seines Untersuchungsbereiches herausgearbeitete frühneuzeitliche Ausbauperiode ist auch in anderen Landschaften als von den Territorialherren gelenkter Ausbau — wenn auch vielfach in geringerem Umfang — festzustellen. Diese frühneuzeitliche agrarische Ausbauzeit, die sich nach dem Dreißigjährigen Krieg in der Hochzeit der territorialstaatlichen Wirtschafts- und Peuplierungspolitik wiederholt — ihr Gegenstück tritt uns in den zwei Wellen der gewerblichen Inwertsetzung des Landes, einer frühneuzeitlichen und einer späteren (W. TUCKERMANN)[27]), entgegen —, läßt sich als Frühphase in die von mir als Zeitalter der Territorialwirtschaft bezeichneten Periode der mitteleuropäischen Kulturlandschaft einordnen[28]).

JÄGERS Arbeit hat die Diskussion über das Problem der Periodisierung unserer Kulturlandschaft erneut in Gang gebracht. Dabei ist ihm darin zuzustimmen, daß schon die Genese der deutschen Agrarlandschaften in ihren entscheidenden Perioden sehr schwer auf einen einheitlichen Nenner gebracht werden kann, da im einzelnen doch „erhebliche Unterschiede im Entwicklungsgang bestehen" (S. 86). Die Schwierigkeiten werden natürlich noch größer, wenn wir die Kulturlandschaft als Ganzes im Auge haben. Denn in dieser spiegeln sich nicht nur die Auswirkungen der Besiedlung und der wirtschaftlichen Inwertsetzung in ihrem geschichtlichen Ablauf wieder, sondern es gewinnen auch die menschlichen Gemeinschaften über soziale, politische, volkliche und religiöse Gruppen einen sich in den einzelnen Zeitabschnitten wandelnden landschaftsgestaltenden Einfluß. Auch diese „feineren Modifikationen"[29]) können unter Umständen maßgeblich für die Bestimmung von kulturlandschaftsgeschichtlichen Perioden sein, weil oft gerade hinter diesen die eigentlichen „Akteure" bei der Gestaltung der Kulturlandschaft stehen. So werden sich für die Kulturlandschaftsgeschichte, die selbstverständlich ihre Periodenbildung unter geographisch-landschaftlichen Aspekten vorzunehmen hat (S. 6)[30]), ähnliche Probleme ergeben wie für die Geschichtswissenschaft mit ihren verschiedenen Teildisziplinen, wo der Streit um die Perioden schon so lange währt und wohl auch schwerlich volle Übereinstimmung erreicht werden kann. Das liegt an dem komplexen Charakter des Forschungsgegenstandes in der Geschichte ebenso wie in der Geographie, hier in Sonderheit der Erforschung der Kulturlandschaft.

[27]) W. TUCKERMANN, Das altpfälzische Oberrheingebiet. 2. Aufl., 1953, S. 62.

[28]) Vergleiche H. OVERBECK (Anm. 15), S. 211; dazu auch der Hinweis bei H. JÄGER (S. 100) auf die „gesellschaftlichen, wirtschaftlichen, aber auch die Gegebenheiten der Territorialpolitik", sowie E. TACKE (Anm. 24), S. 102ff. und 160ff.

[29]) E. WINKLER, Fünfzig Jahre schweizerischer Kulturlandschaftsgeschichtsforschung. In: Zeitschrift für schweizerische Geschichte, 24 (1944), S. 113.

[30]) Vergleiche dazu auch die grundsätzlichen Gedanken von G. PFEIFER in einem (zusammen mit A. SCHÜTTLER veröffentlichten) Aufsatz über „Die kleinräumige Kartierung landwirtschaftlicher Nutzflächen und ihre kulturgeographische Bedeutung". Petermanns Mitteilungen 1941, S. 154f.

THE PUNCHED CARD AND ITS APPLICATION IN GEOGRAPHICAL RESEARCH

ROGER G. BARRY

with 1 Figure

Die Lochkarte und ihre Anwendungsmöglichkeit in geographischer Forschung

Zusammenfassung: Der Aufsatz beschreibt die wichtigsten Eigenschaften des Lochkartensystems. Zahlenangaben müssen für die Ausführung der Lochung in Kategorien eingeordnet werden. Das dann mögliche mechanische Aussortieren der Karten erleichtert die Feststellung von Beziehungen wesentlich. Dies wird an Hand von Beispielen gezeigt. Außerdem werden auch Vorschläge für weitere Anwendungsmöglichkeiten gemacht.

