TABLE 3. REPRESENTATION OF ALGOL SYMBOLS ON 5-TRACK PAPER TAPE AND ON 80-COLUMN CARDS

ALGOL Symbol	Paper Tape Representation	Punched Card Representation	
		Standard	Tolerated
+	+	+	
−	−	−	
× (multiplying operator)		*	
/	/	/	
↑	'POWER'	'POWER'	**
<	'LESS'	'LESS'	'LS'
≦	'NOT GREATER'	'NOT GREATER'	'LQ'
=	'EQUAL'	'EQUAL'	'EQ'
≧	'NOT LESS'	'NOT LESS'	'GQ'
>	'GREATER'	'GREATER'	'GR'
≠	'NOT EQUAL'	'NOT EQUAL'	'NQ'
≡	'EQUIV'	'EQUIV'	'EQV'
⊃	'IMPL'	'IMPL'	'IMP'
∨	'OR'	'OR'	
∧	'AND'	'AND'	
¬	'NOT'	'NOT'	
, (comma)	, (comma)	, (comma)	
. (point)	. (point)	. (point)	
10 (ten)	10 (ten)	' (apostrophe)	
:	:	..	
;	;	.,	$
:=	:=	:=	=
(	(	(	
)	)	)	
[	[	(/	
]	]	/)	
␣	(space)	(space)	
÷	//	//	
' (string quote)	'' (apostrophes)[a]	'' (apostrophes)	
' (string quote)	'' (apostrophes)[a]	'' (apostrophes)	

[a] The representation of string quotes using apostrophes does not provide for nested strings. To obviate this difficulty use '(' for ‘ and ')' for ’.

3. Representation on 80-Column Punched Cards

3.1. Table 2 shows the correspondence between hole combinations and characters used in ALGOL.[5] For easier reading the card columns are shown horizontally. In ALGOL programs the hole combinations not listed in this table are not admitted except in comments or strings (note, however, last paragraph in Section 3.2). Again, explanatory material is enclosed in parentheses.

3.2. The representation of ALGOL symbols by means of the character set shown in Table 2 is listed in Table 3. However, ALGOL word symbols (bold type symbols in the ALGOL Report) are not included in this table. Again, some explanatory material in parentheses is added to Table 3.

On punched cards, word symbols such as **go to** are represented in the same way as on paper tape (see Section 2.2.). It is planned to extend the character set for 80-column punched cards in order to simplify the representations of some of the ALGOL symbols, of Table 3. This extension will be carried out as soon as technical facilities permit.

3.3. Concerning the layout on 80-column punched cards, only columns 1 through 72 are relevant to ALGOL program texts; columns 73 through 80 have no significance to ALGOL compilers.

[5] The assignment coincides with the character set H of IBM (International Business Machines Corporation).

Report on Proposed American Standard Flowchart Symbols for Information Processing

By ROBERT J. ROSSHEIM, *Auerbach Corporation*
Member, ASA X3.6 Subcommittee

This paper presents the essential contents of the Proposed American Standard Flowchart Symbols for Information Processing. This is the first proposed standard prepared by Subcommittee X3.6 on Problem Description and Analysis of the American Standards Association (ASA).

Introduction

The International Standardization Organization (ISO) established a committee on Computers and Information Processing whose scope is: standardization of terminology, *problem description*, programming languages, and communication characteristics of computers and information processing devices, equipments and systems. [Italics are the author's.] These objectives were adopted at the international level in May, 1961 and led to the establishment of Subcommittees X3.1, X3.2, . . ., X3.7 by the ASA Sectional Committee X3 on Computers and Information Processing and under the sponsorship of the Business Equipment Manufacturers Association (BEMA, formerly OEMI).

To the X3.6 Subcommittee was delegated the responsibility of developing standards for problem description. The scope of this work encompasses "Information Processing Problem Description and Analysis Standards to provide a systematic means of studying information processing problems, documenting and preparing the required information for analysis." For the past two years, working groups of X3.6 have been studying standards for problem description and analysis in the areas of methodology, input/output, data transformation, and terminology. During the last year considerable effort has been devoted to the processes of survey, analysis, discussion, synthesis, argument and compromise, leading to a set of flowchart symbols that have achieved full intra-committee acceptability. The remainder of this report is devoted to the proposed standard which is now in the review process prior to its emergence as an ASA standard.

