computer gateways

Development of Functional Requirements for Multi-Function Text Communication Terminal System

Volume I

Concepts

by

R.J.A. Buhr (CGI)
D.A. MacKinnon (CGI)

Contributing Consultants:
A.R. Kaye (Carleton Univ.)
G.V. Bochmann (CERBO Informatique Inc.)
D. Thalmann (CERBO Informatique Inc.)

prepared for Canadian Department of Communications
under Contract OST82-00148

18 May 83

Computer Gateways Incorporated
Ottawa, Canada

DOC CONTRACTOR REPORT

DEPARTMENT OF COMMUNICATIONS - OTTAWA - CANADA

COMMUNICATIONS SYSTEMS RESEARCH AND DEVELOPMENT

TITLE: DEVELOPMENT OF FUNCTIONAL REQUIREMENTS FOR MULTI-FUNCTION TEXT COMMUNICATION TERMINAL SYSTEM

AUTHORS: R.J.A. BUHR
D.A. MACKINNON
A.R. KAYE
G.V. BOCHMANN
D. THALMANN

CONTRACTOR: COMPUTER GATEWAYS INC.

DEPARTMENT OF SUPPLY AND SERVICES CONTRACT NO: OST82-00148

DOC SCIENTIFIC AUTHORITY: R. LEAFLOOR

CLASSIFICATION: UNCLASSIFIED

DATE: May 1983

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EXECUTIVE SUMMARY

This report describes a conceptual, block diagram model of a range of multi-functional terminals (MFT) supporting text preparation and interchange. In this context, the term "text" refers to machine representation of the kind of material we expect to see between the covers of typical paper documents, including alphanumeric, graphical and photographic material. However, in a machine context, the term "text" also has broader implications than in a paper context. In particular, machine text may be further characterized by terms such as "editable", "printable", and "displayable". The conceptual model of the MFT presented in this report is concerned with the processing and communications of "text" in this broad sense.

The conceptual model aims to provide a framework to show Canadian manufacturers how emerging CCITT and ISO standards and concepts may be used as the base for viable MFT products. In support of this aim, the conceptual model is in block diagram form containing components called "facilities" which may be pieced together in various combinations to form different MFT configurations. Thus, although the viewpoint of this report is general, including machine representable text in a broad sense, the model may be used to produce particular MFT configurations which are less general.

This report was produced under tight time constraints in order to provide as quickly as possible a framework for open discussion of the subject and for further development of the model. Accordingly, the reader should view this report as a preliminary source of definitions, concepts and ideas, rather than as a definitive description of an MFT model.

The model takes into account ISO work on text preparation and interchange, defined CCITT telematic services (Teletex, Videotex, Fax), future CCITT telematic services (mixed mode Teletex, ...), the ISO reference model for Open System Interconnection (OSI) and market viability factors. It should be noted that the work of ISO and CCITT is under constant revision; references in this report refer to the status as of March 1983.

In a multifunctional terminal, a text document may have a number of different possible "representations". These representations may include both the content of the document and information about the structure of the document. The content of the document is the kind of material we expect to see between the covers of a typical paper document. The structure of a document is concerned with how this material is organized. There are two kinds of structure, logical and layout. The logical structure identifies logical components of the document, such as chapters, paragraphs and figures, and indicates their relationships. The layout structure of a document describes how the content of the document is to be arranged in pages and blocks on a presentation medium such as a screen or printer.

A single document may have several different representations in a MFT. For example, an internal representation may be used for editing purposes, a device specific representation may be used for special purposes such as printing or filing, and an interchange representation may be used for communication purposes. The ISO work on text preparation and interchange identifies three interchange representations, text image representation (TIR), text processable representation (TPR), and full text representation (FTR). TIR communicates layout information. TPR communicates logical information. FTR communicates both.

The MFT model defines a set of facilities to edit, format, image, store, retrieve, and interchange document representations. The editing facility is used in the conventional way to create, enter and modify document representations. The formatting facility is used primarily to create layout information for existing document representations. The imaging facility converts document representations in layout form and into device specific representations. The storage and retrieval facility allows document representations to be stored on secondary storage. The interchange facility is used to control the interchange of documents between MFTs.

