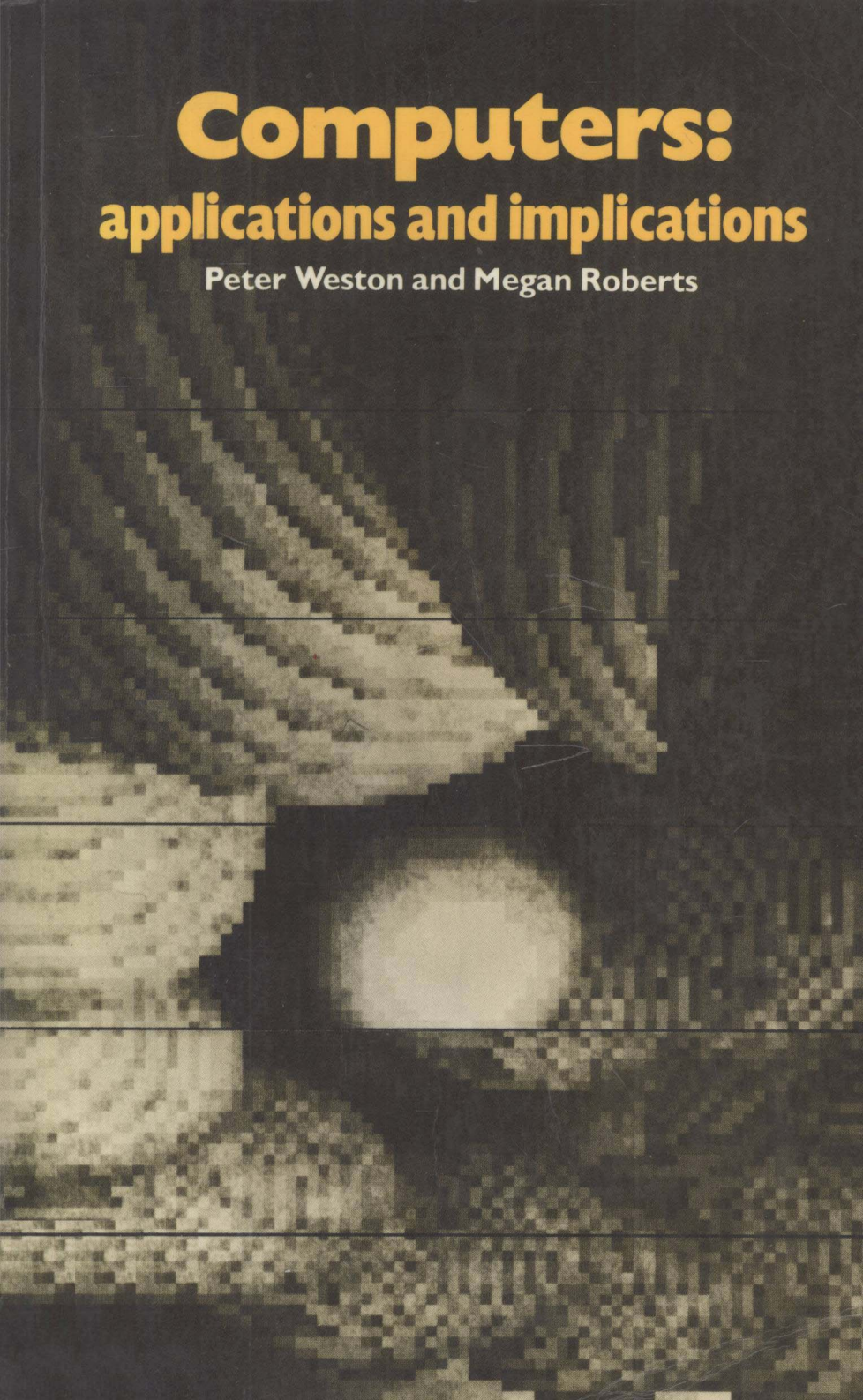
Computers:
applications and implications

Peter Weston and Megan Roberts



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P. R. Weston and M. Roberts

Harrap London

First published in Great Britain 1982
by Harrap Limited
19–23 Ludgate Hill, London EC4M 7PD

Reprinted: 1982 (*twice*)

ISBN 0 245-53634-5

Composed in 'Monophoto' Gill Sans
by Keyspools Ltd, Golborne, Lancs
Printed in Great Britain
by Mackays of Chatham Ltd

Acknowledgments

Lorna Graham and Paul McGee deserve a special mention for the many constructive suggestions they made on the original draft of the manuscript.

