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ABSTRACT

Nearly all organizations are faced with problems of classifying and coding financial data, management and technical information, components, stores, etc. and need to apply some logical and meaningful system of identification. This report examines the objectives and applications of classification and coding systems and reviews eight systems currently being used by companies. The eight systems reviewed are: Opitz, Brisch, Gildemeister, Pittler, Zafo, Vuoso, Production Engineering Research Association (PERA), and PGM. (Author/SJ)

Classification & Coding

An introduction and review of classification and coding systems

Management Guide No. 1

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Contents

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Part 1. Classification and Coding

1. Introduction

The object of coding and classification in industry is to assist the many functions of manufacture by providing a logical and meaningful system of identification for information, data and components.

The original fields of application of industrial classification and coding were essentially design and stores control. However, with the development of work statistics and group technology, the use of classification has spread into production planning and control and as an aid to the selection of components for group machining. Also, advances in the application of computers to the management functions have extended the uses of classification and coding especially for information storage and retrieval.

Classification is not new, it has been used in certain fields of activity such as libraries for a number of years. The Universal Decimal Code–UDC which is used for the classification of technical books, reports, specifications etc. was developed from a system devised by the American, Melvil Dewey in 1873. Other universal systems have been developed to cover particular industrial or technical requirements, e.g. the NATO coding system, SfB.

However, the application of classification to obtain workpiece statistics and to everyday industrial affairs is a more recent development.

2. Definition of Classification and Coding

Classification has been defined as "the systematic arrangement of similar items into suitably selected categories".

The construction of an industrial classification system is normally a compromise and attempts to satisfy as many of the demands as possible made on it by the users. The basic requirements which must be satisfied in order to obtain a workable classification system are:

1. The essential needs of the user must be established and the best compromise achieved.
2. Only the permanent characteristics contained within the information, data or components be selected and used in designing the classification.
3. The definition of the classification categories must be precise and unambiguous.
4. The classification must be comprehensive, i.e. the categories are capable of including all that which comes within the scope of the classification.

Coding is the allocation of symbols (alpha numerics, etc.) to the classification categories. The best type of symbolisation is generally considered to be purely numerical and of uniform length. The advantages and disadvantages of the various systems of symbolisation are described in "Parts Identification Systems" by H.A. POHS*.

* *Machine Design, July 21, 1966, pp 142-147*

3. The Purpose of Classification and Coding

The necessity for classification in industry is becoming more essential. This is mainly due to the requirement of fast and easy access to information in order to make management decisions. The problem of information retrieval, handling and communication has grown more intense as industrial organisations become larger and products more complex and diversified.

As technology advances and competitive pressures increase, the retrieval of information on components, design, basic materials research, etc. can save time and unnecessary redesign or research work.

Also by the use of a classification system effective reduction and control of primary materials, bought out items, items of own design and tools can be achieved. Often substantial amounts of capital are tied up or wasted in unnecessary stock, excessive storage space, handling and maintenance costs.

4. The Application of Classification

The successful introduction and application of classification within a company requires an overall plan. The development and form of the plan will depend on:

a. Which of the various departments of the company are to use the classification.

b. The demands and requirements to be made on the classification by these departments.

c. The amount of information and data to be included in the classification.

Typical examples of such a plan are shown in Figures 1 and 2. The plan shown in Figure 1 has been developed by E.G. Brisch & Partners Ltd. and the data and information is classified under ten main headings or classes. The plan shown in Figure 2 was developed and used by a government department.

When the overall plan has been evolved, each of the main classes can be sub-divided into the required number of lower levels of classification. Each level of classification being assigned a digit.

The construction of the complete classification requires an accurate identification of each item otherwise the system will be illogical and allow an item to be classified in two or more different positions.

A further example of an overall commodity classification and coding plan is the NATO* codification system.

This system is used by the member nations of NATO and is based on the American Federal Supply Classification. It is designed to establish a unique stores number and title for items of supply used, stored and issued by their Services. Internationally, it facilitates the interchange of equipment and stores between NATO forces to meet mutual support and cross-servicing requirements.

The NATO code number consists of thirteen digits separated into three basic sections as shown by the code number for a resistor in the example below:

Group/Class Prefix	Country of Origin	Item Identification Number
5905	99	023-4567

** Further information on the NATO codification system can be obtained from the Defence Codification Authority, 73/75 Strand, London W.C.2.*

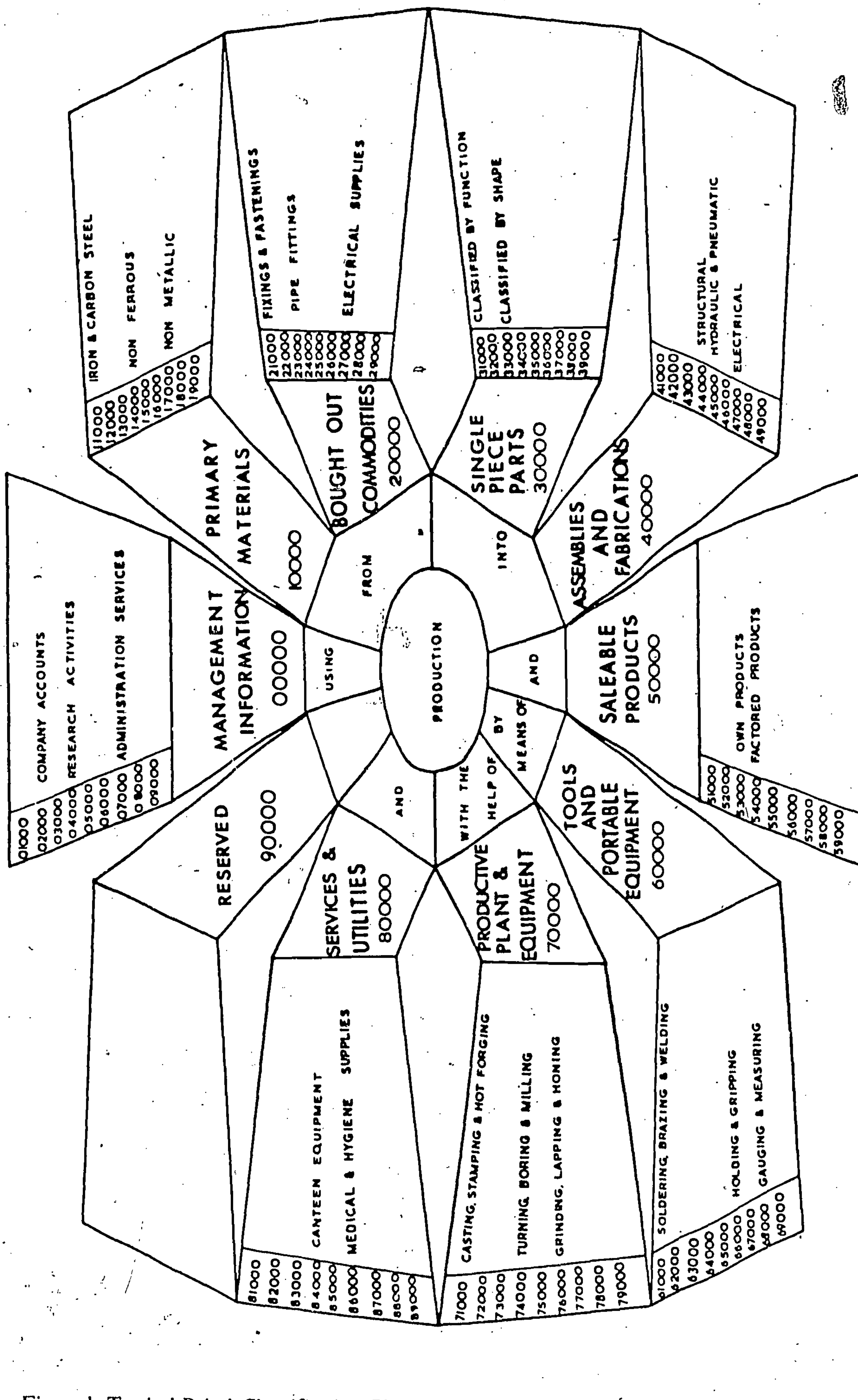

Figure 1. Typical Brisch Classification Plan

Section	Title
10	Metals—Stainless Steel
11	Metals—Ferrous (excl. Stainless Steel)
12	Metals—Non-Ferrous
13	Metals—Ferrous and Special
14	Chemicals
15	Gases and Containers
16	Plastics Elastomers, Insulating Materials and Adhesives
17	Graphite
18	Fuels
20	Pipe Fittings
21	Valves, Traps and Strainers
22	Bearings and Couplings
23	Belting, Jointings, Joint Rings, Packing and Seals
24	Lifting Tackle and Hand Trucks
25	Fasteners
26	Hand Tools
27	Machine Cutting Tools, Accessories and Abrasives
28	Welding, Brazing, Soldering and Metallising Equipment & Materials
29	Lubricating Materials
30	Building Materials
31	Protective and Decorative Materials
32	Hardware
33	Domestic Stores
34	Packaging, Identification Materials and Containers
35	Clothing and Fabrics
36	Stationery
37	Furniture

Section	Title
38	Salvage
40	Workshop and Drawing Instruments
41	Physical Instruments
42	Electrical Instruments
43	Instrument Charts and Accessories
44	Remote Handling and Shielding
45	Laboratory Apparatus
47	High Vacuum Equipment
48	Photographic Equipment
50	Batteries
51	Conduit, Cable Accessories and Distribution Switch and Fuse Gear
52	Switches
53	Motors and Starters
54	Power Plugs and Sockets and Miscellaneous Electrical Accessories
55	Cables and Wires
56	Lamps and Lighting Fittings
58	Cable Assemblies
59	Capacitors
60	Transformers, Chokes and Components
61	Electronic Plugs and Sockets
62	Rectifiers–Metal
63	Relays
64	Resistors
65	Semiconductors
66	Valves, Electronic
67	Valve and Semiconductor Accessories
69	Miscellaneous Electronic Accessories and Components
84	Experimental Electronic Components

Sections 01-09 are used for drawing numbers.

Sections 85-99 are spare and used for expansion.

The complete identification number is constructed by use of the Section Number followed by a five-digit unique identifier e.g. 10-10011.

Figure 2. An Alternative Overall Classification Plan

The four digit Group/Class prefix indicates the type of equipment, commodity or component. The first two digits identify the group and the last two digits identify the classes within each group. In the example the 59, selected from the index of groups shown in Figure 3, indicates that it is an electrical or electronic component. The second two digits—05—the class digits, are allocated as shown in Figure 4 and identify the component as a resistor.

The second section of the code number is a two digit code to identify the country which originated the equipment or commodity, e.g. 00—USA; 99—Great Britain.

The third section of the code number is the item identification number which contains seven digits, split by a hyphen after the third digit for ease of reading. These digits give uniqueness to the complete NATO number and are normally issued sequentially and have no significant meaning.

5. The Implementation of Classification within a Company

The demands made on a classification system will vary according to the particular requirements of the various users. The aim of the overall classification plan will therefore be to obtain the best compromise and satisfy as many as possible of the demands made by the users.