Of particular concern to the MFT are the capabilities and limitations of interchange representations for CCITT Telematic services (Teletex, Facsimile and Videotex). The Teletex service provides a limited text image representation which does not preserve all layout information and which supports only a limited number of layout variations. The basic service is single mode (alphanumeric), but code extension techniques provide flexibility for mixed mode text. The G4 Facsimile service supports the interchange of individual pages of information with provision for identifying when pages are members of of a larger document. As with Teletex, it is concerned with preserving the layout structure of text. For mixed mode operation an extension of service may be required to support the concept of a block. Videotex is the only service which supports a wide range of graphic element types and attributes. Like Teletex and facsimile, Videotex is oriented towards preserving layout structure. Thus the Telematic services, as presently defined, lack representations for interchange of logical structure. This deficiency may be rectified by extending the definitions of these services, or by encoding logical structure in language form.

It is not envisaged that every MFT would have, or be capable of having, complete functionality to peform all possible operations on all possible modes of text in all possible combinations. Most MFTs would be less general. Particular examples are as follows:

- A dual mode MFT would be capable of carrying out editing and formatting functions of a general purpose MFT but only in character box and photographic modes.

- A mixed mode printer would be capable of printing any mixed mode document received from an MFT or from any of the single mode Telematic services.

- A simpler version of such a mixed mode printer might be capable of accepting input in only character box and photographic mode.

- An OCR/facsimile reader would allow letters or reports containing both character box and photo- graphic text. This machine is the input counterpart of the dual mode printer.

- A forms based MFT would be capable of displaying forms, perhaps using only character box and photographic modes, or only character box and geometric modes.

Possible user operations in an MFT would include:

- Creating generic logical and layout structures for classes of documents.

- Creating letters or memoranda.

- Completing forms.

- Creating complex documents containing text objects of various modes, both with and without scaling of photographic and geometric blocks.

- Editing blocks and geometric objects.

- Creating logical structures for existing layout structures.

- Transmitting to facsimile and other machines, including single and mixed mode machines.

A general MFT conceptual model presented in this report describes in block diagram form how the editing, imaging, formatting, storage, retrieval, and interchange facilities may be used in isolation and combination for particular MFT configurations. Seven configurations are identified:

- An OCR/ facsimile scanner.

- A mixed mode printer supporting interchange of TIR documents only.

- A videotex database server.

- An OCR/ printer.

- A mixed mode printer accepting both TIR and TPR documents (the latter printed according to a predefined layout structure).

- A videotex terminal.

- A system with keyboard disk, graphics input device mapped display and mixed mode printer.

To provide an example of different operating environments, three different operating environments for the last configuration above are defined, a What You See Is What You Get (WYSIWYG) text processor, a declarative document processor, and a procedural document processor. Thus, it is shown how different operating environments may require different interactions among facilities.

Block diagrams showing interactions among facilities are not sufficient in themselves to fully describe the functionality of an MFT. Determining this functionality requires the following seven steps:

1) Identify text objects;
2) Identify text operations;
3) Select generic document classes;
4) Select logical or layout structure;
5) Select configuration of facilities;
6) Select graphic elements;
7) Select desired functionality.

As a step in defining the more detailed functionality of an MFT, Chapter 3 develops text structuring principles in considerable detail, including hierarchies and relative positioning of blocks, forms of superposition, block attributes, positioning rules, hierarchies of geometric objects, videotex macros and sub-pictures, geometric coding versus facsimile coding, and possible future extensions for colour, three dimensional geometric objects, limited computer animation, and "sound text".

In conclusion, this report lays a conceptual foundation for the specification of functional requirements for a range of multi- functional text communication terminals. The conceptual foundation includes a coherent terminology derived principally from ISO SC18 work, an overview of the characteristics of defined telematic services, an external user view of the MFT, a functional block diagram model, and an office document architecture.

There are two major recommendations for further work. The first is to develop detailed specifications of the functional text processing and interchange requirements for the MFT. The second is to design and develop a prototype multifunctional terminal to demonstrate the feasibility of the concept and to provide a working model for evaluation by Canadian industry.

1. Introduction

1.0 Nature and Purpose of the Report

This report is Volume I of a projected two-volume series of reports on this subject. This first volume was produced under tight time contraints in order to provide as quickly as possible a framework for open discussion of the subject and for further development of the model. It provides preliminary concepts relavent to the development of a detailed model of a Multi Function Terminal (MFT) for text preparation and interchange. Thus it lays the foundation for the detailed specification of MFT functional requirements in Volume II. The reader should view this report as a preliminary source of definition, concepts and ideas, rather than as a definitive description of MFT models.