History

Before presenting the proposed standard it is interesting to note some of the difficulties which arose, and the resolutions of these difficulties which have enabled the work of the X3.6 Subcommittee to progress.

A truism, often used in the data-processing business and in many other areas of human endeavor, is: "Once I have a clear statement of the problem, I can solve it." The work of X3.6 is to develop standard methods useful in preparing clear and complete descriptions of information systems. The requirements of an information system comprise the "problem." All too often an information system is designed, implemented and installed without benefit of a clear or complete statement of the problem. The process of arriving at a clear and understandable problem statement is full of semantic difficulties. The information system designer is often an outside specialist who must first learn the

problem from the people in the midst of it (the operations people) and then, after designing the system, must transmit the details of the problem and the system design to other implementing specialists, i.e. methods men, computer programmers, forms designers, procedure writers, hardware suppliers, etc.

The province of X3.6 is the standardization of methods for the considerable amount of *man-to-man* communication required in describing information systems. It became necessary in the development of standard flowchart symbols to distinguish between this kind of activity and that of X3.4 concerned with standard programming languages for *man-to-machine* communication describing computer *solution* procedures (programs) for information systems. This distinction is somewhat elusive. First you see it; then you don't. The confusion partly stems from the fact that flowcharting is a technique commonly used both to describe and document systems, and also to describe and document programs. Moreover, flowcharts in a multitude of forms—some standard and others personalized—are used in many disciplines to assist in description and communication. Here is a case where, despite the fact that flowcharting is used everywhere and by everyone, there has been little tendency to settle on standard symbols and definitions.

X3.6, in proposing these standard flowchart symbols for a particular use (problem description for man-to-man communication), does not imply exclusive use of these symbols. These same symbols may be used for detailed charting of computer programs, and the definitions could be extended in a consistent way to meet the requirements of that application. Also it may be found advantageous in special parts of some problem descriptions to define and utilize additional special symbols. Through the establishment and publication of a national industry-wide standard set of symbols, with definitions of what each symbol represents, the ASA will serve the data processing community in assisting man-to-man communication about information systems.

Compromise and Concurrence

The working group in X3.6, whose members did the spade work in preparing the draft standard, has attempted to be practical and down-to-earth, rather than academic or theoretical. Recognizing that this standardization effort comes at a time when people have been using flowchart symbols for information system description for 10 to 15 years, the major work has been one of collection, comparison and resolution of differences in existing practice. Fortunately, usage of symbols within the industry (represented by the material obtained by the committee) was not at wide variance. In the main, therefore, this standard represents common usage. Although many symbol sets with varying degrees of official sanction were found, in few cases were the symbols defined. A major part of the contribution in the ASA standard derives from the symbol definitions.

Furthermore, it has been encouraging to find, having agreed on a proposed set of flowchart symbols, that representatives of organizations express a willingness to adapt their own standards to the ASA standard, where there are differences. At the time of this writing informal reports that preparatory steps are being taken to adopt the standard flowchart symbols have been received from a number of organizations, including Department of Defense, Bell System, RCA, General Services Administration, IBM and Univac. In general, the degree of concurrence has been large among members of contributing organizations who were asked to review and to try using the symbols. Comments and criticism when submitted have been helpful and constructive. Significant changes in the proposed standard have resulted from this review.

From time to time in the deliberations of the X3.6 working group, symbol requirements for special or advanced applications (such as real-time process control) have been suggested or requested. In general, the decision has been to defer these problems in favor of making progress in those areas where there is much experience and wide usage. The ASA is responsible for maintenance of standards it publishes. Procedures are established for such maintenance and X3.6 will be prepared to adapt the flowchart symbol standards, adding new symbols as future industry requirements evolve.

