Reproduction of Punched Cards: A Simple and Inexpensive Method

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If hand-sorted, edge-punched cards are to be used by more than one party, more than one set of cards is often required. The making of more than one set becomes more difficult as the complexity of written material in the center of the card increases, and as the number of cards increases. To facilitate this reproduction of cards by the easiest and least expensive way, a novel method using Xerography has been devised. It has three particular advantages: (1) the reproduced cards are permanent; (2) they are as legible as the original; and (3) the cost per card decreases as the number of reproductions increases.

This card file and its proposed expansion were developed during the course of a study[1] to determine whether a correlation exists between repellency to stored-product insects (Spp. *Tribolium*) and the chemical structure and/or physical properties of selected compounds.

The accumulated data were reduced to the more definable factors for placement on double-row McBee Keysort cards of sufficient size (5 × 8 in.) to allow perimeter coding for pertinent data plus room for expansion. It was also necessary to enter the chemical structure and other selected data on the center of the card for visual examination. These notations included a serial number, empirical formula, compound name, melting and boiling points, and a box showing the repellency data. Most of these data are also coded on the card perimeter. (The relatively small number of compounds involved—1,200—and the large amount of data precluded the use of IBM cards.)

The sponsor's need for three additional complete card sets prompted an extensive investigation into the available methods of reproducing the center of the card. Hand-copying the formulas and typing the other information on all cards was too time-consuming. Carbon-backed and carbon-inserted card sets are available, but the third copy was barely legible when 90-lb. stock or heavier was used, and all copies were rather easily smudged.

Xerography was then considered: could the entire card be duplicated onto blank pre-punched stock? The effect of heavy paper on the selenium-coated drum of the model 914 Xerox machine and the difficulty of feeding heavy paper restricted the weight of the stock to 110-lb. paper. It was found impractical to duplicate the entire card because (1) the 1% expansion of the image inherent in the copying process caused misalignment between perimeter numbers and holes and (2) registration from copy to copy was not better than $\pm 1/16$ in. in width and $\pm 1/8$ in. from top to bottom.

[1] Contract 12-25-010-2639 for the Agricultural Marketing Service of the U. S. Department of Agriculture. Results to be published in another journal.

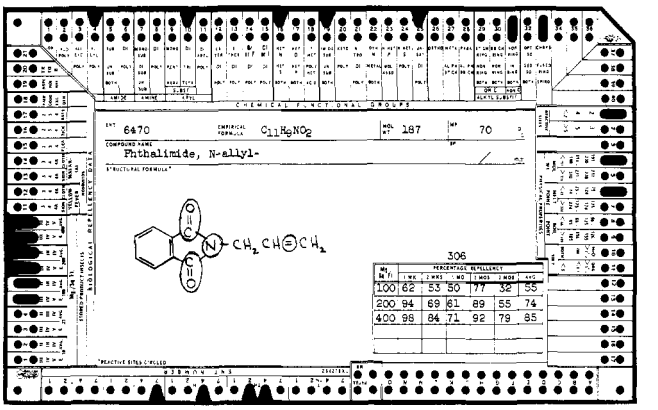

Fig. 1.—A completed original card. Note "floating" center.

By using an opaque template under the original card on the scanning plate to block off all perimeter printing, only the center of the card would be copied. A "floating" center on the original card (Fig. 1) provided allowance for variation in registration from copy to copy and for occasional misalignment of the original on the scanner.

Xerography thus became feasible for our purposes. With the proposed lease of a Xerox 914 machine by Midwest Research Institute, the cost was forecast as a reasonable 10 to 13¢ per card.

Since the machine's feeding mechanism will not handle 5 × 8 in. stock, cards were supplied by Royal-McBee in tandem, *i.e.*, two printed, punched cards connected on the long side to form a sheet approximately 8 × 10 in. This gave a very fortunate advantage: copying two cards at a time cut the duplicating cost in half, since the Xerox 914 is geared to charge *per* impression. Unfortunately, the machine we used would not accommodate a four-card set (10 × 16 in. or 8 × 20 in.).

Six hundred master tandem cards (*i.e.*, two 5 × 8 in. cards) were used as the original cards on which all information was appropriately entered in the card center for each of the 1,200 compounds, *e.g.*, serial number, empirical and structural formula, and repellency data in the box in the lower right-hand corner. No edge punching was done at this time.