The skill in construction of the plan and classification system is in the balancing of the demands made upon them while attempting to satisfy all the basic rules. The rules employed in the construction of an ideal classification and coding system are:

a. Constant length in order to obtain ease in handling either manually or by electronic data processing equipment.

b. Comprehensiveness, i.e. contain as much as possible usable and significant information within the meaning of each digit.

c. Applicable to the widest range of products possible. Over-specialisation will narrow the field of application.

d. Only permanent characteristics of the information, data or components shall be selected and used in the construction of the classification.

e. Each digit should have a unique meaning within a group of digits, i.e. fixed digital significance.

f. The classification should be mutually exclusive but should not separate similar components because of other minor variations.

g. Adaptable to present and future design and requirements.

User demands may be such that one basic classification cannot cope with all the special requirements. In this situation a primary classification can be developed with compatible secondary classifications to cover the individual special requirements.

6. Centralised Classification Systems

The increase in the size of companies in modern industry by natural growth, mergers etc. has created major problems in organisation and communication. Also the benefits of bulk purchase etc. are often lost since the requirements of one company within the group are not identified with those of the other member companies. The use of a centralised classification system in these circumstances can provide the solution to this problem especially for raw materials and bought out components such as fasteners, pipe fittings etc. This is often feasible even though it may not be practical for the different companies' products and components.

Group	
10	Weapons
11	Nuclear Ordnance
12	Fire Control Equipment
13	Ammunition and Explosives
14	Guided Missiles
15	Aircraft; and Airframe Structural Components
16	Aircraft Components and Accessories
17	Aircraft Launching, Landing, and Ground Handling Equipment
18	Space Vehicles
19	Ships, Small Craft, Pontoons, and Floating Docks
20	Ship and Marine Equipment
21	*Unassigned*
22	Railway Equipment
23	Ground Effect Vehicles, Motor Vehicles, Trailers, and Cycles
24	Tractors
25	Vehicular Equipment Components
26	Tyres and Tubes
27	*Unassigned*
28	Engines, Turbines, and Components
29	Engine Accessories
30	Mechanical Power Transmission Equipment
31	Bearings
32	Woodworking Machinery and Equipment
33	*Deleted*
34	Metalworking Machinery
35	Service and Trade Equipment
36	Special Industry Machinery
37	Agricultural Machinery and Equipment
38	Construction, Mining, Excavating, and Highway Maintenance Equipment
39	Materials Handling Equipment
40	Rope, Cable, Chain, and Fittings
41	Refrigeration, Air Conditioning, and Air Circulating Equipment
42	Fire Fighting, Rescue, and Safety Equipment
43	Pumps and Compressors
44	Furnace, Steam Plant, and Drying Equipment; and Nuclear Reactors
45	Plumbing, Heating, and Sanitation Equipment
46	Water Purification and Sewage Treatment Equipment
47	Pipe, Tubing, Hose, and Fittings
48	Valves
49	Maintenance and Repair Shop Equipment
50	*Unassigned*
51	Hand Tools
52	Measuring Tools
53	Hardware and Abrasives
54	Prefabricated Structures and Scaffolding
55	Lumber, Millwork, Plywood, and Veneer
56	Construction and Building Materials
57	*Unassigned*
58	Communication, Detection, and Coherent Radiation Equipment
59	Electrical and Electronic Equipment Components
60	*Unassigned*
61	Electric Wire, and Power and Distribution Equipment
62	Lighting Fixtures and Lamps
63	Alarm and Signal Systems
64	*Unassigned*
65	Medical, Dental, and Veterinary Equipment and Supplies
66	Instruments and Laboratory Equipment
67	Photographic Equipment
68	Chemicals and Chemical Products
69	Training Aids and Devices
70	*Unassigned*
71	Furniture
72	Household and Commercial Furnishings and Appliances
73	Food Preparation and Serving Equipment
74	Office Machines, Visible Record Equipment, and Data Processing Equipment
75	Office Supplies and Devices
76	Books, Maps, and Other Publications
77	Musical Instruments, Phonographs, and Home-Type Radios
78	Recreational and Athletic Equipment
79	Cleaning Equipment and Supplies
80	Brushes, Paints, Sealers, and Adhesives
81	Containers, Packaging, and Packing Supplies
82	*Unassigned*
83	Textiles, Leather, Furs, Apparel and Shoe Findings, Tents and Flags
84	Clothing, Individual Equipment, and Insignia
85	Toiletries
86	*Unassigned*
87	Agricultural Supplies
88	Live Animals
89	Subsistence
90	*Unassigned*
91	Fuels, Lubricants, Oils, and Waxes
92	*Unassigned*
93	Nonmetallic Fabricated Materials
94	Nonmetallic Crude Materials
95	Metal Bars, Sheets, and Shapes
96	Ores, Minerals, and Their Primary Products
97	*Unassigned*
98	*Unassigned*
99	Miscellaneous

Figure 3. Group Index of the NATO Codification System

Group 59. Electrical and Electronic Equipment Components

Note–Mounting hardware, included in classes of this group, includes such specially designed items as brackets, holders, retainers, etc. Excluded from classes in this group are such hardware items as screws (Class 5305), bolts (Class 5306), studs (Class 5307), washers (Class 5310), rivets (Class 5320), and other common items indexed to specific classes, other than in Group 59. The FSC indexes and structure will govern the classification of items used on or with mounting hardware cited above.

5905 Resistors
Includes Resistive Attenuators; Varistors; Resistive Ballast Tubes; Rheostats; Resistor Mounting Hardware; Thermistors.
Excludes Resistance Wire.

5910 Capacitors
Includes Interference Filter Capacitors; Capacitor Mounting Hardware.
Excludes Semiconductor Devices and Associated Hardware.

5915 Filters and Networks
Note–This class includes those filters and networks which consist of a combination of resistors, capacitors, or coils, but not a combination of resistors only (classified in 5905), capacitors only (classified in 5910), or coils only (classified in 5950).

5920 Fuses and Lightning Arresters
Includes Fuseholders; Fuse Boxes; Fuse Posts; Fuse Links; Fuse Blocks; Current Limiters.

5925 Circuit Breakers
Includes Cutouts.
Excludes Relays.

5930 Switches
Includes Rotary, Knife, Toggle, Push Button, Mercury, Thermostatic, and Differential Pressure Switches.
Excludes Switchgear.

5935 Connectors, Electrical
Includes Plugs; Receptacles; Tube Sockets.
Excludes Semiconductor Device Sockets.

5940 Lugs, Terminals, and Terminal Strips
Includes Binding Posts; Battery Clips; Stud Terminals; Test Clips.

5945 Relays, Contactors, and Solenoids
Includes Electromagnetic Actuators.

5950 Coils and Transformers
Note–This class includes transformers with a kilovolt-ampere rating of 1kva and below.
Includes Potential and Current Transformers; Chokes.
Excludes Constant Current Transformers; Ignition Coils.

5955 Piezoelectric Crystals
Includes Processed Unmounted Crystals.

5960 Electron Tubes and Associated Hardware
Includes Rectifying Tubes; Photoelectric Tubes; Electron Vibrator Tubes.
Excludes Transistors; Tube Sockets; X-ray Tubes; Semiconductor Devices and Associated Hardware.

5961 Semiconductor Devices and Associated Hardware
Includes Rectifying Crystals; Photoelectric Cells; Transistors; Semiconductor Device Sockets; Rectifiers, Semiconductor Device.
Excludes Microelectronic Circuit Devices.

5962 Microelectronic Circuit Devices
Note–The terms "Microelectronic" and "Integrated" as used in connection with circuit devices included in this class, are delimited to exclude "interconnected miniaturized components." In this class, the term "microelectronic" may be considered a colloquial term related to the term "integrated." As defined in Cataloging Handbook H 6-1, an integrated Circuit Device is "a functional electronic device fabricated in the form of a single monolithic structure wherein a number of inseparably associated active and/or passive circuit elements (components) are integrally diffused (produced) on or within a continuous body (substrate base) to perform the function of a circuit."
Includes Integrated Circuit Devices such as Adder-Subtractors, Buffers, Counters, Counter Adapters, Flip Flops, Half Adders, Shift and Half Shift Registers, Linear Amplifiers, Logic Gates, Logic Gate Expanders, Operational Amplifiers; Integrated Circuit Modules; Integrated Electronic Devices: Hybrid; Magnetic; Molecular; Opto-Electronic; and Thin Film.
Excludes Single Circuit Elements such as Capacitors, Diodes, Resistors, Semiconductor Devices and Assemblies, and Transistors; Printed Circuit Boards and Circuit Card Assemblies; Filters and Networks; Modules Containing Discrete Electronic Components; and Integrated Circuits peculiar to Night Vision Equipment classified in Group 58.

5965 Headsets, Handsets, Microphones and Speakers

5970 Electrical Insulators and Insulating Materials
Includes Tube, Knob, Cleat, Strain, and Standoff Insulators; Feed Thru Insulators; Bead Insulators, Loom, Insulating; Varnished Cambric Tape; Friction Tape.

5975 Electrical Hardware and Supplies
Includes Conduit; Raceways; Face Plates, Condulets; Outlet and Junction Boxes, Multiapplication; Pole Line Hardware, not elsewhere classifiable.

5977 Electrical Contact Brushes and Electrodes
Includes Brushes for electrical rotating equipment; Carbon Stock for Brushes; Brush Arms and Holders; Lighting Electrodes.
Excludes Anodes; Cathodes, Welding Electrodes.

5985 Antennas, Waveguides, and Related Equipment
Note–Items specifically designed for specific use on or with specific individual types of equipment are excluded from this class and are to be classified in the same classes as their next higher assemblies.
Includes Aerial, Mast, and Tower Equipment.
Excludes Tower Structures.

5990 Synchros and Resolvers
Excludes Synchro Systems; Servo Mechanisms.

5995 Cable, Cord, and Wire Assemblies: Communication Equipment
Note–This class includes only those types of cable, cord, and wire assemblies which are used on or with equipment and components covered by Groups 58 and 59. Sets of cables, cords, or wires or wiring harnesses are not classified in this class but are classified in the same classes as their next higher assemblies.

5999 Miscellaneous Electrical and Electronic Components
Includes Permanent Magnets and Magnetostriction Elements.

Figure 4: Definition of Classes in Group 59 of the NATO Codification System.

The main difficulties normally associated with a centralised system are the cost of operation and maintenance. These may be offset by the financial savings achieved and by making each member of the group responsible for the establishment and maintenance of particular areas of the classification plan. The choice of responsibility can be assigned to the member with the largest usage or requirement within a particular area.

7. Classification and Coding for Design and Information Retrieval

The major premise of information is that when information and data are correctly organised, identified and filed, it is possible to store, search and retrieve information when required.

Drawing numbering systems are primarily used for unique identification of the component in the form of a part number. The numbers are allocated from a sequential block of numbers or by a product orientated numbering system.

If, however, the part number is allocated by the use of a classification and coding system which defines the main features of the design, all components of similar design will be brought together into a "family". This will occur irrespective of the drawing title or application in different products. The drawings of components within a given "family" have common code numbers but are separated by the addition of a unique identifier in order to obtain the complete part number.

The design information is therefore identified and filed in an organised manner and it is practical to search for and retrieve a particular design. The system can be extended to include any associated production paperwork such as planning schedules, work routings etc.