This report describes a preliminary, conceptual, block-diagram model of a range of multi-functional terminals (MFT) supporting text preparation and interchange. The model aims to provide a framework to show Canadian manufacturers how emerging CCITT and ISO standards and concepts could be used as the basis for viable MFT products.

The term "text" refers to machine representations of the kind of material we expect to see between the covers of a typical paper document, including alphanumeric, graphical and photographic material. However, in a machine context, the term "text" has broader implications than in a paper context. In particular, machine text may be further characterized by terms such as "editable", "printable" and "displayable". In general, the MFT model must be concerned with this broader view of text.

Factors affecting this report's view of the MFT are shown in Figure 1.1.

The CCITT has defined standards for a number of so-called Telematic services which enable interchange of text in particular forms. The Teletex standard enables interchange of pages of alphanumeric text, for display and printing. The Videotex standard enables interchange of pages of alphageometric text principally for display purposes. Alphageometric text includes geometric drawings and alphanumeric text.

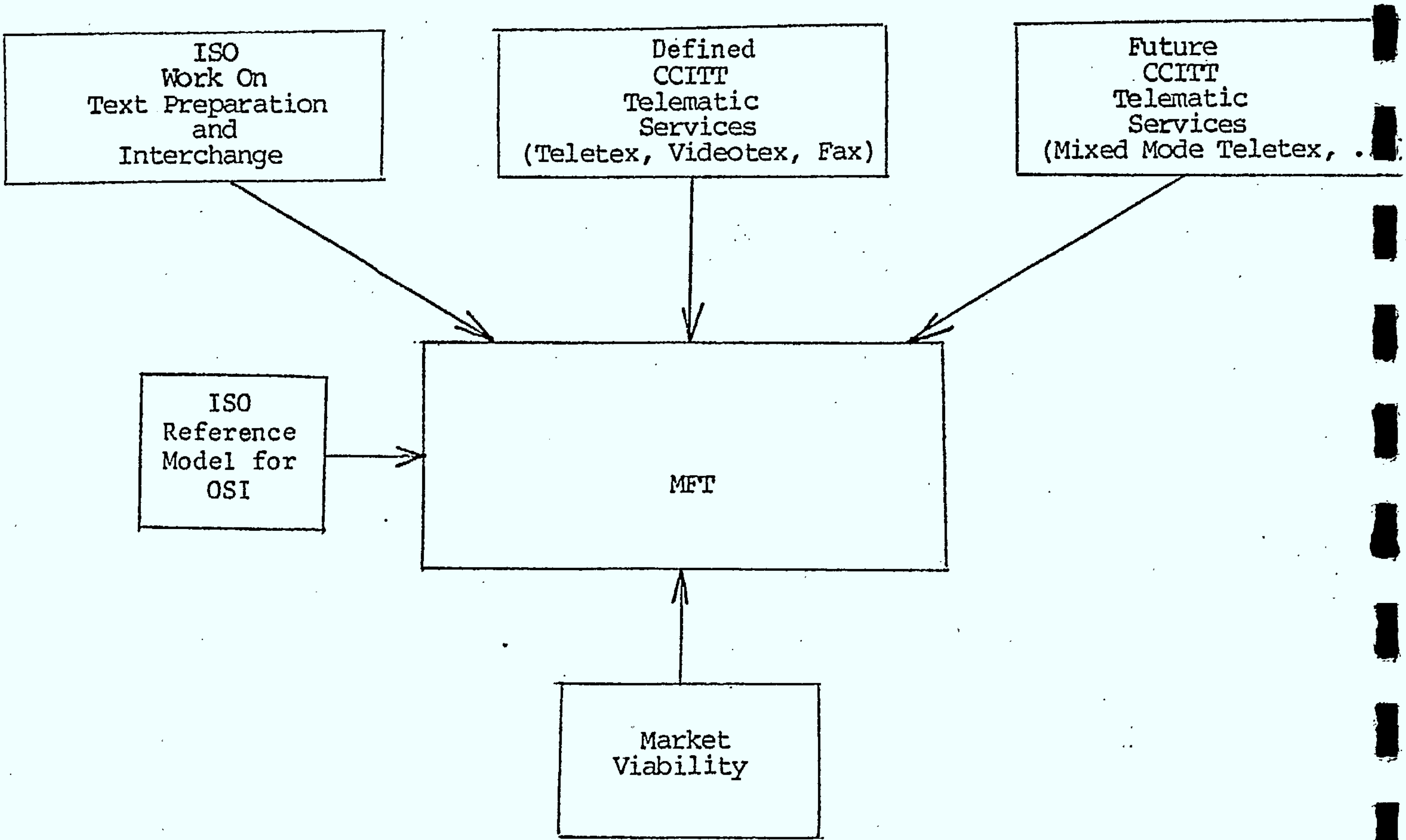


Figure 1.1: Factors Affecting the MFT

A digital facsimile standard enables interchange of pictorial information in bit-map form. As well, a standard for Mixed Mode Teletex is under development which will allow interchange of some combinations of these different forms of printable or displayable text. Future Telematic services are expected to support the interchange of editable text.

One concern of this report is to show how Telematic services supporting the interchange of displayable or printable text can be integrated in various ways to form parts of MFT products. However, a view of this report is that viable MFT products must provide for more than just interchange of displayable or printable text. They must also provide for the interchange of editable text. Therefore viable MFT products are unlikely to be just mixed mode Teletex machines, in the sense that mixed mode Teletex is currently envisaged by CCITT as a service supporting only the interchange of printable text.

Accordingly, the MFT conceptual model in this report is based on more than just existing CCITT Telematic services. It is also based on current international thinking in the text preparation and interchange area, as expressed in the open technical literature and as being developed by the ISO.