Introduction

The technique of storing data on punched cards was developed primarily by H. HOLLERITH of the United States Census Bureau in the 1890's. Today, the punched card system is used by many meteorological services, census offices and an increasing number of business organisations for data storage, statistical studies and accounting. The use of the system in studies involving a large body of data has been recognized, and particular applications have been described, by research workers in many disciplines. COTTAM and CURTIS (1948), for example, illustrate its value in ecological studies with reference to an investigation of the frequency and density of tree, shrub and herb species in an oak wood. However, the potentialities of the method have been overlooked by many geographical research workers and this note therefore outlines the essential features of the punched card system and suggests its possible applications in geographical studies.

The Punched Card

The fundamental principle of the punched card is the representation of information by a certain pattern of holes punched in the card. The Hollerith card format (part of which is shown in Fig. 1) consists of eighty columns with the numbers 0, 1, 2, ..., 9 in each column[1]). An individual item of data can be allotted to each of the columns.

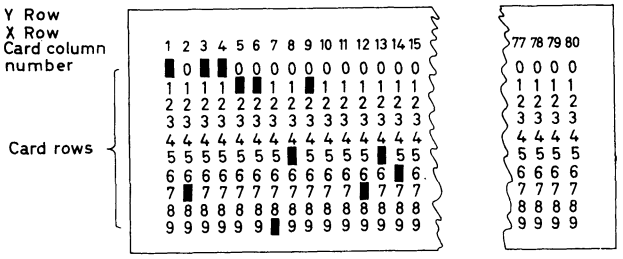

Fig. 1: Format of the Hollerith Punched Card

[1]) Certain types of cards have only forty or sixty-five columns. The 1951 Census of England and Wales was put on to sixty-five column cards. (General Report, 1958, p. 17.)

For example, the 1951 Census figures for the population of the Barnsley registration district in the West Riding might be indicated — 07, 001, 1951, —— 756, in columns 1 to 14 inclusive, as shown in Fig. 1. The West Riding is the seventh standard region in the listing of the fifty-three regions in the Census Reports and Barnsley is the first registration district within it. The population of 75,600 is coded in hundreds and the five columns (10—14) allow numbers to exceed a million.

The upper and lower rows of the double space at the top of the card are referred to as the Y (or 11) and X (or 10) rows, respectively. A negative number may be indicated by a punch in the X row in the column preceding the number or by an overpunch in the X row of the column containing the number. Alphabetic punches use the Y, X, or O rows in conjunction with the 1 to 9 rows in a single column. Thus, "A" is represented by a y punch and a 1 punch, "B" by a Y punch and a 2 punch. Similarly with X and 1 to X and 9 for "J" to "R" and 0 and 2 to 0 and 9 for "S" to "Z"[2]).

The punching is carried out with a Card Punch machine, similar to a typewriter, in which the required figures are punched by pressing appropriate keys.

The Prerequisites and Advantages of Card Data

There are two essential and interrelated factors involved in the utilisation of punched cards. The information must firstly be amenable to numerical representation, perhaps as a code or series of codes, and secondly it must be classifiable into a convenient number of categories for the number of columns on the card. Library texts, for instance, may be catalogued on punched cards on the basis of the general subject, sub-topic and so forth, each represented by a code. Two columns may refer to the general subject — "15" may indicate geography, "16" geology, etc. — allowing one hundred categories (00 to 99 inclusive) and a further column, giving ten divisions (0 to 9), may specify subcategories. Examples of the complete three column coding might be biogeography "150", economic geography "151", historical geography "152" and so on[3]). A punched card catalogue would allow rapid organisation of bibliographies for selected topics, regions or other groupings.

A practical advantage of the storage of data on cards is the avoidance of bulky forms which list data. The information on the cards can be checked visually by passing them through a Card Interpreter; a machine which prints on the top of each card the data already punched on the card.

The sorting of punched cards by machine is one of the principal advantages of having data on cards. The Card Sorter "reads" successive cards on a single column set by the operator for each sorting. This "reading" is carried out by electrical brushes which detect the position (i. e. the row) of the punch in the particular column and direct the card into the appropriate pocket for that number. There are thirteen pockets, one for each of the twelve card rows, and a "reject" pocket for cards without a punch in the column on which the cards are being sorted. The machine can also be set to reject any cards with a punch in certain rows of a column. Alphabetic punches or negative overpunches require double sorting.

Once the initial labour of punching data onto cards is completed, the Sorter provides a fast, efficient means of examining the material in terms of a variety of classifications of the original material. This may be especially useful in the organisation of data into categories for plotting on maps. The number of occurrences of particular groupings or the joint occurrences of two or more factors are quickly calculable, since sorting speeds are of the order of four to six hundred cards per minute and the cards are counted by running them through an automatic counter attached to the machine. Some Card Sorters have individual counters for each pocket.