The establishment of a retrieval system provides a sound basis for rationalisation and standardisation of components and for the introduction of value analysis. In the production departments better use can be made of existing tooling, the manufacturing methods rationalised allowing quick cost comparisons to be made and new estimates prepared.

The uses and the effect of a retrieval facility on the management structure is shown in Figure 5.

8. Example of a Typical Management System using a Retrieval System

a. General

A typical retrieval system for the design and production departments is shown in Figure 6 and covers component manufacture by machine groups established by group technology and the normal functional workshop.

On receipt of an order and by checking against the master records it is possible to prove whether it is a repeat or not. If the order is a repeat the necessary paperwork will exist within the system for the necessary instructions for manufacture to proceed quickly through the various departments (Left-hand path through Figure 6). When the order is not a repeat the instructions can be issued for design and production effort to satisfy the new product or requirements (Right-hand path through Figure 6).

b. Retrieval in the Design Department

The retrieval facility in the design department will consist of a file containing all the company's component drawings stored in code number order. The copies of the drawings may be full size prints, reduced size prints or microfilms mounted in aperture cards. The choice of method is dependent on the company, i.e. the print room facilities available, the size of the file (total number of drawings) and amount of money available.

The use of the facility is best illustrated by consideration of the design process. When a new design is prepared, it is normal for a design layout to be prepared. When the layout is accepted, the component drawings are detailed from the layout, checked and issued to the production department. During this process the designer or draughtsman may remember the existence of a previously drawn component which may be usable in the new design. When no retrieval facility exists, any search carried out for the component relies on memory. Such searches normally end in failure and result in the creation of a new drawing.

However, if a drawing retrieval facility is available, the designer when preparing the design layout and detail drawings can search the drawing file in a logical manner for existing components to satisfy the new requirements. When no suitable identical component is retrieved, three alternatives exist. The first is that by modification of the design the nearest existing component may be acceptable. The second alternative is that by slight modification of the nearest existing component it may be made to satisfy the new requirements. The third and last alternative is to design and create a new component.

If either of the first two alternatives are acceptable, not only is the cost of design reduced, but the additional costs of planning and possible special tooling is eliminated.

The retrieval of simple components such as washers, collars, bushes etc. to satisfy specific requirements is good. However, the chance of retrieving complex components to completely satisfy new design requirements is fairly low. This is mainly due to the fact that complex components are normally designed to satisfy an exact design requirement and the chance of this requirement ever repeating itself is very small.

The establishment of a design retrieval facility and the necessary discipline of searching for previously designed components has been criticised in that it stagnates original design. However, the function and design requirements of a component dictate the shape, size and material and it is unnecessarily expensive and inefficient to create a new component if there is one already in existence.

c. Retrieval in the Production Engineering Department

The retrieval facility in the production planning department will consist of master files which contain copies of the company's component drawings, operation schedules, estimated setting and machining times, work routes, estimated cost etc. The use of the facility can be best illustrated by considering the action of the department on receipt of an order. (See Figure 6.)

The order will contain a complete list of components required, number off and the delivery date. The first action by the planning department is to check the component code numbers against the master files. This check will reveal one of three possibilities.

The first possibility is that the component had been manufactured previously. The next step is to check whether or not the component is manufactured as part of a component family on a group of machines. If it is a member of a component family no further work is required and the order for the component is passed direct to production control. The planning necessary for the components contained within the component family would have been carried out when the machine group was established. Copies of this paperwork will be permanently associated with the machine group on the shop floor. When the component is not part of a component family, the existing paperwork is checked, and provided no major change in manufacturing conditions has taken place, it can be re-issued to production control. The component is then scheduled and manufactured by the workshop in the normal manner.

The second possibility is a component similar to that required has been manufactured previously. Again, the next step is to check if the similar component is manufactured on a machine group. If this is the situation, the requirements of the new component are checked against the acceptance parameters and tooling layout for the component family. The component may be acceptable without any modification of the group set-up and the only action required is the up-dating of the component family paperwork in the master files. This is achieved by synthesising the necessary machining times, costs, etc. from the existing component family paperwork.

When the similar component is not manufactured on a machine group, the paperwork for the new component is synthesised by use of the master file. The master file is up-dated and the new paperwork issued to production control.

The third and last possibility is that no similar component has been manufactured previously. The complete function of the planning department is required and new schedules, estimated times etc. are prepared. The new paperwork is issued and the master file up-dated.

The re-use and synthesising of component production data and information can provide large savings in time and money. The re-use of existing data simplifies the whole planning procedure and allows planners to devote more time to the planning of "specials" and