We are also extremely grateful to those people who have provided us with information and suggested improvements. Accordingly we acknowledge the help provided by organisations and individuals:

Mrs. D. Wilson, Milk Marketing Board, Thames Ditton, Surrey.
L. Morrison, Eastern Electricity, Ipswich, Suffolk.
L. Galitz, University College of North Wales, Bangor.
R. W. Brown, Mrs. M. Hughes and Mrs. S. M. Williams, Computer Centre, Kelsterton College, North East Wales Institute of Higher Education, Connah's Quay, Clwyd.
P. M. Rogers, Mrs. M. Daybell and R. McCauley, Data Processing Department, Pilkington Brothers Ltd., St. Helens, Lancashire.
D. J. Roberts, Welsh Water Authority, Dee and Clwyd Division, Bala.
P. Whitehead, Remsdaq, Deeside Industrial Estate, Deeside, Clwyd.
P. Piddock, Faculty of Education, University of Birmingham, Birmingham.
Advisory Unit for Computer Based Education, Hatfield, Herts.
Mrs. R. Passmore, Control Data Limited, Shaftesbury Avenue, London.
A. R. Worral, Flint High School, Flint, Clwyd.
D. Roberts, University College of North Wales, Bangor.
Independent Broadcasting Authority, Winchester, Hants.
The Open University, Milton Keynes.

We are grateful to the following for permission to reproduce extracts:
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Computer Weekly, Dorset House, London (page 61).
G. Fitzgerald (C.E.G. Paper April 1980), Thames Polytechnic, London (pages 105, 106, 108).
Consumers Association, London (pages 112, 113).
Computing, Haymarket Pub. Ltd., London and John Lamb (pages 117, 119, 120).
British Computer Society (pages 118, 119).

K. Johnson, *Timetabling*, published by Hutchinson Publishing Group Ltd. (pages 122–3).
Compete (CAL): produced as part of the Chelsea Science Simulation Project by M. Leveridge (page 132).
Independant Broadcasting Authority, Winchester, Hants. (page 144).

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Wales Tourist Board (page 75).
Ferranti Electronics Ltd., Oldham, Lancs. (page 102).
Advisory Unit for Computer Based Education, Hatfield, Herts. (page 136).
Barclays Bank Ltd. (Barclaycard), London (page 142).

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I. Pritchard, Ysgol Syr Hugh Owen, Caernarfon, Gwynedd (page 110).
S. R. Williams, Kelsterton College, North East Wales Institute of Higher Education, Connah's Quay, Clwyd (page 1).

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We are grateful to Dr. Chris French of U.M.I.S.T. for permission to reproduce his computer graphics on the cover.

Preface

It is envisaged that this book will be used to complement existing material on computing and act as a stimulus for development work. While early chapters serve to introduce and explain basic concepts and principles involved in data processing, some of the suggested tasks are designed to take the student beyond the content provided. A wide range of applications is used to illustrate a variety of principles and methods. However, repeated illustration in every application has been avoided in order to highlight particular techniques. Some elementary knowledge of hardware is assumed, although this is briefly reviewed, but specific hardware devices and types of software, are explained.