Geographical Applications

The results of a climatic study based upon punched card data and card sorting are discussed in detail elsewhere (BARRY, 1959, 1960). The report used daily climatological data for eleven stations for sixteen months (approximately 6,000 cards) and considered the relationships between a classification of airflow types and temperature, precipitation and other data. The information for each station-day was included on a single card using the following card-layout: —

Columns		
	1— 3	Identification number of weather station
	4— 5	Day
	6— 7	Month
	8	Year (last figure only)
	9—10	Daily maximum temperature (to nearest whole degree F.)
	11—12	Daily minimum temperature
	13—15	24-hour rainfall total (in hundredths of inches)
	16—18	24-hour snowfall total
	19—30	Four sets of 3 columns giving a coding of the four 6-hourly weather summaries (type of precipitation, fog, etc.)
	31—32	Snow depth (in inches)
	33—34	Coding of "Airflow Type"
	35—36	Coding of "Airflow Type" (for a change of type during the day).
	37	Coding of frontal passage
	38—39	Coding of isobar curvature
	40—52	Selected tephigram parameters
	53—60	Indices of zonal and meridional air flow over the area

A typical sorting procedure might be concerned with an investigation of the relationships between a given airflow type "A" (coded 15 in columns 33—34) and maximum temperatures. The cards for a particular station are first sorted for a 1 punch in column 33 and cards without this are discarded. The batch

[2]) These combinations differ for certain accounting machines.

[3]) A card-index system with punched holes along three margins of the cards, using knitting-needle sorting, is sold commercially and has been described by COOK (1958), who also suggests its application in research work.

possessing a 1 punch in column 33 are resorted for a 5 punch in column 34 and the number of cards with 15 in columns 33—34 may then be counted. In the second stage, the cards are sorted on column 9 for the maximum temperatures in tens of degrees and each group of "tens" is further sorted on column 10. The occurrences of individual or grouped temperature values associated with airflow type "A" are determined by counting.

This operation may be repeated in conjunction with type "A" for all the categories of information which are listed and similarly for the other airflow types coded in columns 33/34.

Climatological studies are particularly suitable for punched card methods, but the techniques can undoubtedly be applied to a wide range of research problems within geography. Demographic material in census returns is numerical and largely pre-classified. Thus, the layout of card columns for population data might be as follows:

		Column	
Standard Region		1—2	
Registration District		3—5	
1921	Population (in hundreds)	6—10	
1931	Total Population (in hundreds)	11—15	
1931	Male Population (in hundreds)	16—20	
1931	Female Population (in hundreds)	21—25	
1951	Total Population (in hundreds)	26—30	
1951	Male Population (in hundreds)	31—35	
1951	Female Population (in hundreds)	36—40	
1921—31	Total Percentage Increase or Decrease	41—43	X overpunch to indicate percentage decreases
1931—51	Total Percentage Increase or Decrease	44—46	
1931—51	Percentage Increase or Decrease by Births or Deaths	47—49	
1931—51	Balance of Percentage Increase or Decrease	50—52	
Coding of any change in area of the registration district (perhaps indicating the necessity for visual inspection)		53	

Urban and land-use surveys offer further possible applications. LEARMONTH (1959) raises the possibility of utilising punched cards for data from land-use surveys in India and a survey scheme such as that proposed by COLEMAN and MAGGS can readily be coded on a numerical basis.

Summary and Further Possibilities

The most useful application of punched cards is in the examination of inter-relationships within large quantities of data. Correlations between pairs or sets of variables are readily determined from the results of the basic sorting and counting by the calculation of the frequencies of class values and statistical investigation of the frequency groupings.

DODD and PITTS (1959) advocate the use of punched cards for storing geographical information on a world scale and suggest that information for a standard unit of territory (perhaps a square mile) might be punched on a single card. They envisage the formulation of statistical laws in human geography by processing the stored data. However, it is improbable that the characteristics and "determining factors" for each unit area could be specified on a single card, unless the information was classified in general and naive terms. The scheme also presupposes large financial resources and international cooperattion. Nevertheless, it would be possible and worthwhile to formulate pilot studies, based on sample surveys, with precise, limited objectives. Undoubtedly the punched card system provides a useful basis for statistical analysis of selected geographical problems at the present time and undertakings on a broader scale will become feasible as experience is accumulated.

Hitherto, geographers have been slow in applying quantitative methods within sectors of the discipline which permit quantification. The procedures outlined in this note are simple and straightforward. A greater challenge is presented by the advent of electronic computers. Several models employ punched cards for input of data and instructions to the computer and therefore an understanding of the principle of the punched card and related techniques is a first step towards using computers for the solution of numerical problems in geographical research[4]).

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[4]) *Acknowledgements:* The author wishes to thank Dr. A. T. A. LEARMONTH for advice and criticism.