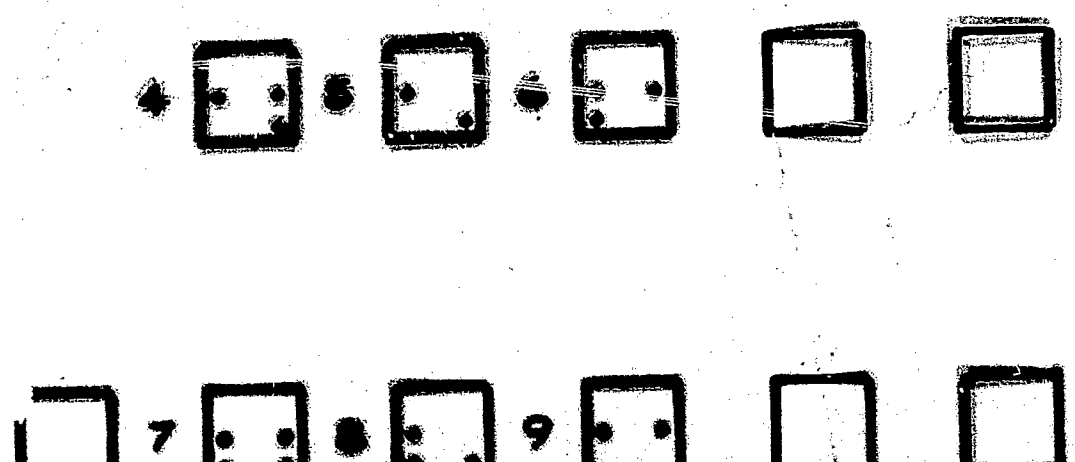
APPENDIX



No.1 IBM
KEYPUNCH
KEYBOARD

No. 2 - SINGLE KEY PUNCH
ALPHABET & LOWER KEY
CONTRACT WORKS





No. 3 - SINGLE KEY PUNCH NEMETH NUMBERS & UPPER KEY CONTRACTIONS