X3.6 Membership

The size of the industry population with a justifiable interest in flowchart symbols is large. Membership on the X3.6 Subcommittee, within the many practical constraints which always exist, is intended to include people who are technically aware of the subject material and each of whom can represent a significant segment of the industry. The names of the members and their organizational affiliations are required as supporting documents to the standard. They have been included here to indicate to the reader the extent of industry coverage in X3.6, and to identify people to whom inquiries and future contributions can be made.

New Directions for X3.6

As indicated above, much of the activity in X3.6 for the last year or more has been directed toward development of the set of flowchart symbols. The final throes of committee agreement and action are enervating, sometimes in the extreme, as any who have participated will attest. The membership of X3.6 have glimpsed some of the new directions for standardization of problem description methodology. We are going into a period of exploring the different paths available prior to selecting the next area of major effort. (The phrase "group grope" seems to apply at this stage.) The interest and contribution of any individual is welcomed. Written expression of interest may be directed to Robert Green, Chairman, X3.6 Subcommittee, Research and Development, Standard Register Company, Dayton 1, Ohio, or to any member on the list who may be an associate in your company, an acquaintance, or available in your locale. The X3.6 Subcommittee is interested in forming a working group on the West coast if there is sufficient interest coupled with an inability to travel to the East coast where most of the past X3.6 meetings have been held.

Contents of Proposed Standard

The document which presents the Proposed American Flowchart Symbols consists of the following items, published hereafter as part of this paper:

Foreword (not part of standard)
Membership List
Section 1. Purpose and Scope
Section 2. Definitions (glossary of terms)
Section 3. Flowchart Symbols
Section 4. Presentation Techniques
Section 5. Summary of Standard Flowchart Symbols

A number of appendices contain further supporting material and records of the process which led to the formulation of this proposed standard. They are not reproduced here.

PROPOSED AMERICAN STANDARD FLOWCHART SYMBOLS FOR INFORMATION PROCESSING

Introductory Statement
(June 19, 1963)

This Proposed American Standard was prepared by Sectional Committee X3, Computers and Information Processing, operating under the auspices and procedure of the American Standards Association and issued for trial and criticism. Since it is subject to change, readers are cautioned to make certain they have the latest issue, copies of which may be obtained from the ASA, 10 East 40th Street, New York 16, N. Y.

Foreword

(This Foreword is not a part of Proposed American Standard Flowchart Symbols for Information Processing X3.6, 1963.)

The purpose of a flowchart is to improve man-to-man communication relative to the description and analysis of an information processing problem. Flowcharting is a technique in which symbols represent both the sequence of operations and the flow of data and paperwork.

The use of flowcharts became widespread in the field of information processing concurrent with the application of electronic computers to problems of business and industry. Occasionally, however, the interpretation of a flowchart resulted in misunderstanding. One source of misunderstanding stemmed from a lack of uniformity of meaning for specific symbols in the flowcharts.

The historical development of flowchart symbols has many facets. Initially, groups of individuals in a company coordinated their work on flowcharting. Later, this same need for a uniform set of symbols became apparent to larger groups of persons who exchanged flowcharts, e.g. government, commercial and industrial user groups, equipment manufacturers, form suppliers, professional societies, and consultants. Eventually, as each group attempted to establish a uniform set of symbols for its own members, the need for an American Standard for flowchart symbols was recognized.

The X3 Sectional Committee on Computers and Information Processing Standards delegated to the X3.6 Subcommittee on Problem Description and Analysis the responsibility for preparing a standard for flowchart symbols. In meeting this obligation, the X3.6 Subcommittee:

(1) identified and analyzed the information processing functions to be flowcharted,

(2) obtained and studied sets of symbols from organizations as listed in Appendix A,

(3) performed a statistical study on the definitions and the symbols representing those functions,

(4) circulated the results to a representative audience for comment, and

(5) developed and recommended a standard for flowchart symbols for information processing problem description.