January, 1981

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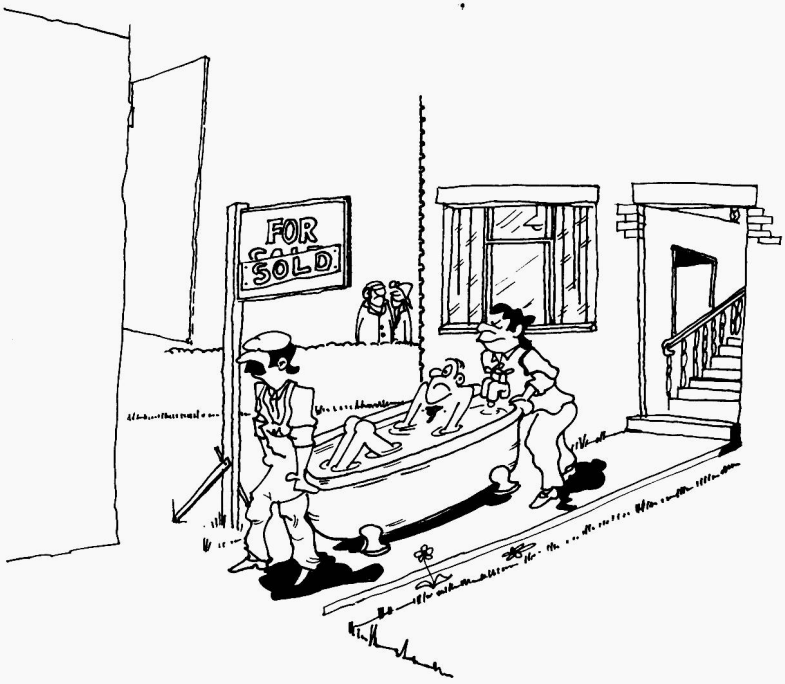
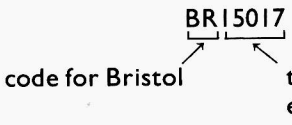
1 Data processing, computers and files

George and Mary Rossmere have recently moved from a house in Bristol to a bungalow near Sheffield. This involved selling their house and buying a bungalow through estate agents in Bristol and Sheffield.



Naturally, an estate agent must keep details of properties he is trying to sell. He must also keep details of the seller and buyer of each property. Mr. and Mrs. Rossmere had asked the estate agent in Bristol to call and see their house. He had noted down all the details, such as number of bedrooms, type of central heating and size of gardens, before advising them how much to sell the house for. The estate agent has his own method of recording all the details and making them available to prospective buyers. Let us briefly consider how he does this.

When he returned to his office he allocated the house a *code*. The code he chose was:



This code would be placed onto every document concerning the house, thus enabling documents to be cross-referenced. The following actions were then taken:

(a) Details of the visit, the house and the Rossmeres were placed in a filing cabinet.

(b) Brief details of the house (address, age, price, type (i.e. detached) and number of bedrooms) were entered in a book known as the property register; this contains details of all properties he has ever dealt with.

(c) Brief details of the house were also entered onto the beginning of a reference list of properties currently for sale.

(d) Full details of the house were printed, on a fact sheet, for prospective buyers to take with them and read.

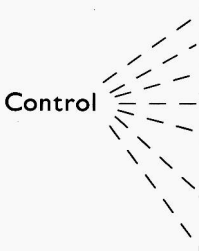
He also arranged for photographs of the house to be taken; these would be used for advertisements in his window and the local newspapers.

Each time a prospective buyer inquires about property the estate agent initially searches through the reference list. He uses the *code number* of a property to locate its detailed fact sheet which is given to the customer. Once a property has been sold the reference list must be altered. In fact it is altered as soon as somebody agrees to buy a property, by noting this fact alongside the property details. All correspondence relating to the sale of a property will be kept in a filing cabinet.

What we have briefly described is a system, used by one estate agent, in selling a property. As you will have realised this system has a number of interdependent parts such as advertising, the reference list, a property register, detailed fact sheets and correspondence. Every system consists of various interdependent parts. In larger and more complex systems more parts and functions are involved. Some parts of a system may involve carrying out functions manually, whilst others will require certain pieces of equipment.

Our estate agent is basically *processing* data relating to each property. The system requires tasks such as typing, printing, searching and filing to be carried out using data he has collected (details of a property) together with some he has produced (code number of a property). As part of the system the estate agent produces information such as the detailed fact sheet for each property and an invoice for the seller detailing the fees charged.