The sheer bulk and complexity of the technical literature in these areas is daunting. Furthermore, because ideas are evolving, this technical literature is a moving target. In consequence, manufacturers may be rightly cautious about contemplating products. Nevertheless, standards are emerging and ideas are crystalizing, to the point that product requirements can be defined. Therefore an important purpose of this report is to describe the emerging standards and crystalizing ideas in the MFT context with the aim of assisting Canadian manufacturers in formulating their plans for products in this area.

1.1 Scope of the Report

The MFT conceptual model is being developed in two stages. This volume of the MFT report is the result of only the first stage, to lay the groundwork. It should be regarded as preliminary in nature.

The emphasis in this stage is on developing a conceptual model of the MFT that is suitable for a large variety of equipment configurations and over a wide range of terminal functionality.

The emphasis in the next stage will be on refining the model and on developing detailed functional requirements for a range of MFTs.

The reference material for this report includes CCITT descriptions of telematic services, ISO/TC97/SC18 material on text preparation and interchange, the ISO/TC97/SC16 Reference Model for Open System Interconnection (OSI) and technical papers in the open literature on text processing. One purpose of this report is to give a self-contained view of this material as it relates to the design of multi-functional terminals. Our terminology springs largely from the work of TC97/SC18/Working Group 3.

Outside the scope of this report are the following possible aspects of multi-functional terminals:

- document formatting for typesetting;
- interactive computer graphics for CAD or like applications;
- voice messaging;
- incorporation of material from ISO/TC154 on trade document forms filling;
- identification of existing products which could be used to configure a multi-functional terminal.

1.2 Terminology

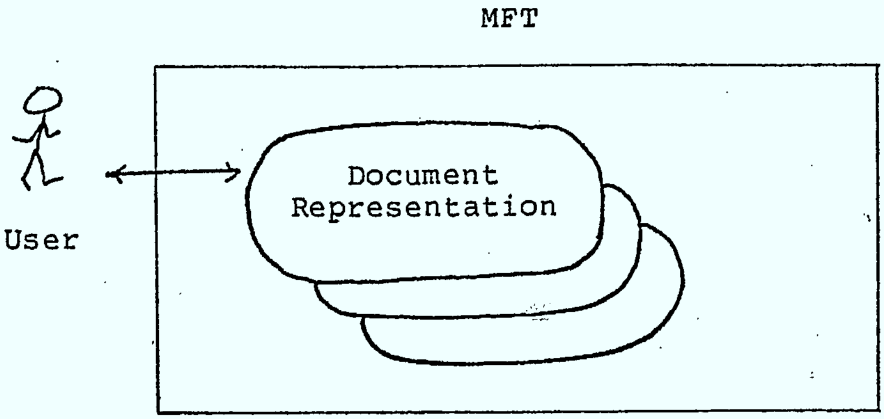
One of the main problems to be faced by the reader of this report is terminology. The terminology of this field is an awkward mix of historical terms arising from word processors, typesetting systems, and so on, and new terms introduced by standardization groups to enable clear explanation of concepts. One purpose of this report is to present a consistent view of the terminology. Unfortunately, certain terms, because of their historical nature, may be inherently confusing. In this section we present an overview of the main terms, in the MFT context, and give a cautionary warning about terms which may be confusing.