Membership of the X3.6 Subcommittee as of March, 1963, was as follows:

Name of Representative	*Business Affiliation*
Robert Allen	Moore Business Forms, Inc.
Milton Bryce	Univac Division, Sperry Rand Corp.
Charles Chronis	Minneapolis-Honeywell Regulator Co.
Julius Cocozza	Curtis Publishing Co.
Raymond Dobrowolski	Control Data Corp.
Jay Lee Donaldson	The Standard Register Co.
John Dresch	Univac Division, Sperry Rand Corp.
Robert Green (Chairman)	The Standard Register Co.
Mandalay Grems	Univac Division, Sperry Rand Corp.
Herschel Harrison	International Electric Corp.
Arthur Katz	Radio Corporation of America
Ellen Kerksieck	International Business Machines Corp.
Lionel Levin	International Telephone and Telegraph Corp.
Donald Nailor	U. S. Army Strategic Communications Command
Joseph O'Hara	Datatrol Corp.
John Pfaff	Burroughs Corp.
Robert Raup	General Services Administration
Ray Rodgers	Bell Telephone Laboratories
Robert Rossheim	Auerbach Corp.
John Seeley	Uarco, Inc.
Samuel Shugar	Western Electric Co., Inc.
John Wood	The State of New York
John Young	The National Cash Register Co.

Others who have assisted with this work as members, alternates, or contributors are:

Peter Brown	International Telephone and Telegraph Corp.
Daniel Drusdow	Radio Corporation of America
Mike Ford	Defense Supply Agency
Howard Gammon	Department of Defense
Abe Hassan	The National Cash Register Co.
Mary Hawes	The Teleregister Corp.
Robert Hutchison	Western Electric Co., Inc.
John Maroney	Western Electric Co., Inc.
Walter Roberts	General Services Administration
Ottice Tidwell	American Telephone and Telegraph Co.
Richard Utman	Business Equipment Manufacturers Assoc.

1. Purpose and Scope

1.1 PURPOSE. This standard establishes symbols for use in the preparation of flowcharts for information processing systems, including automatic data processing systems.

1.2 SCOPE. This standard prescribes and defines symbols used on flowcharts to represent both the sequence of operations and the flow of data and paperwork of information processing systems.

This standard does not cover: (1) identifying, descriptive or explanatory information written inside or adjacent to a symbol; or (2) pictorial type flowcharts that utilize pictures or drawings to depict a system.

2. Definitions

Analysis. The investigation of a problem by a consistent method and its separation into related units for further detailed study.

Annotation. An added descriptive comment or explanatory note.

Automatic Data Processing. The manipulation of data within a machine to solve a problem by using stored program techniques.

Auxiliary Operation. An operation performed on equipment not under direct control of the central processing unit.

Auxiliary Storage. Storage that supplements the primary storage.

Bidirectional Flow. Flow that can extend over the same lines in either or both directions.

Central Processing Unit. The component of a computing system that contains the arithmetic, logical, and control circuits of the basic system.

Communication Link. The means for automatically transmitting information from one location to another.

Connector. A means of representing on a flowchart the junction of two lines of flow or a break in a single line of flow.

Data. A representation of information in the form of words, symbols, numbers, letters, characters, digits, etc.

Decision. A processing operation to determine further action based upon the relationship of similar items of data.

Display. A visual representation of data.

Document. A medium on which information is recorded in a form for human usage, e.g., a report sheet, pages of a book, etc.

Flow Direction Function. The indicating of the sequence of available information and executable operations.

Flowchart. A graphical representation of the definition, analysis, or solution of a problem where symbols are used to represent operations, data, flow, equipment, etc.

Flowline. A means of connecting flowchart symbols on a flowchart.

Function. A specific purpose or a characteristic action.

Information. The meaning assigned to data by the known conventions used in its representation.

Information Processing. The processing of data representing information and the determining of the meaning of the processed data.

Input/Output. A general term for the equipment, data, or media used in the entering or recording function, commonly abbreviated I/O.

Input/Output Function. The making available of information for processing, and the recording of the processed information.

I/O. An abbreviation for input/output.

Magnetic Tape. A continuous medium coated with a magnetic substance on which data is recorded.

Manual Input. The entry of data into a computer or system by direct manual manipulation of a device.

Manual Operation. The processing of data in a system by direct manual techniques.