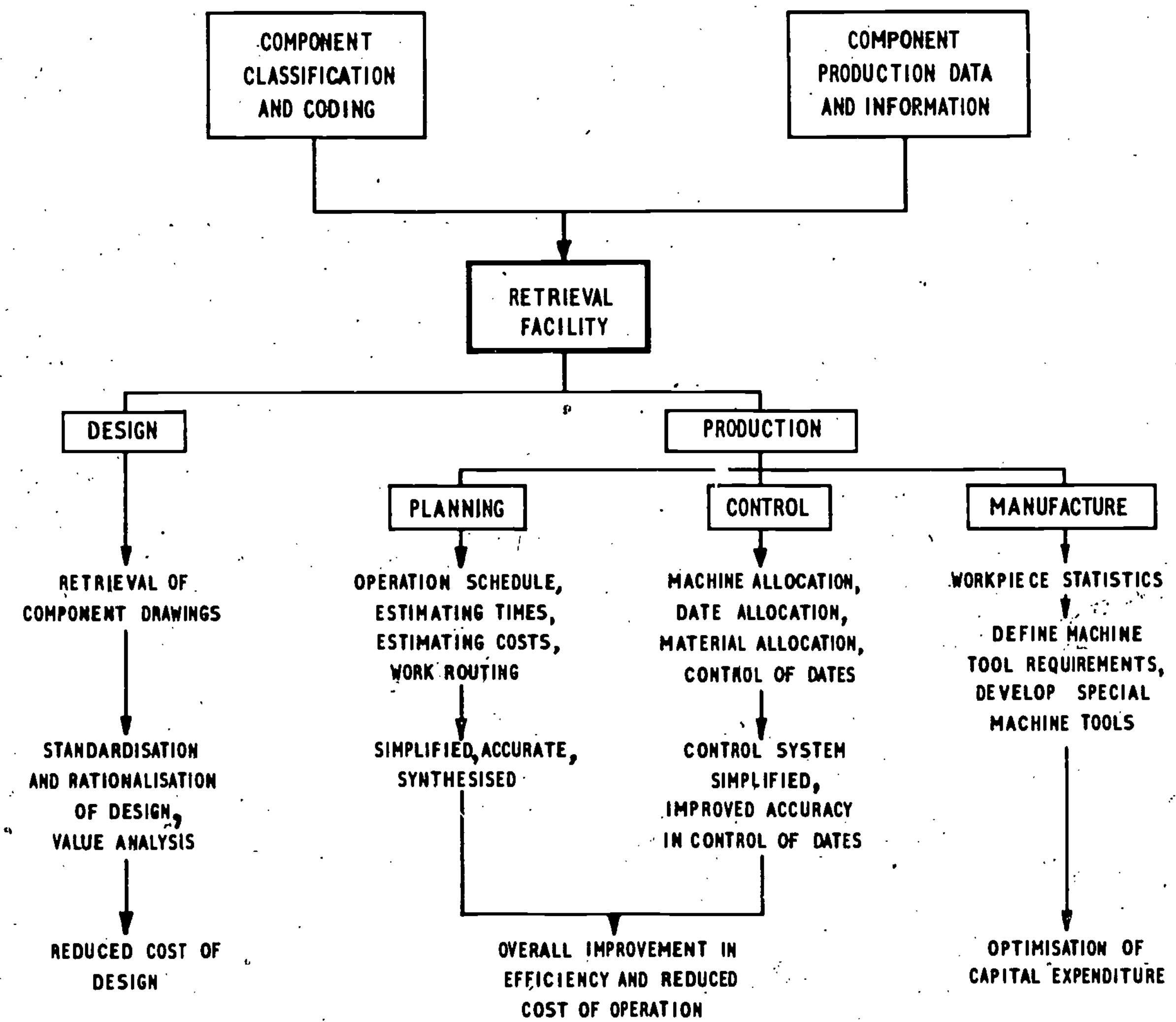

Figure 5. Use of the Retrieval Facility by Management

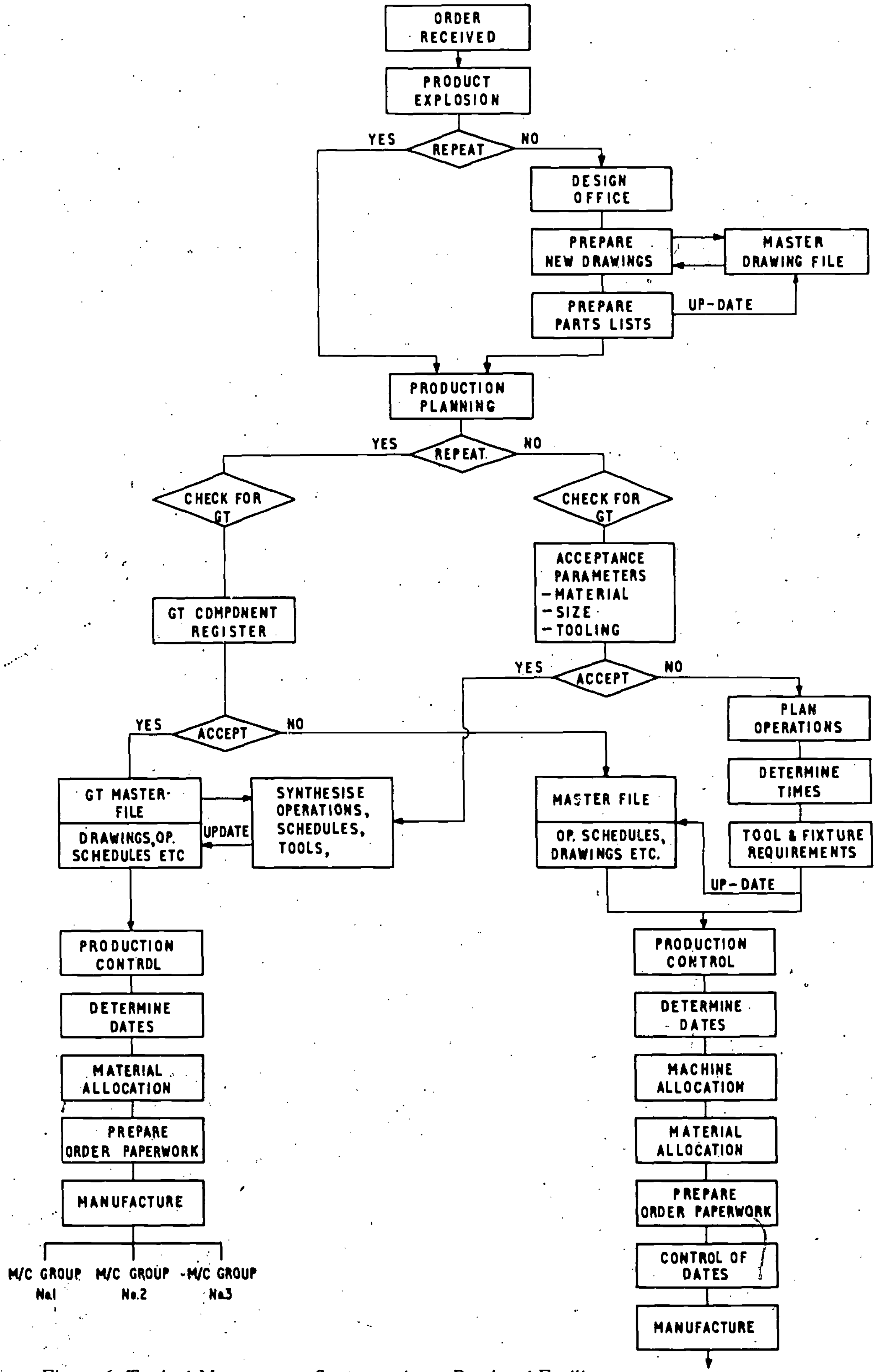

Figure 6. Typical Management System using a Retrieval Facility

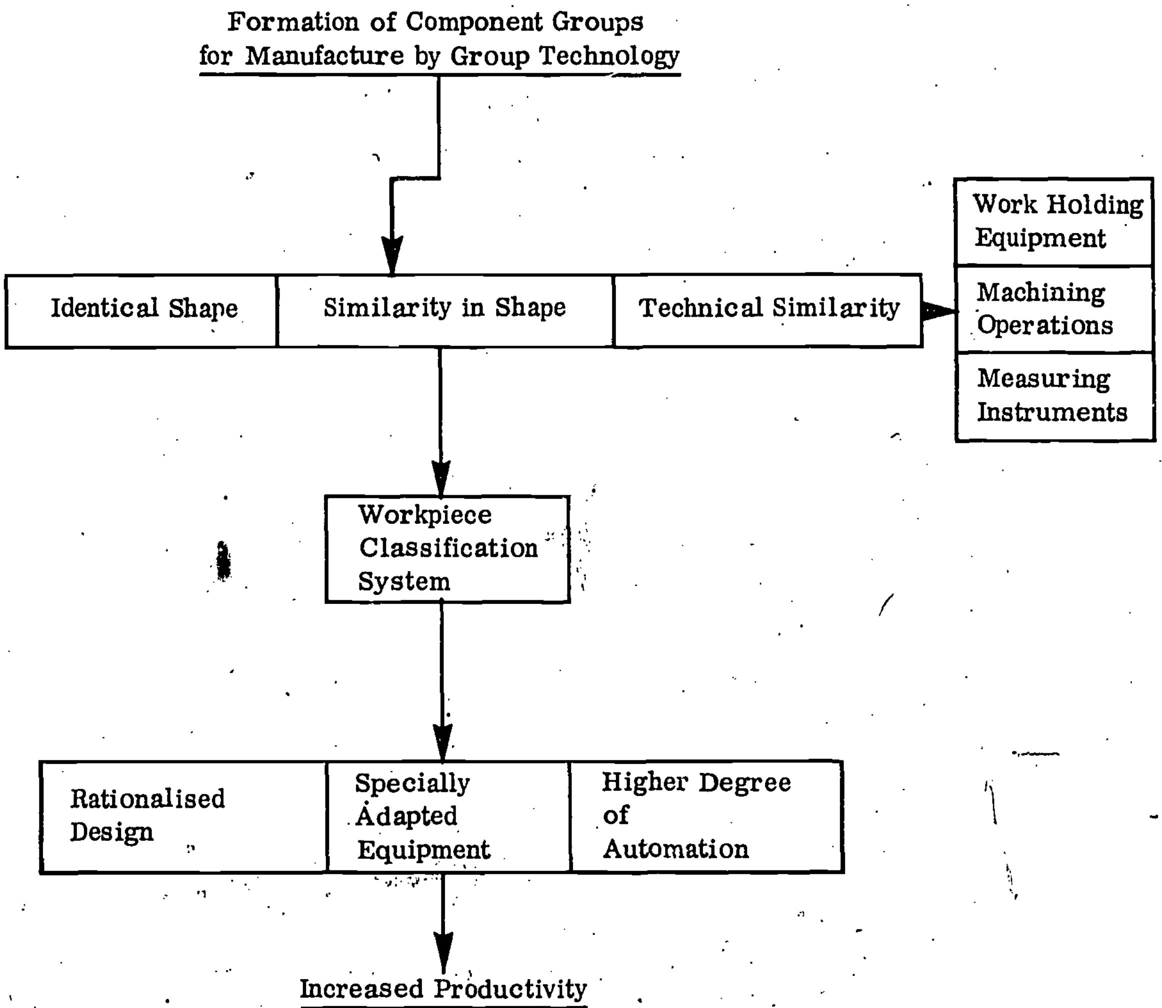

Figure 7. Manufacture by Group Technology

improving the existing production methods. Accurate estimating times and costs can be established since actual or real times for components can be determined and entered in the master files. Use of these standard times, costs etc. eliminates anomalies and variations due to the individual approach and abilities of planning personnel.

d. Workpiece or Component Statistics for Workshop Management

The retrieval facility established in the production department contains the complete data and information on all components produced by the company. Since each component is identified by a code number which contains basic information as regards size, shape, material, etc. it is possible to generate workpiece statistics. By use of these statistics it is a simple matter to compare the physical characteristics of components with the manufacturing facilities available.

Generally such comparisons show there is a large discrepancy between the requirements for the components and the available facilities. In all aspects the machines provided are too large, too precise and over capable of the actual demands made upon them. This may be satisfactory from the point of view that components will always be within the scope of the machine tools but the difference between actual demand and available resources is so great that large financial savings are possible.

The generation and use of component statistics by a company is therefore a sound platform on which to base the selection, purchase and development of new machine tools.

9. Rationalisation and Standardisation

Often a company's standardisation policy is ill-defined or non-existent and the establishment of a sound effective policy is generally difficult. However, by the grouping of components for similarity in shape, size and material by means of a classification system a sound basis is obtained for the introduction of a standardisation program.

The grouped identical, or similar components can be examined with the object of rationalising and standardising the component part design or applying value analysis.

The grouped components can also be examined for similarity of production process in order that the group may be produced using the same machines and tooling. This in effect is the rationalisation and standardisation of the production process and is similar to group machining as defined in group technology.

It is also possible to introduce standardisation procedures for the various features which make up the overall component design, i.e. grooves, undercuts, radii, chamfers, counter bores etc. In the analysis of the production methods of the grouped components details of these features must be recorded in order to provide the necessary tooling. By examination of this information, preferred sizes for each of the features can be established. Standard sheets listing the preferred sizes and tolerances can be prepared and issued to designers and draughtsmen.

10. Classification and Coding for Group Technology

Group technology is a method of manufacturing component parts by the classification of the parts into groups and applying to each group similar technological and machining operations. The grouping of components increases the batch size and permits the use of flow line production on groups of machines with adaptable tooling and set-ups. This results in reduced throughput times and better utilisation of labour and existing equipment.

The essential characteristics for the formation of component groups which are suitable for manufacture by the group technology process are shown in Figure 7. The formation of the component groups is facilitated by the use of a classification and coding system. Component groups which increase batch sizes are developed in three distinct methods.

1st Method—Identical Shape

Identical shape is achieved by standardisation, rationalisation and unification of components by designers. This makes it possible for the design department to use repeat parts and permits batch sizes to be increased.

2nd Method—Similarity in Shape

This method groups components by their similarity in shape and the necessity for identical or similar sequences of manufacturing operations. The standardisation and unification of the manufacturing and machining operations makes production with conventional machine layouts or with machine flow lines more efficient by reducing operation and setting times.

3rd Method—Technical Similarity

The third method is the grouping of components which require an identical sequence of operations. This promotes the development and use of machines with a high degree of automation.

The first and second methods are complimentary and often occur simultaneously.

It is by this grouping of components that rationalisation of machining processes, sequence of operations, operation and setting times, jigs and fixtures, tools and other ancillary items is made possible. This reduces the work content at all stages of manufacture and results in an overall increase in production efficiency.

The classification and coding systems suitable for use in group technology have many common interfaces with systems for design retrieval and the basic rules of classification still apply. The system as a whole may be based on the geometric shape and/or the function of the component and/or the production requirements which are based on the tooling and machining requirements. However, classification by function should not be used unless the term is descriptive and has an exact meaning, e.g., piston, crankshaft. Definite names and generic terms in current engineering terminology are not exclusive and components with different functions can be given the same name even when used in the same equipment.

It is therefore preferable that the classification be based on the permanent characteristics of the components. The selection of characteristics and their systematic arrangement must be related to the overall requirements which the classification has to satisfy but should include:

a. Geometric definition of external and internal shape,

b. Other features such as holes, slots and spines, etc,

c. Material and where practical the initial form, e.g. bars, casting, forging,

d. Size.

These characteristics can be supplemented when required by other features such as levels of accuracy in machining, weight of component, etc.

By the use of a classification system containing this type of information, components are sorted into groups. Each component within a group may then be studied and assessed for production by the group method of machining. The size of some component groups may be such that manufacture in their own right is not economic, but by merging one group with one or more other groups economic and efficient manufacture can be achieved.

Part 2. Review of Classification Systems used in Group Technology

1. Types of Available Classification System

Associated with the growing interest and practice of group technology has been the development of new classification systems and adaptation of existing systems for use in the technology.

The systems which have been developed fall into two main categories. The first category is that which has been used to establish workpiece or component statistics. These systems are not normally of fixed length and require component data, i.e., shape, features, machining operations, surface finish, etc. to be recorded on punched cards and may use up to 80 columns or more. The data is entered into computer store, searched, analysed and statistical patterns etc. established. This type of system may be used for group technology but has the disadvantage of large labour and time content for the recording and processing of the data. Also the acceptance of a component into a component group requires the study of the actual component drawing and not the study of a mass of possibly unrelated data extracted from the drawing.

Systems considered to be included in this first category are the Vuoso, PERA, Brisch Polycode and a number of systems developed in Russia.

The systems which come into the second category are those which set a realistic figure for the number of digits to be used for recording component data. These systems contain as much usable information as possible in the minimum number of digits and are normally of fixed length. A number of the systems are suitable for both manual and machine processing. The better known systems in this category include the Brisch Monocode, Opitz, Pittler and Gildemeister.

2. Parameters for the Assessment of Classification Systems

In order to assess the advantages or disadvantages of the various classification systems, a number of parameters should be selected. The choice of parameters should be objective with regard to the basic demands to be made on the system by the company, i.e. the requirements for group technology and the possible interfaces with the various management techniques such as design retrieval and stores identification.

The following parameters have been established and by their use a practical assessment may be obtained of the various classification systems available at the present time. The parameters have been selected or based on one major premise; the information and data contained within the classification cannot replace the drawing or decide the exact method of production. The classification system is simply an aid or technique to break down and group in a logical manner a mass of component drawings, information and data so as to allow detailed study and analysis to be performed. Therefore, after the initial sorting by use of the classification, reference must be made to the drawing. The stage at which this occurs will vary with the classification system.