It is particularly important to notice that, in this report, the term "text" is used in a very general sense to include alphanumeric, alphageometric (graphical) and pictorial information. Thus, the term "text" encompasses all that we are used to thinking of as lying between the covers of a document, including figures and photographs, as well as printed material.

Figure 1.2 depicts the various possible document representations within a multi-functional terminal. The block labelled "MFT" in Figure 1.2 represents the entire terminal, including storage, imaging and communication devices. Documents are represented internally in this MFT by so-called "document representations". These representations are the machine readable encodings of the document. Note that the term "format" is frequently used in the same sense that "representation" is used here. "Representation" is preferred to "format" because of the possible confusion between the terms "format" and "formatting".

Document representations include both the content of the document and information about the structure of the document. The structure of a document may be characterized as logical or layout. In its simplest form, the logical structure of a document identifies the logical components of the document, such as chapters, paragraphs and figures. The layout structure of a document describes how the document is to be presented on an imaging medium such as a page or screen. It contains information such as page width, character spacing and line spacing.

Document representations may be of a number of different kinds, including internal, device specific and interchange. For each of these kinds of representations, a different encoding may be used. For example, a document may be stored on a secondary storage device in a device specific file representation. It may be transformed into another device specific representation for printing. It may be stored internally in primary memory for editing purposes in a different internal representation. It may be transformed for interchange purposes into yet another representation. In the context of telematic services, the interchange representation would be that required by the telematic service.



Document representations
- include document content
- represent structure
  - logical
  - layout
- may be of different kinds
  - internal
  - device specific
  - interchange
  - others

Figure 1.2: Document Representations in a MFT

In general, each different kind of document representation is in itself a complete description of the document for its specific purpose. For example, the internal representation of a particular document in a particular MFT is sufficient to manipulate and edit the document. That internal representation is not, however, sufficient for that purpose on a different MFT with different software and/or hardware. As another example, the device specific representation of a particular document for a particular kind of printer is sufficient to print that document on that kind of printer, no matter what kind of MFT is driving the printer.