Medium. The material on which data is recorded, e.g., tape, cards, paper, etc.

Normal Direction Flow. The direction of flow from left to right or top to bottom.

Offline Storage. Storage not under control of the central processing unit.

Online Storage. Storage under direct control of the central processing unit.

Operation. The process of executing a defined action.

Predefined Process. A named process consisting of one or more operations or program steps that are specified elsewhere, e.g., subroutine or logical unit.

Problem Description. A term associated with both the statement and solution phase of a problem and used to denote the transformations of data and the relationship of procedures, data, constraints, environments, etc.

Processing. A term including any operation or combination of operations on data, where an operation is the execution of a defined action.

Processing Function. The process of executing a defined operation or group of operations.

Punched Card. A card that is punched with a combination of holes to represent letters, digits, or special characters.

Punched Tape. A continuous recording medium in which data is punched.

Random Sequence. A sequence not arranged according to any prescribed order.

Represent. To use one or more characters or symbols to depict a well defined concept.

Reverse Direction Flow. The direction of flow other than left to right or top to bottom.

Symbol. A unit representation for characteristics, relationships, transformations, graphics, etc.

System. A collection of men, machines, and methods required to accomplish a specific objective.

Terminal. A point in a system or communication network at which information can either enter or leave.

Transmit. To transfer information from one location to another.

3. Flowchart Symbols

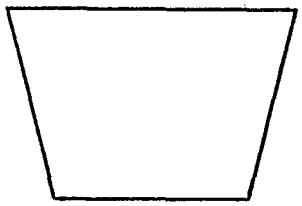
3.1 Symbols Represent Functions. Symbols are used on a flowchart to represent the functions of an information processing system. These functions are: input/output, processing, flow direction, and annotation.

A basic symbol is established for each function and can always be used to represent that function. Specialized symbols are established which may be used in place of a basic symbol to give additional information.

The size of each symbol may vary but the dimensional ratio of each symbol shall be maintained.

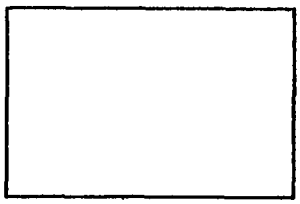
3.2 Basic Symbols

3.2.1 *Input/Output Symbol.* The symbol shown below represents the input/output function (I/O), i.e., the making available of information for processing (input), or the recording of processed information (output).



Dimensional ratio
width:height = 1:$\frac{2}{3}$

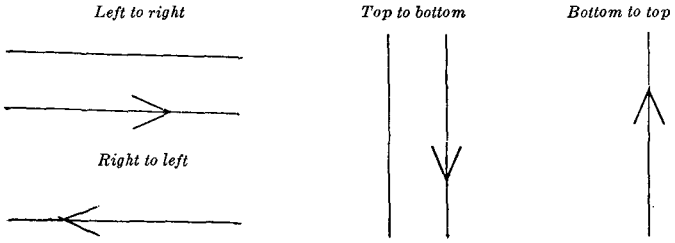
3.2.2 *Processing Symbol.* The symbol shown below represents the processing function, i.e., the process of executing a defined operation or group of operations resulting in a change in value, form, or location of information, or in the determination of which of several flow directions are to be followed.



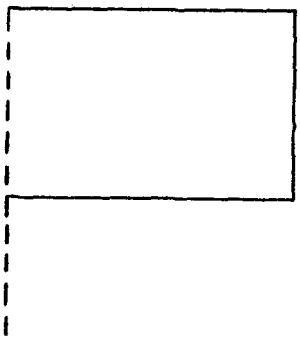
Dimensional ratio
width:height = 1:$\frac{2}{3}$

3.2.3 *Flow Direction Symbol.* The symbols shown below represent the flow direction function, i.e., the indication of the sequence of available information and executable operations. Flow direction is represented by lines drawn between symbols. Normal direction flow is from left to right or top to bottom. When the flow direction is not left to right or top to bottom, open arrowheads shall be placed on reverse direction flowlines. When increased clarity is desired, open arrowheads can be placed on normal direction flowlines. When flowlines are broken due to page limitation, connector symbols shall be used to indicate the break. When flow is bidirectional, it can be shown by either

single or double lines: but open arrowheads shall be used to indicate both normal direction flow and reverse direction flow.