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Assessment Parameters

i. The classification shall contain basic component data and information essential for the grouping of components into families, i.e.:

a. Geometric definition of the external and internal shape.

b. Information on subordinate features such as holes, slots.

c. Material and the initial form, e.g., bar, forging, casting.

d. Size—major diameter and overall length, or length, width and height.

ii. Since the coding of drawings is a time-consuming operation, the labour content of this stage of group technology must be kept to the lowest possible level.

iii. The system shall lend itself to manipulation by sorting machines and it should be possible to:

a. Execute the sorting of components from the lowest to the highest form of complexity.

b. Determine the various subordinate features related to the principle features.

iv. The classification shall contain the maximum usable amount of data and information within a reasonable number of digits, preferably not greater than 10.

3. Classification Systems described in the Review

The classification systems described in this review are either in current use for group technology in this country or referred to in various papers on the subject. All the systems have originated in Western Europe except the Vuoso system. Many systems have been developed in Russia for group technology, but from what is known of them, they appear to offer no major advantage over those developed in Western Europe. It is for this reason they have been excluded from the review.

4. The Opitz Classification System

The Opitz classification system was first used for the establishment of workpiece statistics for the development of new machine tools. The original system has been modified by incorporating the results of the workpiece statistics and improving the presentation. The present system consists of a 5-digit primary code and a 4-digit supplementary code. (See Figure 8.)

The primary code is essentially a geometric code which groups components by the logical arrangement of shape characteristics and significant features. (See Figure 9.) The supplementary code provides information on dimensions, material and its initial form and accuracy. (See Figure 10.) Fixed digital significance exists in certain areas of the code with individual digits describing the same features for all classes of component and each position within a digit has a corresponding meaning. This makes the code easy to memorise and in use high rates of coding can be achieved.

This classification system is suitable for most general applications since it is not based on any one company's components but on component statistics extracted from a number of companies. Two positions (5 and 9) are left open to allow for the classification of components specific to an individual company. This classification can be either by shape or function or a combination of both.

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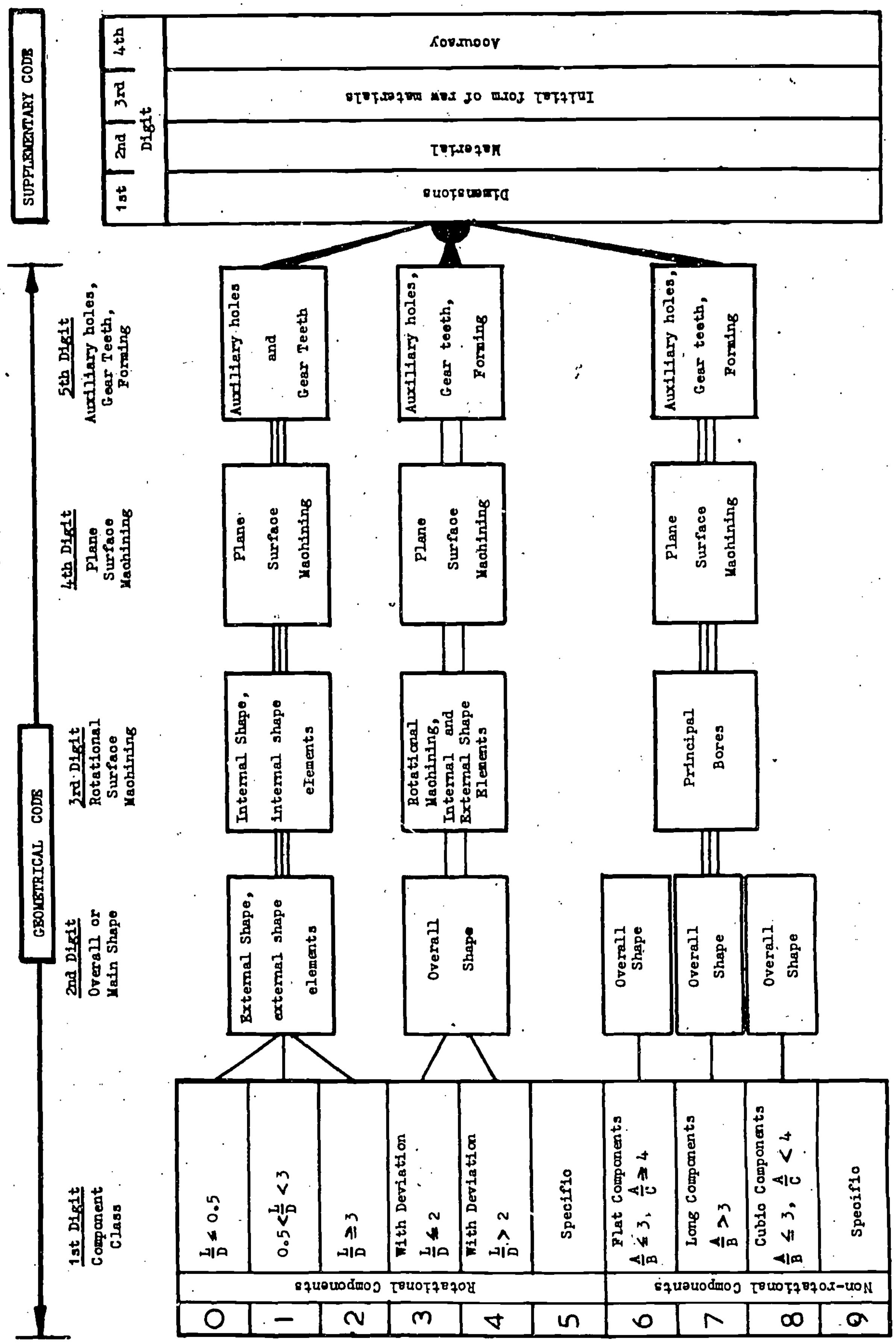

Figure 8. The Opitz Classification System

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1st Digit

		Component Class
0	Rotational Components	$\frac{L}{D} \leqslant 0{\cdot}5$
1	Rotational Components	$0{\cdot}5 < \frac{L}{D} < 3$
2	Rotational Components	$\frac{L}{D} \geqslant 3$

2nd Digit

		External Shape, external shape elements
0		Smooth, no shape elements
1	Stepped to one End	no shape elements
2	Stepped to one End or smooth	with screwthread
3	Stepped to one End or smooth	with functional groove
4	Stepped to both Ends (Multiple increases)	no shape elements
5	Stepped to both Ends (Multiple increases)	with screwthread
6	Stepped to both Ends (Multiple increases)	with functional groove
7		functional taper
8		Operating thread
9		Others (> 10 functional diameters)

3rd Digit

		Internal Shape, internal shape elements
0		Without through bore blind hole
1	Smooth or Stepped to one End	no shape elements
2	Smooth or Stepped to one End	with screwthread
3	Smooth or Stepped to one End	with functional groove
4	Stepped to both Ends (Multiple increases)	no shape elements
5	Stepped to both Ends (Multiple increases)	with screwthread
6	Stepped to both Ends (Multiple increases)	with functional groove
7		functional taper
8		Operating thread
9		Others (> 10 functional diameters)

4th Digit

	Plane Surface Machining
0	No surface machining
1	External plane surface and/or surface curved in one direction
2	External plane surfaces related to one another by graduation around a circle
3	External groove and/or slot
4	External spline and/or Polygon
5	External plane surface and/or slot and/or groove, spline
6	Internal plane surface and/or groove
7	Internal Spline and/or Polygon
8	External and Internal splines and/or slot and/or groove
9	others

5th Digit

		Auxiliary Hole(s) and Gear Teeth
0		No auxiliary hole(s)
1	no gear teeth	axial hole(s) not related by a drilling pattern
2	no gear teeth	axial holes related by a drilling pattern
3	no gear teeth	radial hole(s) not related by a drilling pattern
4	no gear teeth	holes axial and/or radial and/or in other directions, not related
5	no gear teeth	holes axial, and/or radial and/in other directions related by drilling pattern
6	with gear teeth	spur gear teeth
7	with gear teeth	bevel gear teeth
8	with gear teeth	other gear teeth
9	with gear teeth	others

Figure 9. Part of the Opitz Geometrical Code

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	1st Digit: DIAMETER 'D' or EDGE LENGTH 'A' — MM's	1st Digit: Inches	2nd Digit: MATERIAL	3rd Digit: INITIAL FORM	4th Digit: ACCURACY IN CODING DIGIT
0	≤ 20	≤ 0·8	Cast Iron	Round Bar, black	No Accuracy Specified
1	> 20 ≤ 50	> 0·8 ≤ 2·0	Modular graphitic cast iron and malleable cast iron	Round Bar, bright drawn	2
2	> 50 ≤ 100	> 2·0 ≤ 4·0	Steel ≤ 26.5 tonf/in² Not heat treated	Bar-triangular, square, hexagonal, others	3
3	> 100 ≤ 160	> 4·0 ≤ 6·5	Steel > 26.5 tonf/in² Heat treatable low carbon and case hardening steel, not heat treated	Tubing	4
4	> 160 ≤ 250	> 6·5 ≤ 10·0	Steels 2 and 3 Heat treated	Angle, U-, T-, and similar sections	5
5	> 250 ≤ 400	> 10·0 ≤ 16·0	Alloy Steel (Not heat treated)	Sheet	2 and 3
6	> 400 ≤ 600	> 16·0 ≤ 25·0	Alloy Steel Heat treated	Plate and Slabs	2 and 4
7	> 600 ≤ 1000	> 25·0 ≤ 40·0	Non-ferrous Metal	Cast or forged Components	2 and 5
8	> 1000 ≤ 2000	> 40·0 ≤ 80·0	Light Alloy	Welded Assembly	3 and 4
9	> 2000	> 80·0	Other Materials	Pre-machined Components	(2+3+4+5)

Figure 10. Opitz Supplementary Code

The information and data contained within the classification satisfies most of the requirements for group technology and is also suitable for the establishment of a design retrieval facility. From the Opitz code number it is possible to construct a rough outline of the shape of the component and the possible sequence of machining operations required to produce it.

Since the primary use of the Opitz classification system is the grouping of components for group processing, no attempt has been made to provide for the unique numbering of components. If this is a requirement for the application of the classification in a company it can be achieved without difficulty and the following are possible solutions:

i. Addition of a unique number.

Primary Geometric Code		Supplementary Code		Unique Number
12345	–	1234	–	001

Primary Geometric Code		Unique Number
12345	–	001

Note: The supplementary code is dropped from the drawing number but referred to on any index, file, etc.

ii. Opitz code number supplementary to company's unique number.

Company's Unique Drawing Number		Opitz Code Number
HR/A 123456	–	12345-1234

Note: This method may be preferable since it would cause the least disturbance to the existing systems within the company. Cross-referencing of the two numbers would be essential.

5. Brisch Classification System

a. General

Brisch classification and coding techniques have been developed to cover every facet of the activities of an engineering organisation, from men and operations through materials, components, assemblies and products to tools, plant and finally scrap and waste (see Figure 1, page 2).