We can summarise the stages involved in a *data processing system* as follows:



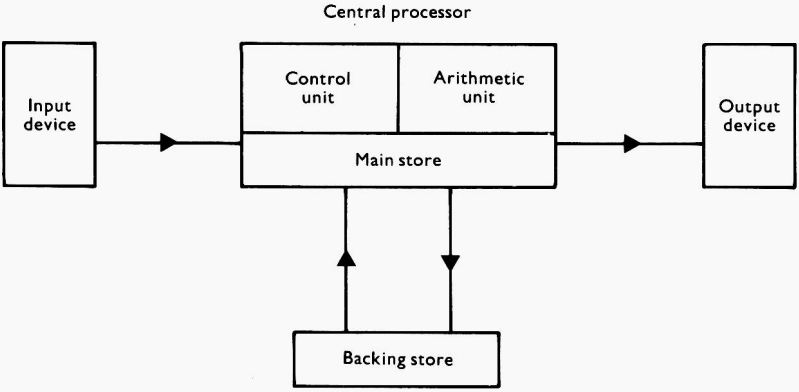
Collection:	of data required.
Preparation:	getting data into a usable form.
Input:	receiving data to be used.
Validation:	checking that data is sensible.
Processing:	carrying out necessary operations on data.
Storage:	keeping data and keeping and/or amending records.
Output:	presentation of information (including, for example, invoices and letters).

Task

Decide what work the estate agent might carry out at each of these stages in his system for selling property.

Computers

One method of processing data is to use a computer. We can represent a *computer system* using the diagram shown.



Backing store: a medium (generally magnetic) outside the main store, capable of receiving data, retaining it permanently and allowing data to be retrieved from it when required.

Our definition of a system is based upon *computerised* data processing systems.

System: an organised method of processing data, using equipment and procedures, in order to achieve a specific end result.

If the estate agent decided to computerise his system of selling properties, information about each property would need to be input as data and stored permanently on backing storage. Let us make the important distinction between information and data:

Information: the meaning given to data by the way in which it is interpreted.

Data: information coded and structured in a form acceptable for input to, and processing by, a computer system.

Computers are, therefore, data processing systems, though they are often referred to as *information processors*.

The process of getting raw data together for computer use is known as *data collection*.

Raw data: data as input to a computer, before being checked or used in processing.

The data for each property would be entered onto a specially designed form and this data would then be converted to a machine readable form. This process is known as data preparation.

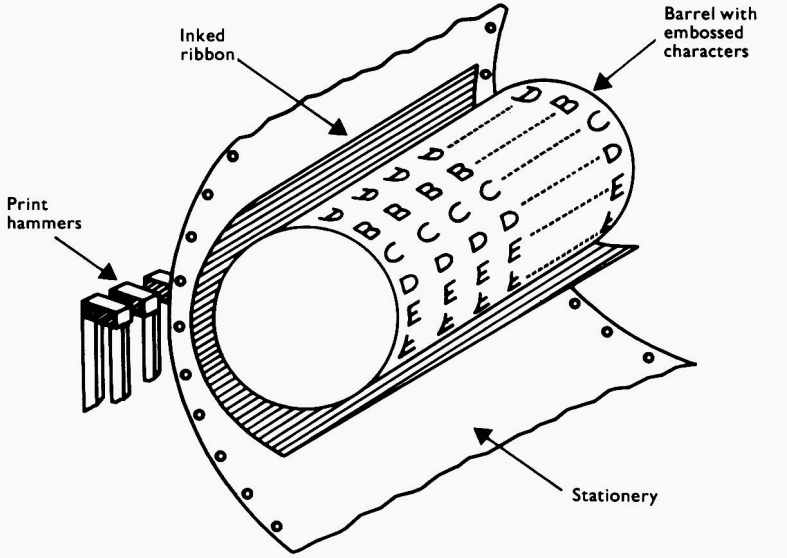
Data preparation: the transcription of data onto a medium suitable for input to a computer, thus converting the data into a machine readable form.

We shall assume, for convenience, that the 80-column punched card is used as the input medium. Each character is represented by a unique pattern of holes punched in a single column of the card. Once the input data is punched onto cards they would then be verified.