3.2.4 *Annotation Symbol.* The symbol shown below represents the annotation function, i.e., the addition of descriptive comments or explanatory notes as clarification. The broken line may be drawn either on the left as shown or on the right. It is connected to the flowline at a point where the annotation is meaningful by extending the broken line in whatever fashion is appropriate.



Dimensional ratio
width:height = 1:$\frac{2}{3}$

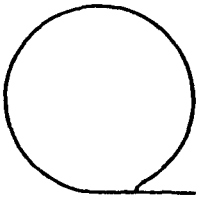
3.3 Specialized Symbols

3.3.1 *Input/Output Symbols.* Specialized I/O symbols may represent the I/O function and, in addition, denote the medium on which the information is recorded or the manner of handling the information or both. If no specialized symbol exists, the basic I/O symbol is used.

3.3.1.1 *Punched card symbol.* The symbol shown below represents an I/O function in which the medium is punched cards, including mark sense cards, partial cards, stub cards, etc.

Dimensional ratio
width:height = 1:$\frac{1}{2}$

3.3.1.2 *Magnetic tape symbol.* The symbol shown below represents an I/O function in which the medium is magnetic tape.

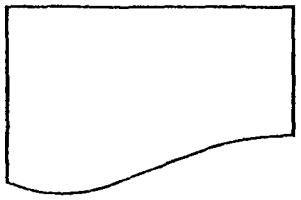


Dimensional ratio
width:height = 1:1

3.3.1.3 *Punched tape symbol.* The symbol shown below represents an I/O function in which the medium is punched tape.

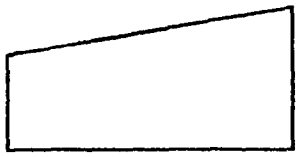
Dimensional ratio
width:height = 1:$\frac{1}{2}$

3.3.1.4 *Document symbol.* The symbol shown below represents an I/O function in which the medium is a document.



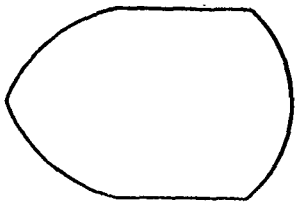
Dimensional ratio
width:height = 1:$\frac{2}{3}$

3.3.1.5 *Manual input symbol.* The symbol shown below represents an I/O function in which the information is entered manually at the time of processing, by means of online keyboards, switch settings, push buttons, card readers, etc.



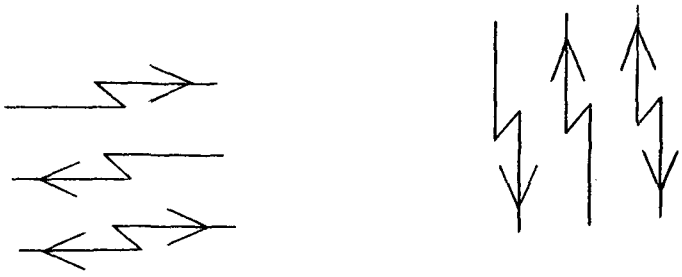
Dimensional ratio
width:height = 1:$\frac{1}{2}$

3.3.1.6 *Display symbol.* The symbol shown below represents an I/O function in which the information is displayed for human use at the time of processing, by means of online indicators, video devices, console printers, plotters, etc.

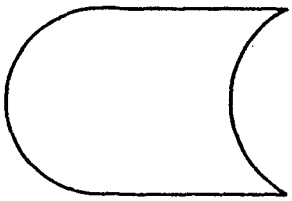


Dimensional ratio
width:height = 1:$\frac{2}{3}$

3.3.1.7 *Communication link symbol.* The symbol shown below represents an I/O function in which information is transmitted automatically from one location to another. The symbol is always drawn with superimposed arrowheads to denote the direction of data flow.