The aims of the system are:

- to give every item a meaningful and unique identity which will provide a common language throughout an organisation,
- to provide individual departments with interrogation facilities, e.g., for the purposes of design retrieval, variety control etc.

There are two basic types of classification produced by E.G. Brisch & Partners. The first type is the well established 'monocode'. The second is the more recently developed 'polycode' approach.

b. Monocodes

Monocodes provide unique item identity. They are of fixed and uniform notation and are based upon permanent characteristics. A monocode generally consists of two members, the first member, called the 'surname' the second the 'christian' name. This format may vary between distinct Brisch classes but never within a class. An example of a monocode is shown in Figure 11.

This demonstrates how the surname defines a family whilst the christian names identify each item within the family.

Current practice in group technology only concerns the production of single piece parts which are covered by one of ten Brisch classes namely class 3. However, the future extension of group technology into, for example, assembly work would also involve class 4 assemblies. assemblies.

The permanent characteristics chosen to be significant and to be identified within a component code are established after consideration of the overall company requirements. The code may be oriented towards either the designer or the production engineer.

The classification is developed by analysis of the company's component drawings, and a synthesised classification structure is produced.

This classification structure is tested, anomalies removed and the whole structure re-checked. The classification is then presented in its finalised form and the drawings coded. It is by this process of analysis and synthesis that the classification and code structure is tailored to the particular requirements of individual companies.

c. Polycodes

Brisch polycodes have been developed to describe data which are either of a non-permanent nature or of such specific detail as to be only useful to individual departments. Polycodes are of fixed digital significance and form an open-ended string of codes. Experience has shown, however, that a practical selection of polycodes for any one project is unlikely to require more than ten codes.

For the purpose of group technology, polycodes may be allocated to such parameters as specific lengths, diameters, types of operation and machine tools required, the form of raw material (i.e. bar, casting, forging) etc. They thus allow a coding of components in terms of production requirements.

Polycodes may be used in conjunction with any component identification method, be it a meaningless sequential number or a monocode. In the latter case the data carried in the polycodes will supplement the monocode to any degree required by the user. It will not duplicate information already contained in the monocode, thus the number of polycodes required is minimised. Figure 12 illustrates for one of the items from the monocode family described previously, the additional information added in the form of polycodes. In this case seven polycodes, from a range of polycodes covering all axial components, were required to retrieve suitable components for group technology.

6. Gildemeister Classification System

This system was developed by the West German machine tool company for use within its own factories. It is a 10-digit code with the first 4 digits used for the classification of components

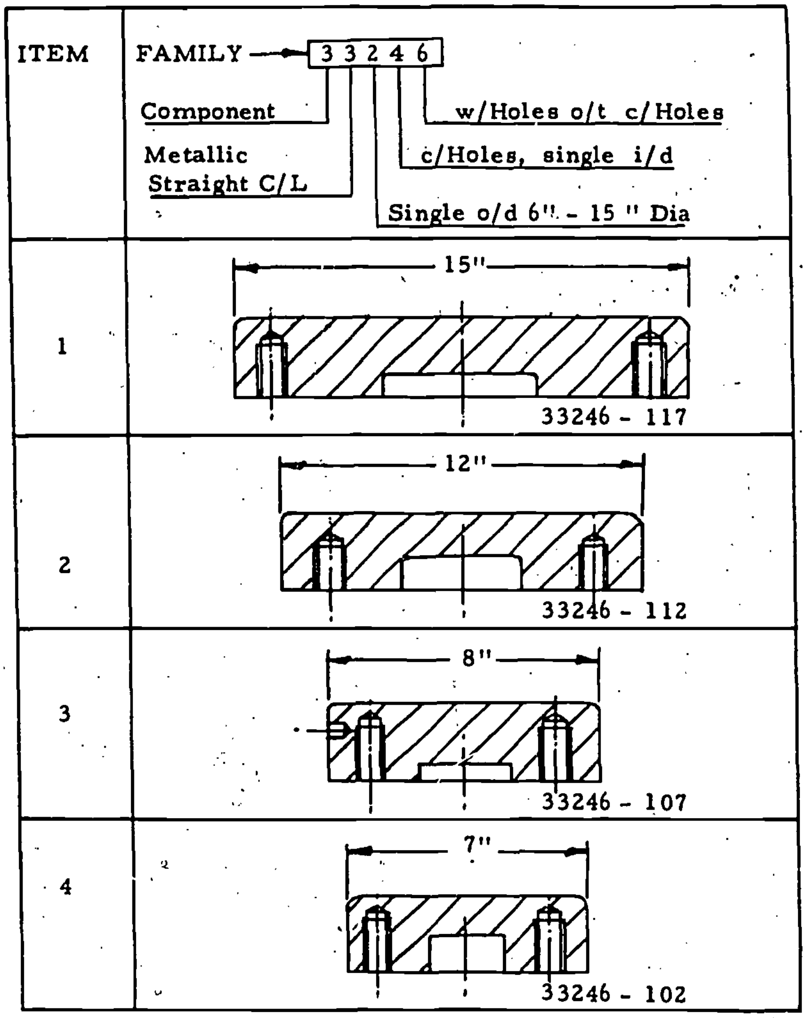


Figure 11. Example of Brisch Monocode

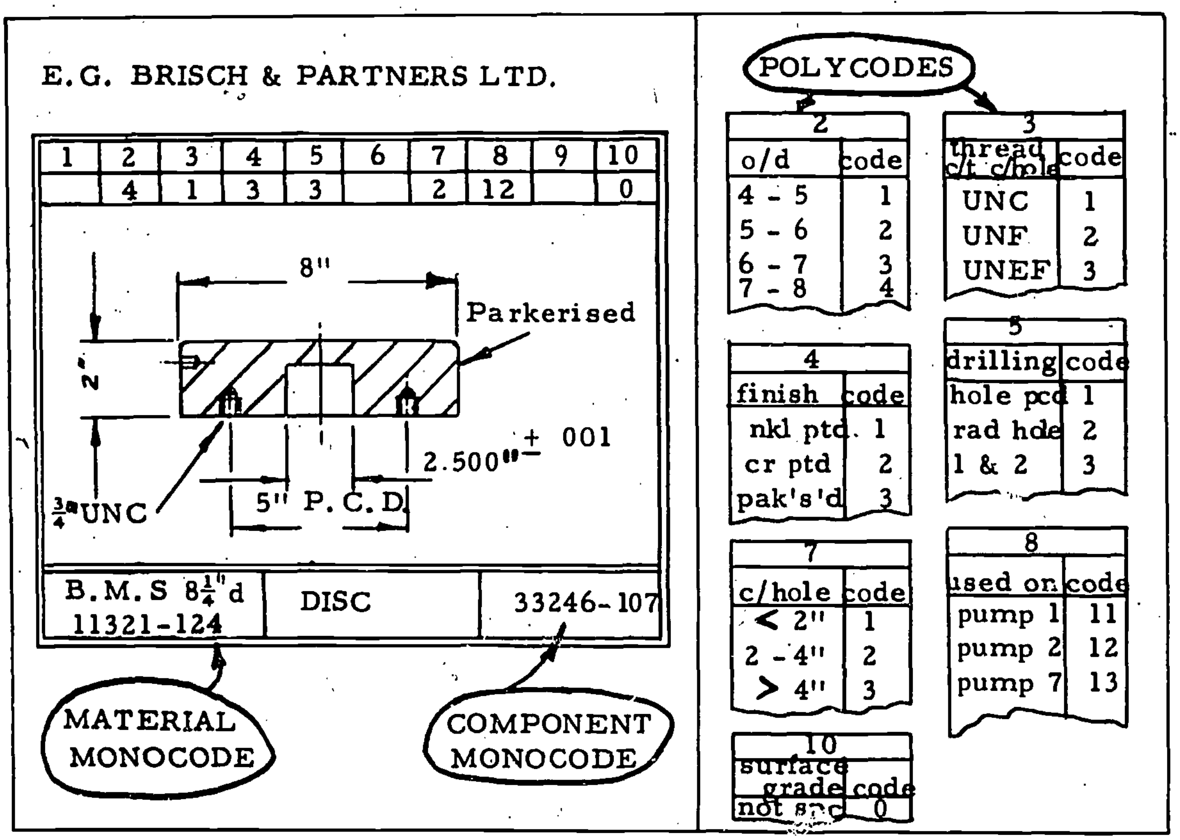
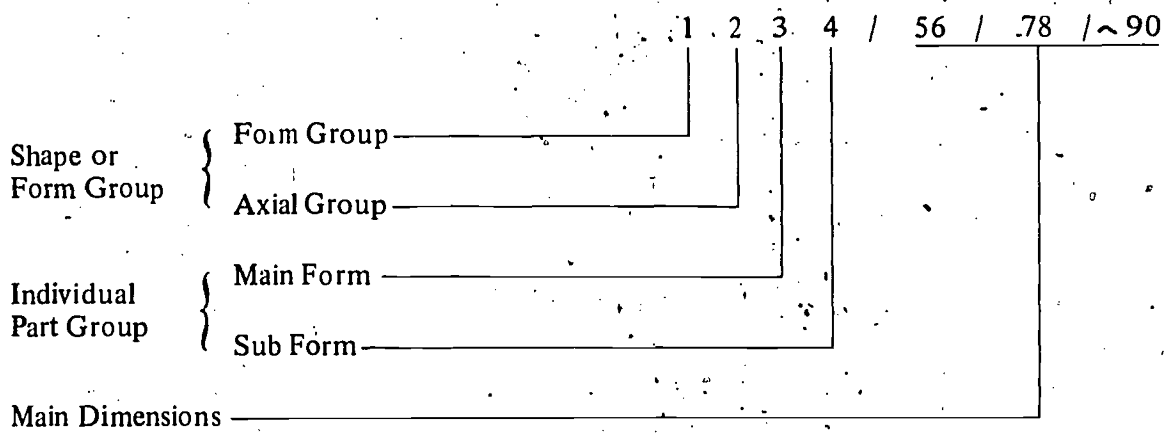


Figure 12. Example of Brisch Polycode

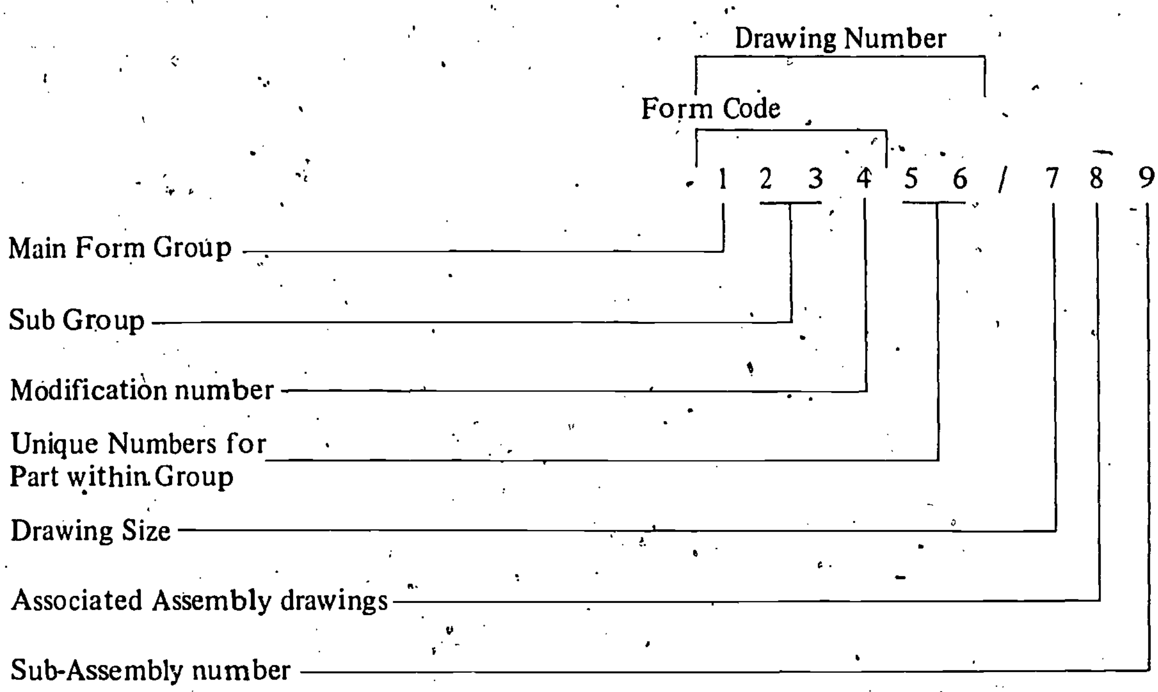
by geometric shape. The remaining 6 digits are used to code the main dimensions of the component. The construction of the complete number is shown below.