Special copy tandem cards were ordered as shown in Fig. 2; they were identical to the originals except that the center of each card was blank. A double template (to accommodate a tandem card) was taped to the Xerox scanner plate. Each original tandem card was placed face down on the template. After the position of the copy cards had been suitably adjusted in the feeder tray, a few trial runs were made to establish the proper registration. To avoid misfeed, new, completely flat cards had

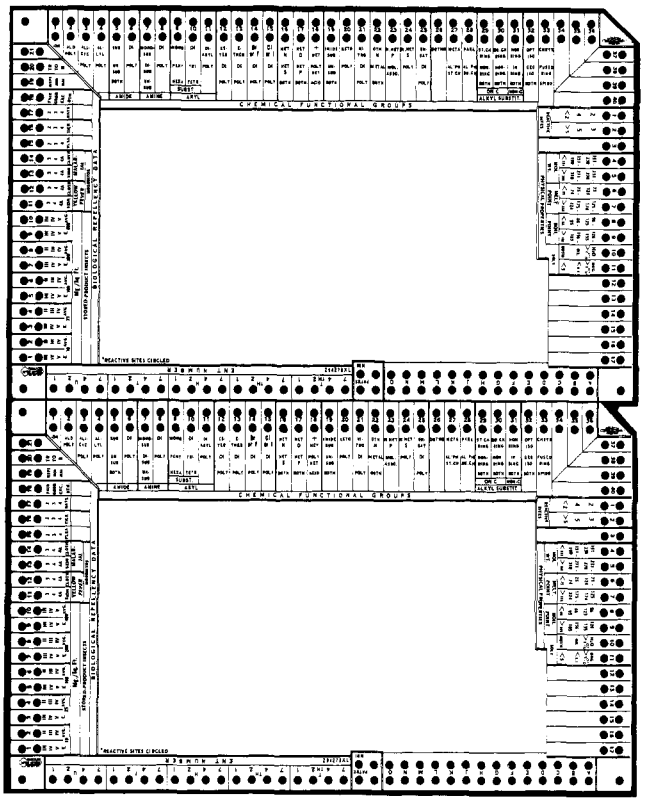

Fig. 2.—Sample copy tandem card with blank center.

to be used. Three copies were made of each tandem original and all were cut in two to give 1,200 original cards and 3,600 copies or four card sets.

The originals were then edge-marked to denote which of three possible positions were to be punched: shallow, intermediate, or deep. Each original was combined with its three copies, and the four were hand-punched simultaneously. (It is important that the intermediate punch cut sharp—otherwise tearing may result.) Machine punching is not practical because the available machines accept only three cards at a time, and punch shallow only. A check was made on all cards to be sure all marked positions were properly punched; improperly punched positions were corrected with McBee card savers. Finally, the cards were separated into the four respective sets, the original set being retained at MRI for subsequent correlation studies. A completed original card is shown in Fig. 1.

The final cost, including the costs of the Xerox machine, cards, and additional time to punch and handle the copies, amounted to approximately 12¢ per card or $144 per extra set. This sum includes approximately 4¢ per special card, 5¢ per card for the Xerox service, and 3¢ for additional labor. Additional expense was incurred in the present program for the purchase of a number of extra original and copy cards to allow for future expansion of the card file.

The only disadvantage to the method is the necessity of having inplant access to a Xerox machine. Going outside for this service would considerably increase the cost.

A Formula Index for Silicon Chemicals*

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In the deep indexing of literature pertaining to silicon chemistry at Linde Tonawanda Laboratories Information Center,[1,2] the need arose for a mechanized structural formula index which would allow structural configurations and functional groups to serve as a means of identifying complicated molecular species. By suitable coding, formulas are arranged in a linear array based on structure. Such a structural code is most useful in identifying a compound where ambiguity may exist in the nomenclature. A further use when making searches, is to help find compounds having particular structural or functional features.

Because of local equipment limitations, floating field selection was impossible; common structural notations such as those of Dyson[3] and Wiswesser[4] with their codes of varying length could not be used. It was therefore necessary to develop a coding system centered around the silicon atom, and this was done around 1955. The system uses a coördinate index and machine-punched IBM cards. At present over 6,000 chemicals have been coded, and the system has proved valuable in processing retrieval questions in the silicon chemicals field.

It is not the function of this paper to show the complete coding for all the structural elements deemed important by our technical staff, but rather to show the principles involved along with examples for illustrative purposes.

Silicon Configurations.—Silicon compounds are characterized by (1) the number of silicon atoms in the molecule and (2) the number of silicon atoms in each of the possible configurations:

$(R_2SiO_{2/2})_n$	R_4Si
$(RSiO_{3/2})_n$	R_3Si
$(R_3SiO_{1/2})_n$	R_2Si

$SiO_{1/2}$ in the above formulas indicates an oxygen bridge to another silicon atom; R represents any other type of linkage to the silicon atom. This may be an organic, metal-organic, or inorganic radical. Columns 2 through 7 of the Si Formula Index Card (Fig. 1) show the con-

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