Verification: the process of rekeying the same data from the same source document and comparing, character by character, with the original keying.

For those cards containing an error, a new card would be prepared and verified. The cards would be read by a *punched card reader* which is an input device. Each card passes between a light source and a row of photoelectric cells. The light passes through the hole(s) punched in a card column striking the photoelectric cell(s) underneath. When light strikes a photoelectric cell a pulse is emitted. The unique pulse pattern derived from a particular column is interpreted as representing a corresponding character.

Details required by the estate agent, such as a list of properties all under £20,000, could be output on a *line printer*. Let us assume that the printer, an output device, is a *barrel printer*. It can print 120 characters per line and up to 1,200 lines per minute. The paper passes between a continuously revolving barrel and an inked ribbon, behind which are situated 120 print hammers. The barrel contains the complete character set, embossed around its circumference, at each of the 120 print positions. A schematic diagram of this printing unit is shown.



Schematic diagram showing the print unit of a barrel line printer

A character is printed by causing the hammer to press the ribbon and the paper against the barrel. For any single line all the A's, then B's and so on are printed until the barrel has made a complete revolution, when the paper is moved up and the next line printed.

One or maybe several programs would have to be written to process the data and produce the output required. An example could be to output a list of all the properties which satisfied a buyer's requirements. In this case the buyer's requirements would need to be input as data and matched against the property data held on backing storage. Both the property data and the buyer's requirements would be *validated*.

Earlier we suggested that validation was a check to make sure that data was sensible. In a computerised system validation is carried out by a program and we have, therefore, chosen to use a narrower definition of this term.

Validation: a check, made by a program, to ensure that data is in the correct format and/or falls within certain prescribed limits.

It is important to note that a program does not necessarily determine all the errors which may be detected in a manual system. A simple example is an incorrect spelling within an address. We shall consider validation again in later chapters.

You will remember that the estate agent from Bristol had devised a method for giving each property a *code* within his system. Essentially, the purpose of a code is to enable coded items to be accessed as quickly as possible. Some of the considerations which must be taken into account when designing a code are listed below:

(a) Any item must be uniquely identified.
(b) The code must allow for any expansion or development of the system.
(c) It must be easy to use.
(d) It should not be longer than is necessary.
(e) It should be easy to check.

These considerations apply to codes used as part of any data processing system, whether manual or computerised. However, when designing codes the available processing methods and facilities must be taken into account.

Codes may be numeric, alphabetic or a combination of the two. The use of letters allows shorter codes to be used. However, if more than 3 letters occur in sequence, the likelihood of errors, when a person attempts to use or specify the code, is increased. When codes are spoken, particularly over the telephone, more errors occur regarding letters than digits.

Some alphabetic codes, or part of a code, can be particularly meaningful to people. For example, MAN is more easily recognisable as a code for Manchester than say 127. It is more likely that an error in this 3-letter code for a town would be detected, by a person using or reading it, than the transposition error in 172.

When designing a code it is important to consider the people who must use it as well as the computer that will manipulate it. If a choice has to be made, it is more important to consider ease of use by people in the system rather than the computer.

Tasks

1. Devise a code for the notes you are given by teachers of all the subjects you study. This code should allow you to locate, quickly and easily, notes on any topic within any subject.
   Suggest how such a code might prove useful to you.

2. (a) Explain the difference between verification and validation. For each of these checking methods give examples of errors which could be found in data about hobbies.
   (b) Suggest errors, in data about hobbies, which could not be detected by validation checks.
   Would it be possible for these errors to be found using a manual system for processing the data?
3. Suggest why ease of use by people, rather than a computer, should affect decisions when designing a code.

Files

The advertisements below have been taken from a local newspaper. Study these advertisements and note the information that is given in each.

NEAR DELAMERE FOREST, CHESHIRE. £32,750. A detached pre - war BUNGALOW standing in grounds of about ¼ acre and surrounded by open countryside adjoining Delamere Forest. Superb condition with full central heating and partial double glazing. Hall, lounge, dining room, kitchen, two double bedrooms, bathroom and w.c. Boarded loft, garage, study / workshop, porch. Highly recommended and an unrivalled position.