The definitions used for the classification of components into form and axial groups are shown in Figure 13. From the limited information available on this system there would appear to be many similarities between this classification system and the Opitz and Zafo systems.

7. Pittler Classification System

Pittler Machine Tool Company developed this system in 1945 for the classification and coding of components used in the manufacture of their range of lathes. The 9-digit code contains a wide range of information about the component. The construction of the code is shown below:



The structure of the classification for the form/shape is shown in Figure 14.

The company have found the information and data content of the code is not sufficient to define components' families and use the Opitz system for group technology purposes.

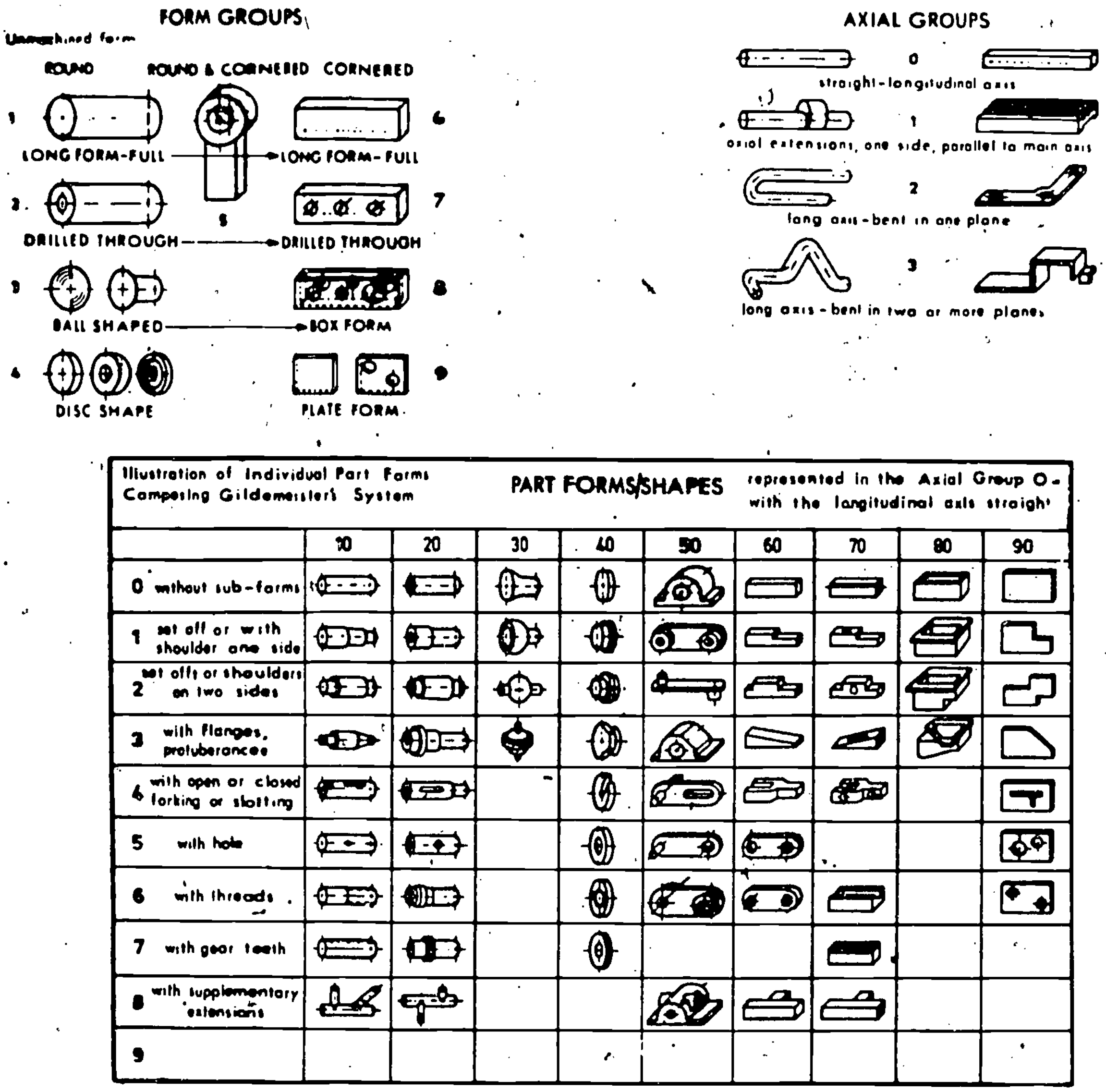


Figure 13. The Gildemeister System

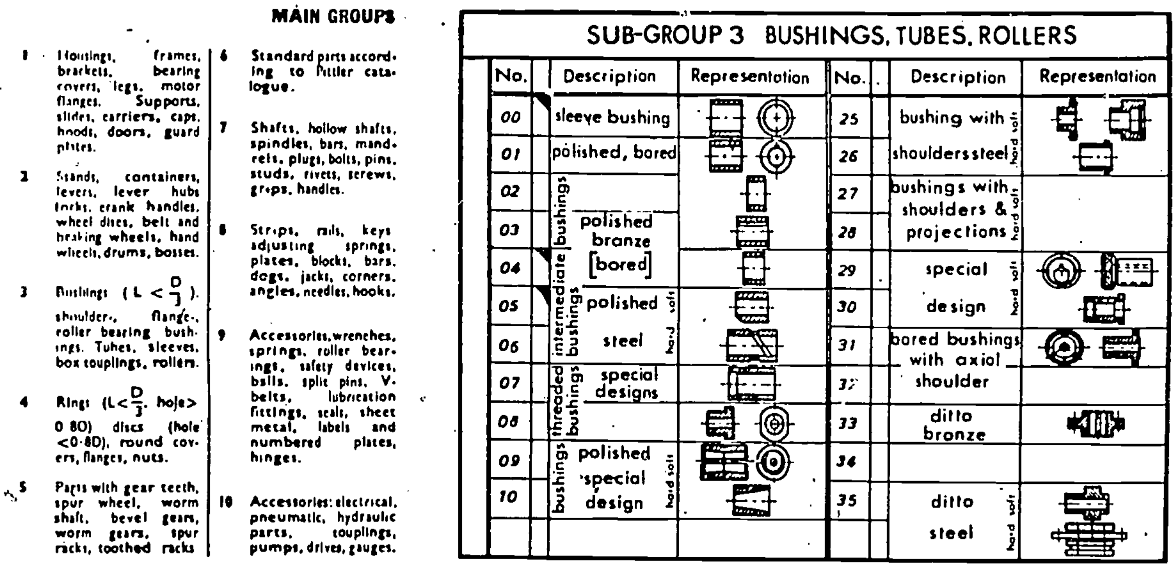
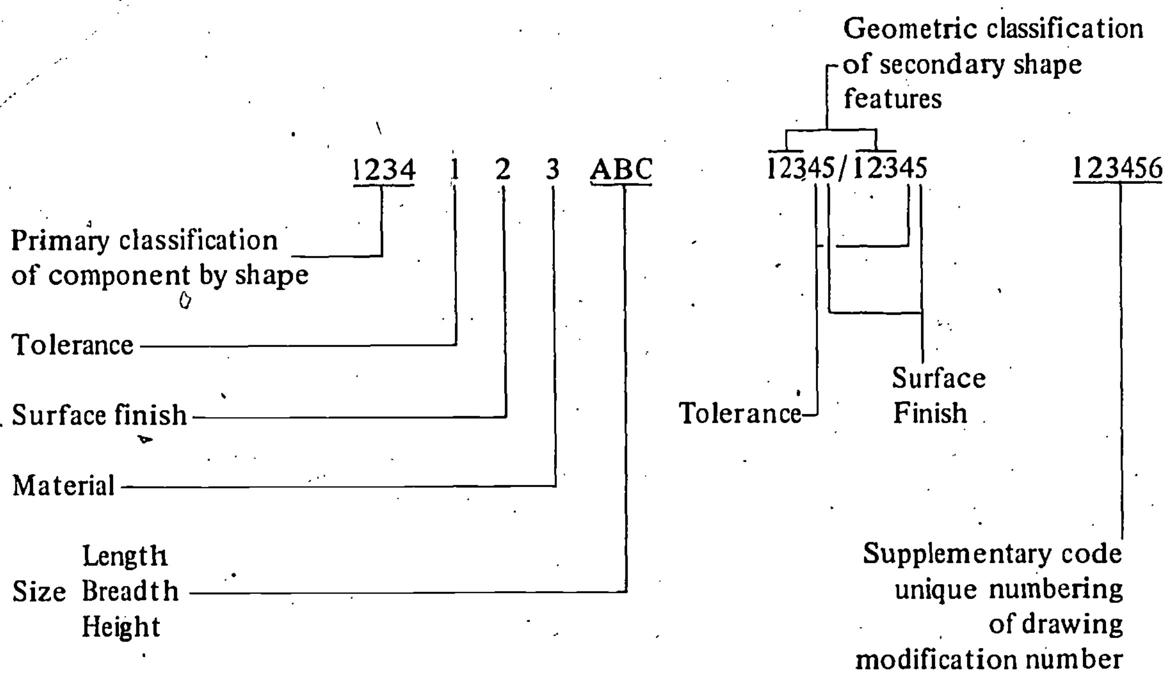


Figure 14. The Pittler Classification System

8. Zafo Classification System

This German system is claimed by its originator to be suitable for use as a general classification for design retrieval and group technology. It is a complex system and essentially consists of three main sections, the first is the primary classification of the component by shape followed by data on tolerances, surface finish, material and size. The second section contains further geometric classification of secondary shape features and characteristics with data on tolerances and surface finish. The third section is a supplementary code for internal use in the company. The complete code number of a component when classified by the Zafo system would be constructed as shown below:



9. Vuoso Classification System

The Vuoso classification system was developed in Czechoslovakia for the same reason as the Opitz system in West Germany—the analysis of workpieces and provision of statistics for the optimisation of machine tool design.