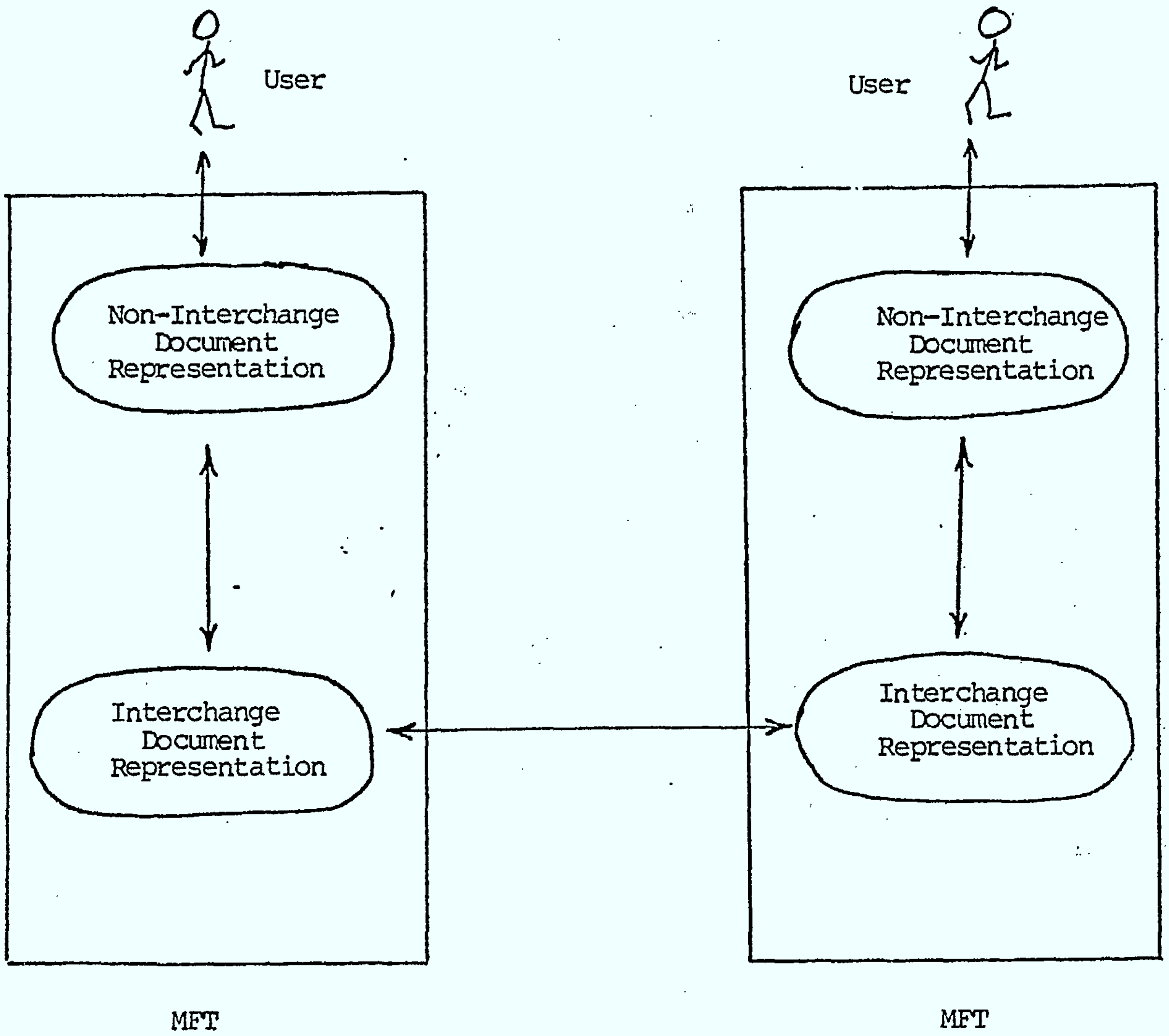
Figure 1.3 illustrates the use of interchange representations to communicate between MFTs. The SC18 work has identified three interchange representations, as follows:

- Text Image Representation (TIR): This representation is used to preserve only layout information needed to produce an image of document on a remote imaging device, such as a printer or screen. (Note that SC18 currently uses the term "format" instead of "representation").

- Text Processable Representation (TPR): This representation is used to preserve logical information needed to make the document editable at the remote MFT.

- Full Text Representation (FTR): This representation is used to preserve complete information about the document, including both logical and layout structures.

We are unfortunately faced with an awkward terminology problem when describing current practice using this new interchange representation terminology. The problem is that many current communication packages for document processing systems use none of these interchange representations in their pure form. Rather their interchange representations include partial information about both logical and layout structures. In spite of this problem, we shall use this terminology in this report, because of its international acceptance and because current developments in text interchange are incorporating these concepts. We simply caution the reader to be careful.



Interchange Representation
- TIR (Text Image Representation)
- TPR (Text Processable Representation)
- FTR (Full Text Representation)

Figure 1.3: View of Communicating MFTs

Defined Telematic services are concerned only with Text Image Representation and would, therefore, normally be used to interchange only layout information.

For example, the internal representation of a document in a word processor could be transformed into Text Image Representation for interchange via Teletex, resulting in a printable version of the document at the remote end. Although the internal representation of the document includes both logical and layout information, the interchange representation includes only layout information.

