COMPUTER TECHNOLOGY

A semiautomatic system for preparing computer data cards*

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A system is described which eliminates manual coding and punching of computer data cards in a psychophysical experiment. Conventional relay logic is used to control the operation of a card punch and to enter data in selected card columns.

Computer data cards are a convenient medium for handling modest amounts of numerical data such as are generated in most psychophysical experiments. Almost all general-purpose computers can accept data on cards, and many simple forms of data analysis can be performed with nothing more than a card sorter equipped with a counter. A major disadvantage in the usual use of cards is that data are collected in some other format (usually handwritten) and later coded and punched into cards. These steps are time consuming and are a common source of error, although systems for bypassing the human punch operator have been described (e.g., see Christopherson, 1970 for a most recent account). We will describe a system for entering data directly from several different sources onto computer cards, thereby bypassing the steps of manually coding and punching. While the specific system is not likely to fit other applications exactly, the overall plan is flexible and can be applied to many other psychophysical studies. With this system, data can be copied from other cards, entered from semifixed sources (slide or rotary switches), from remote keyboards, from relay logic, or from the punch keyboard.

In our experiments, panels of five judges make sensory evaluations of a large number of samples, assigning each sample a numerical rating on a prescribed scale. The types of judgments and the scales used are not relevant to the description of the system and have been described elsewhere (Rubacky, 1970). A data card is prepared each time a sample is

judged. The card contains the following information: sample identification, judges' identification, date, day of the week, time of day, and judges' ratings. Punching is done on a Source Record Punch (SRP) Model 1614 (The Standard Register Company, Dayton, Ohio), priced at \$1,580. The SRP was selected because of price (less than half that of an IBM card punch) and because it was easily modified to accept data from external sources. The operation of the SRP is quite different from the IBM punch. Instead of a keyboard with a single set of digits, the SRP keyboard resembles a calculator with six columns of 12 keys each, which enter the digits 0-9, 11, and 12 into consecutive card columns. Instead of punching one column each time a key is depressed, the SRP punches only when a separate "punch" key is closed, at which time six columns on the card (one for each keyboard column) are punched. To punch the next six columns, or "field," another set of six entries is made and the punch key is closed again. This procedure is inefficient for conventional card punching, but is convenient when data from a certain source must always be entered in the same card column. For example, a judge's station can be hard wired to a given column so that his score will appear in that column regardless of when he makes his judgment, whereas if a conventional punch were used he would have to make his judgment at a certain time during the punching sequence. The SRP does not do away with all sequencing, however, since each field must be selected in order. This is done with an external stepping switch and will be described later.

In addition to the keyboard, two other means for entering data are available on the stock SRP. The punch will copy alphanumeric data from a master card to a blank data card, and it will punch numeric data which are entered on a set of 10 slide switches built into the punch. The card

columns on which these data will be entered must be specified when the punch is ordered. We use the copying capability to transfer a sample identification number from a card which accompanies each sample, and the slide switches to identify the judges, who remain the same during any one session. The remaining data are entered from three sources outside the punch. The day of the year (three digits), the last two digits of the year, and the day of the week (one digit) are entered from a multiple slide switch (Cherry Electric Products Corporation, Highland Park, Illinois), which is set at the beginning of each session. The time of day (four digits, in military time, i.e., 24-h clock) is entered from a counter assembled from conventional relay logic which is advanced by a 1/min pulse. The judges' selections are entered from 10-digit pushbutton keyboards (Herbach and Rademan, Catalog No. TM 14K639) at each of the five judges' booths.

To enter data from an external source to a given column within a field, some means must be provided for electrically connecting that column on the SRP column bus to the desired digit on the digit bus (or, if alphabetic characters are punched, to the two digits which make up the latter). The column and digit buses are readily accessible on terminal boards under the SRP cover. The order in which external data are selected for punching is controlled by a stepping switch, as shown schematically in Fig. 1. Six wipers of the stepper are wired to the six columns of the SRP columns bus. To initiate a trial, the punch operator inserts a master card and a blank data card into the SRP and presses the punch key. At this time the stepper is in its start position and its wipers contact six blank poles while the SRP copies data from the master card (sample identification) and its internal slide switches (judge identification). At the end of this punching sequence a 28-V dc pulse is applied by the SRP to its keyboard release solenoid. We use this pulse to advance the stepper after each field has been punched. Thus, as soon as the SRP has finished copying the master card and its internal slide, the stepper advances and connects the columns bus to the six external slide switches, which carry date and year

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Fig. 1. Schematic diagram of the added control circuits. For clarity, only one bank of the stepping switch is shown. The digits bus can be reached on Terminal Boards 4 and 5, at the left rear and center rear of the SRP chassis. The columns bus can be reached on Terminal Board 6, at the center of the right side of the chassis, and the keyboard clear is the black/white pair on Terminal Board 3, immediately in front of Terminal Board 4. If the color code or board position is changed on newer models, each of these lines can be traced back from the keyboard.

codes. At the same time, a spare wiper of the stepper completes a circuit which parallels the SRP punch switch and automatically initiates a punch sequence. When this punch is complete, the keyboard release pulse advances the stepper to its third position so that it connects the digital clock to the SRP columns bus and initiates another punch sequence. After this is completed the stepper advances to connect the five judges' keyboards to the columns bus. This time a punch sequence is not initiated by the stepper, since the judges' selections may not have been completed. When pressed, a judge's key remains down through an internal latch and completes two circuits. The first circuit connects the digit line that corresponds to that key to the judge's column as shown in Fig. 1. The second set of contacts (not shown in Fig. 1) from each keyboard are wired in series so that the circuit is completed only when selections have been made at all keyboards. In practice, we found it advisable to introduce a 5-sec delay timer between the last keyboard entry and the punch sequence to allow the last judge to correct any erroneous entry. After this delay the judges' selections are punched, and the

stepper is again automatically advanced to its fifth position, from which it causes itself to reset to "start." The reset pulse is also applied to the SRP "eject" switch, which causes the punch to eject the master and data cards, and to solenoids on each of the judges' keyboards, which release all switches to the up position in preparation for the next trial.

This is a somewhat simplified description of the system. In actual practice, E may be required to enter data on the SRP keyboard. To do this, the stepper is programmed to wait at the appropriate step and E manually restarts the punch sequence after entering his data. Spare wipers on the stepper are used to operate indicator lights on E's control panel that show which step the system is performing and which judges have made their selections. Although several convenient dc voltages are available from the SRP, we found it advisable to use a separate power supply to operate all equipment external to the punch (except for interfacing relays) because the punch power supply does not have enough reserve capacity to operate many other components reliably.

Our format uses only the first 44 columns of the data card. The

remaining columns are usually gang punched with fixed data which identify various aspects of the study. In other applications these columns might be punched during the experiment by using more steps of the stepping switch to introduce data in successive blocks of six columns.

Over the past 3 years we have processed over 60,000 cards with this system and have found it much more convenient, and tremendously more accurate, than manual data entry. Anyone contemplating using the SRP should consider two drawbacks, however. The SRP can punch alphanumeric, but can only print numerals. Therefore, if the user's format requires the use of alphanumeric characters, the cards would have to be punched without printing and then jobbed out to a service facility to be interpreted. Second, it can never be adapted to completely automatic data collection, since each data card has to be inserted by an operator.

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