The 4-digit code consists of a 3-digit geometric code and a single digit material identifier. No digits have been added to the code to give a unique drawing number. The complete classification system is shown in Figure 15.

The analysis of workpieces was carried out in two stages, the first was by use of the classification system which grouped the components into basic types. The second stage was the analysis of components within the groups. The method of analysis was based on the fact that each workpiece is composed of a certain number of basic elements such as cylinders, holes, flats, threads, slots etc. For rotational components the relative position of each individual element was related to the axis of rotation by the use of a co-ordinate system. The elements constituting non-rotational components were related by stating their relative positions on the six basic planes or surfaces which bound a rectangular form. The code number, information on the individual elements and production data was recorded on punched cards and entered into an organised file stored in a computer. The file was searched with defined sets of parameters such as components with defined L/D ratio, number of grooves, shoulders, holes etc., in order to obtain workpiece statistics.

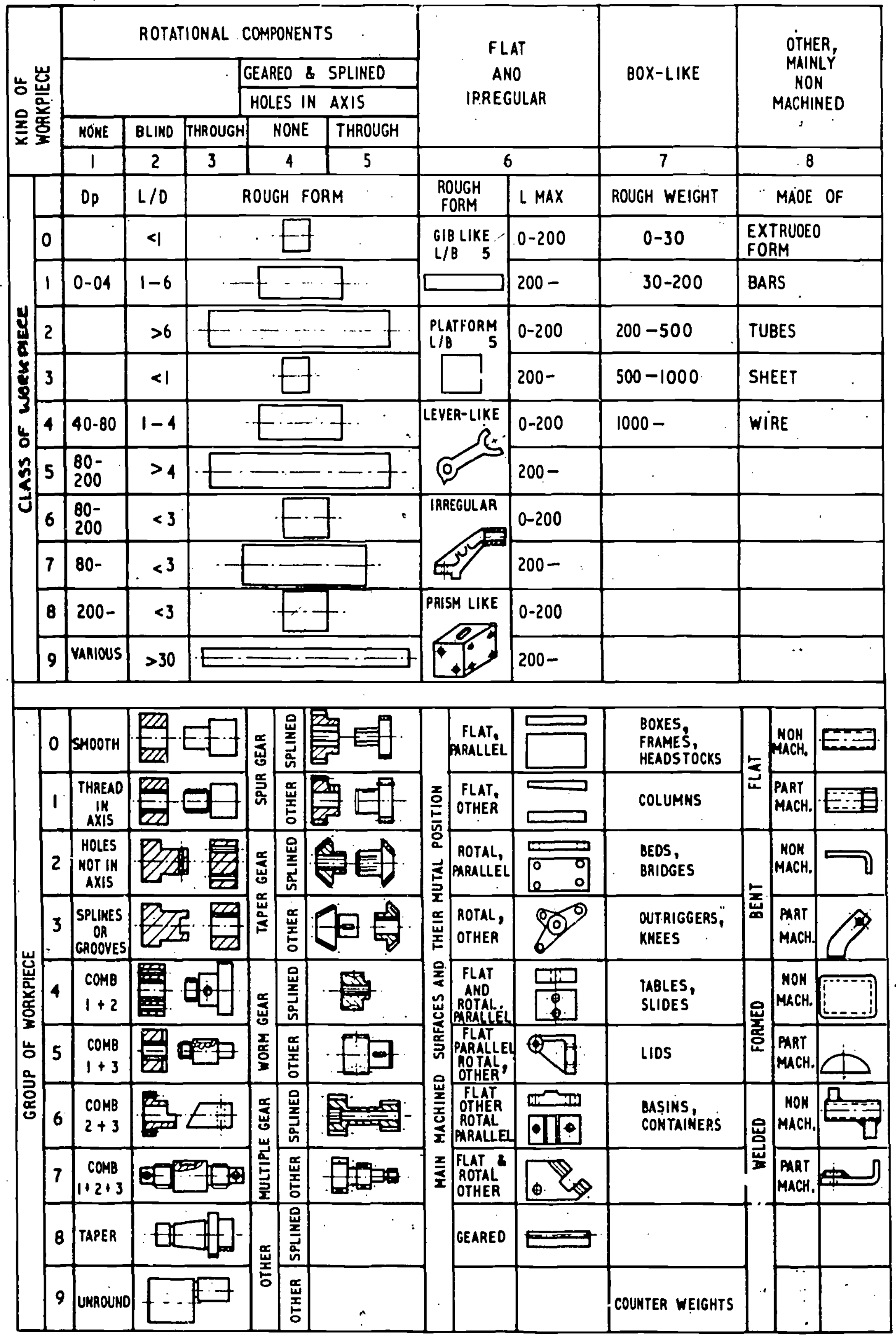


Figure 15. The Vuoso System

10. The PERA System

The PERA component classification or form code was devised for recording workpiece data. The coded data was used in a similar manner to the original Opitz system and Vuoso system—the investigation of workpiece characteristics and statistics. The results of the PERA investigation are published in 'Survey of Turning Requirements in Industry'.

General Statement.

Company Ref. No.	Serial No.	Total Change Points	Change Point for Maximum Diameter	Change Point for Maximum Length	Workpiece Type	Material	Initial Form	Quantity
60	30	08	03	04	1	0	0	0002

Detailed Statement.

Shape and Dimensions			Surface Elements						
Change Points	x Co-ordinates	y Co-ordinates	Corner Condition	Form	Accuracy	Surface Finish	State of Hardness	Function	Additional Machining Features
01	00000	00175	1	0	3	3	2	6	7
02	00253	00175	3	0	9	7	2	1	1
03	00253	00270	3	0	3	6	2	1	6
04	00453	00270	3	0	9	8	2	1	1
05	00453	00188	1	0	7	8	2	1	1
06	00440	00188	1	0	9	8	2	2	1
07	00440	00125	1	0	3	3	2	6	1
08	00000	00125	1	0	9	8	2	2	1

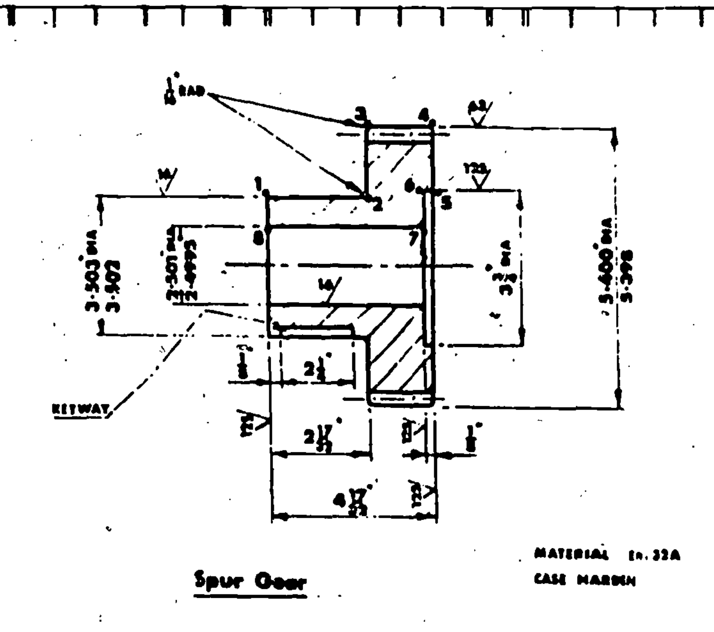


Figure 16. The PERA System

The code consists of a general statement describing the overall features of the workpiece and a detailed statement specifying the geometry of the workpiece and features of the surface elements. The general statement includes:

i. Identification of the workpiece type (essentially, whether it is a solid of revolution or not)

ii. Material

iii. Initial form (bar, casting, etc.)

iv. Overall length

v. Overall diameter

vi. Batch size

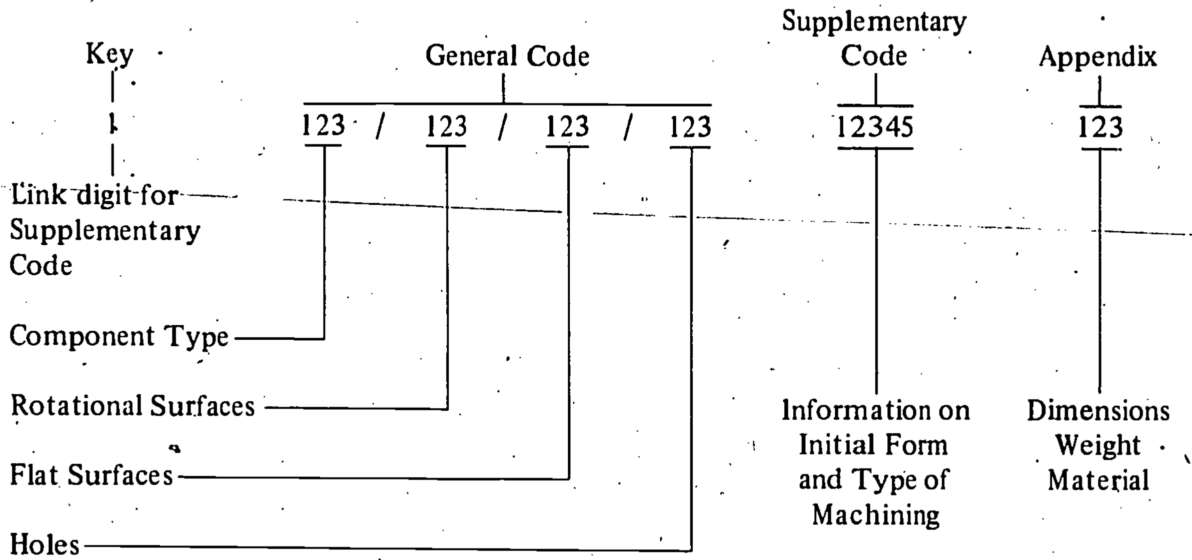
In the detail statement for rotational components the geometrical shape and dimensions of the component are defined by the co-ordinates of the generating section. Each segment of the generating section corresponds to an element of the workpiece surface and associated with each segment is a code number describing features such as form, accuracy, surface finish etc.

The geometric shape of non-rotational components is defined by co-ordinates in the X,Y and Z axes of the six basic planes or surfaces which bound a rectangular form. Elements and features associated with each surface are coded by type, form, accuracy, etc.

A typical example of the use of the form code for a rotational component is shown in Figure 16.

11. The PGM System

This system was developed for group technology by the Swedish firm of industrial consultants PGM Ltd in 1965. The classification is primarily aimed at forming production or manufacturing families but may be used for design retrieval. The system is variable in length and in practice an average of 16 digits is used to describe component shape, etc. The general format of the classification is shown below:



The classification is intended for large companies with a wide range of components and electronic data processing facilities.

Appendix: Further Reading

The following select reading list is divided into 3 main sections:
Group technology; Classification and coding; Standardisation and variety reduction and is based on material available in the BIM Library.

Classification and coding has been further subdivided into types of systems, with preference to those intended for group technology, but also including classification and coding applications to various fields and services.

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