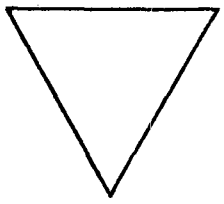
3.3.1.8 *Online storage symbol.* The symbol shown below represents an I/O function utilizing auxiliary mass storage of information that can be accessed online; e.g., magnetic drums, magnetic disks, magnetic tape strips, automatic magnetic card systems, or automatic microfilm chip or strip systems.



Dimensional ratio
width:height = 1:$\frac{2}{3}$

3.3.1.9 *Offline storage symbol.* The symbol shown below

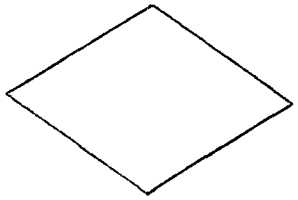
represents any offline storage of information, regardless of the medium on which the information is recorded.



Dimensional ratio
width:height = 1:1

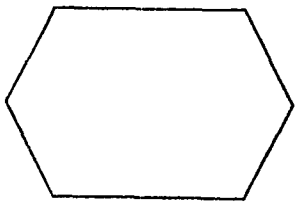
3.3.2 *Specialized Processing Symbols.* Specialized processing symbols may represent the processing function and, in addition, identify the specific type of operation to be performed on the information. If no specialized symbol exists, the basic processing symbol is used.

3.3.2.1 *Decision symbol.* The symbol shown below represents a decision type operation that determines which of a number of alternate paths is to be followed.



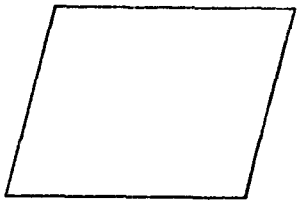
Dimensional ratio
width:height = 1:$\frac{2}{3}$

3.3.2.2 *Predefined process symbol.* The symbol shown below represents a named process consisting of one or more operations or program steps that are specified elsewhere, e.g., subroutine or logical unit.



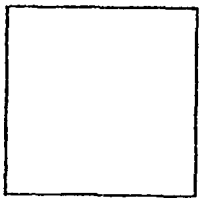
Dimensional ratio
width:height = 1:$\frac{2}{3}$

3.3.2.3 *Manual operation symbol.* The symbol shown below represents any offline process geared to the speed of a human being.



Dimensional ratio
width:height = 1:$\frac{2}{3}$

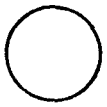
3.3.2.4 *Auxiliary operation symbol.* The symbol shown below represents an offline operation performed on equipment not under direct control of the central processing unit.



Dimensional ratio
width:height = 1:1

3.4 Additional Symbols

3.4.1 *Connector Symbol.* The symbol shown below represents a junction in a line of flow. A set of two connectors is used to represent a continued flow direction when the flow is broken by the physical limitations of the flowchart. A set of two or more connectors is used to represent the junction of several flowlines with one flowline, or the junction of one flowline with one of several alternate flowlines.



Dimensional ratio
width:height = 1:1

3.4.2 *Terminal Symbol.* The symbol shown below represents a terminal point in a system or communication network at which information can enter or leave; e.g., start, stop, halt, delay, or interrupt.

Dimensional ratio
width:height = 1:$\frac{3}{8}$

4. Presentation Techniques

4.1 Symbol Orientation. The orientation of each symbol on a flowchart should be the same as shown in Section 3.

4.2 Symbol Size. The size of each symbol may vary, but the dimensional ratio of each symbol shall be maintained as specified in Section 3.

4.3 Flow Direction. Flow direction is represented by lines drawn between symbols.

4.3.1 Normal direction flow is from left to right or top to bottom.

4.3.2 When the flow direction is not left to right or top to bottom, open arrowheads shall be placed on reverse direction flowlines.

4.3.3 When increased clarity is desired, open arrowheads can be placed on normal direction flowlines.

4.3.4 When flowlines are broken due to page limitation, connector symbols shall be used to indicate the break.

4.3.5 When flow is bidirectional, it can be shown by either single or double lines; but open arrowheads shall be used to indicate both normal direction flow and reverse direction flow.

5. Summary of Standard Flowchart Symbols