BUCKLEY. SPON GREEN, £10,250. An 11 - year - old semi - detached family house with large garden and central heating, in pleasant residential location. Hall, 24ft. through lounge, kitchen, utility lobby, three bedrooms, bathroom/w.c. Garage, central heating.

BRYN-Y-BAAL. A pleasing detached three bedroomed bungalow situated in this convenient area close to local amenities. Gas central heating. Hall, lounge, well fitted kitchen with hob and oven units, bathroom with w.c. Garage. Spacious laid out gardens. **£14,950 inc. carpets**

FLINT. Modern three bedroomed semi - detached house built about 4 years ago. Full gas fired central heating. Hall, spacious lounge, fitted dining kitchen, bathroom with w.c. Garage. Gardens. Private cul-de-sac. **£10,250 inc. fitted carpets and curtains.**

Certain types of information are common to all of the advertisements. Some examples are price, type of property, number of bedrooms and the town or village in which the property is situated. It is reasonable to assume that such information forms the basis upon which people become interested in a particular property.

We saw earlier that estate agents keep information about properties which they have for sale. Although specific details will vary the same type of information will be kept for each property. If a file was held on a computer, the information about a property would be held as data within a record.

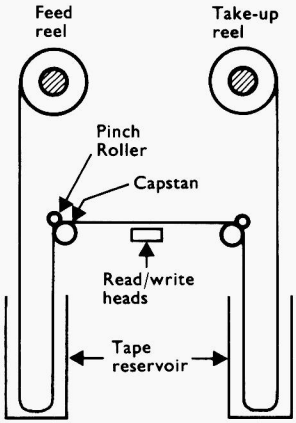
A computer file and record may be defined as:

File: a collection of related records which is often, though not necessarily, organised according to a chosen criterion.

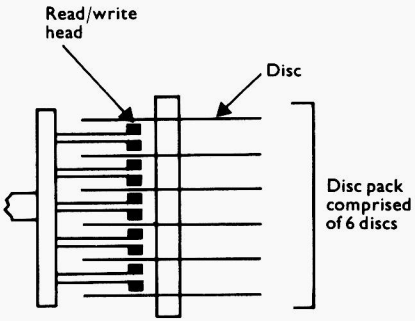
Record: a collection of related data items treated as a unit.

There would be a separate record for each property.

A computerised storage and retrieval system for a property register was implemented in 1977 by an estate agent in Britain. In this system the file of properties is held on magnetic backing storage. The two types of backing storage usually associated with main frame computers are *magnetic tape* and *exchangeable discs*. Diagrams of a magnetic tape unit and an exchangeable disc drive are shown.



Magnetic tape unit



Exchangeable disc drive

Magnetic tape consists of a thin film of oxide on a plastic tape that is wound onto a reel. Data is read/written by passing the tape over the read/write heads. To locate a particular record on the tape it is necessary to read all those records preceding it.

Each disc in a disc pack is coated with a thin film of oxide. Data is stored on both sides of a disc except for the upper surface of the top disc and the lower surface of the bottom disc. Reading and writing is performed by read/write heads that extend in pairs between the discs. These heads, one per surface, are aerodynamically shaped and fly in the fast-moving layer of air adjacent to the disc surface. All heads move together, although at any moment only one head is being used for reading or writing.

Each head is always at the same position, with respect to its own surface, as is every other head. The ability to move the head assembly to any required position basically means that a record may be accessed directly without the need to read any preceding records. In addition, the rate of data transfer to/from the central processing unit is approximately ten times faster than for magnetic tape.

Each estate agent using this system has a *visual display unit* which allows easy and instant access to the property file. The requirements of a prospective buyer are input using the visual display unit. The

computer searches the file and details of suitable properties are displayed on the screen of the visual display unit. Fast direct access is required, together with an instant response to each inquiry. Similarly, if a property is sold this fact must be recorded straight away to prevent the property being offered to another buyer. These reasons led to the choice of discs to store the property file.

Each individual piece of information about a property, such as its price or the number of bedrooms, is an item of data when held on a computer. Data items within a record are held in separate fields. A field is defined below:

Field: a single item of data within a record.

Data held in a field may be stored in its original form or may be coded. For example, all the advertisements stated the type of property that was being offered for sale. A simple but meaningful 2-character code could be held as a field within the record:

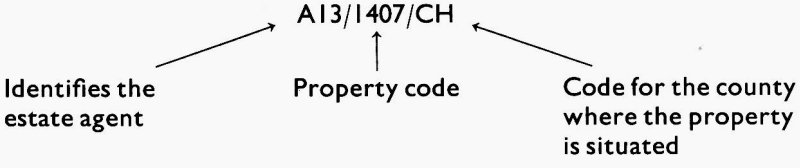
FL	Flat
TH	Terraced house
DH	Detached house
SH	Semi-detached house
DB	Detached bungalow
SB	Semi-detached bungalow
CT	Cottage
FM	Farmhouse.

Use of codes reduces the storage required for each record.

Selling a house may not always be a straightforward matter. From time to time building societies limit the amount of money made available for mortgages. In such a situation a person may decide to lower the selling price of his property. The price field within the record for that property will need altering. This presupposes that the computer is able to uniquely identify each record. Every record has a field whose contents uniquely identify it and specifying the contents enables the record to be located. This field is the key.

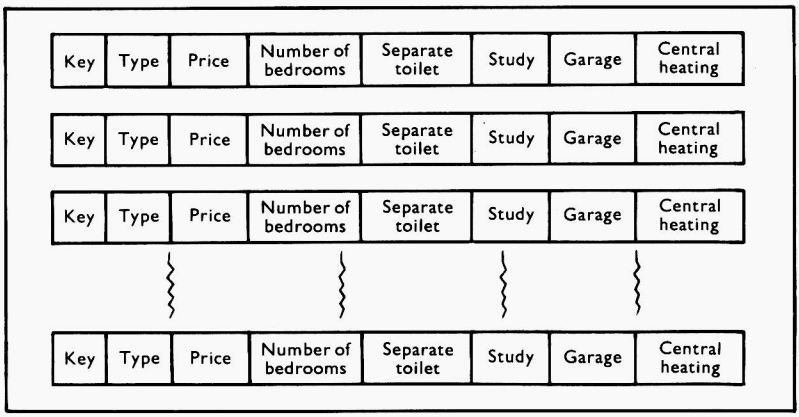
Key: a field used to identify or locate a record.

Obviously each record could be assigned a unique number which would be its key. However, generally there is no restriction on the type of key which may be used. The following field could be used as a key on a property file:



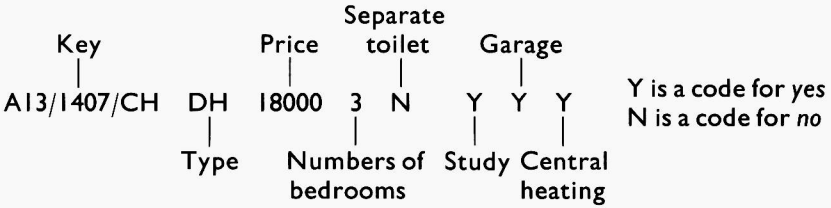
There may be a field within the records whose contents will enable it to be designated as the key. If this is not the case a key, such as a number, may be included within each record, in addition to data required in order to form the record. For the purpose of some file handling processes, such as sorting, any field within a record may be designated as the key. For example, a property file could be sorted on the price field or a field containing the amount of land on which the property stands.

From earlier considerations it should be apparent that a file consists of a number of records and each record consists of a number of fields. This is illustrated by a simplified representation of a property file as shown. Note that, in this fairly typical example, the position of a field is the same within every record.



Property file

A typical record in the file is given. It refers to a three bedroomed, detached house which has central heating, a garage, a study and a bathroom with a toilet.



All of the fields within the property record are *fixed length*. That is to say, each field has a defined length and position within the record. The record, therefore, is itself fixed length.