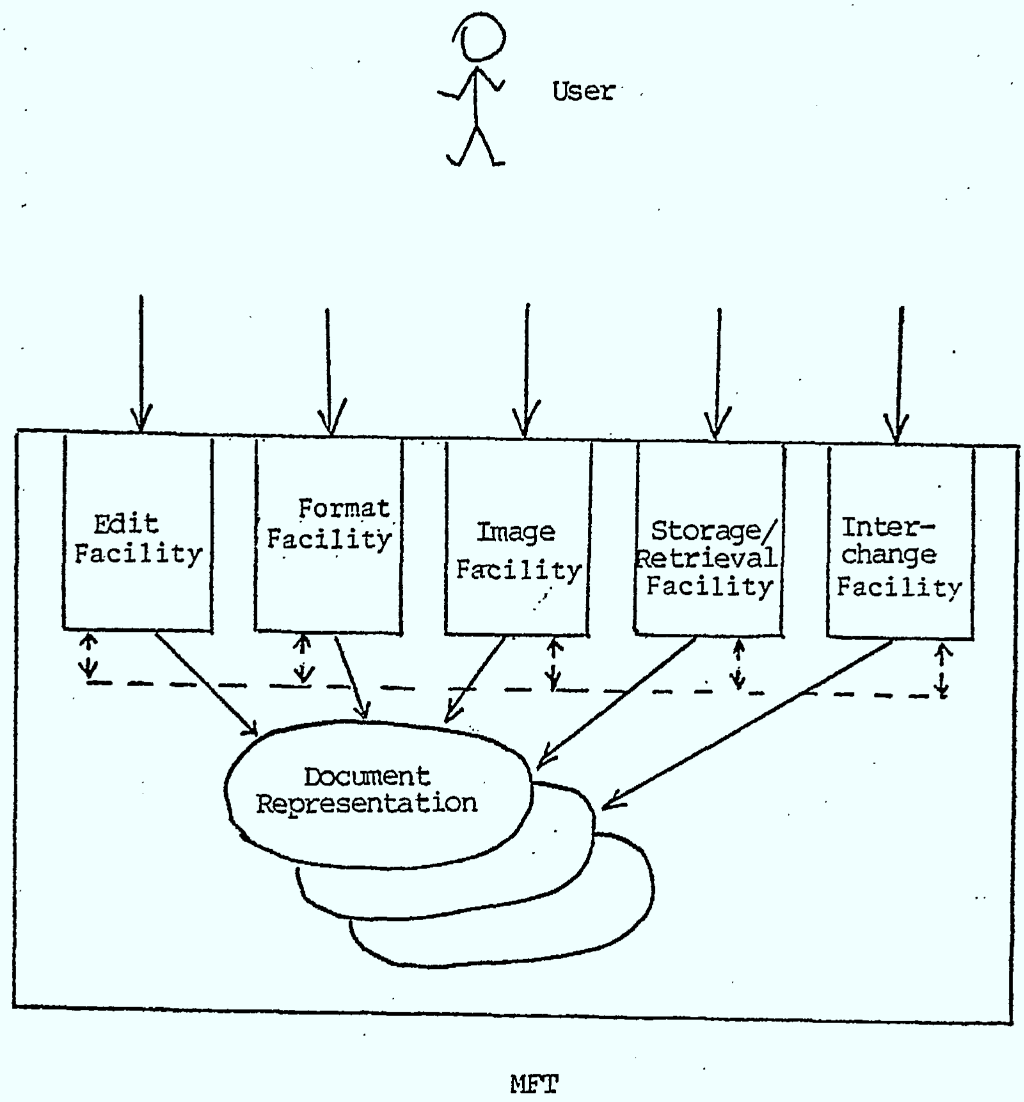
However, logical information could also be interchanged using Text Image Representation. This could be done if the internal representation is encoded in the form of ordinary alphanumeric text, with logical components of the text identified by alphanumeric command strings. Such encoding of internal representations is typical of many current document processing systems.

Figure 1.4 provides a view of the MFT as a set of facilities accessible by the users. These facilities, in turn, access the document representations and each other to perform their different functions. The facilities identified in Figure 1.4 are editing, formatting, imaging, storage and retrieval, and interchange. As we shall see, different types of MFTs may be constructed by combining subsets of this complete set of facilities in a variety of ways.

The editing facility is used in a conventional way to create, enter and modify document representations.

The formatting facility is used primarily to add layout information to existing document representations. In this sense, it is a form of editing. However, it is identified as a separate facility because it is often implemented as a separate facility in existing document processing systems.

The primary purpose of the imaging facility is to convert a document representation containing layout information into a device specific representation which can be imaged on a particular device.



Legend
<- - -> interactions among facilities
——> operations on document representations

Figure 1.4: View of MFT as a Set of Facilities

The storage and retrieval facility is used to store and retrieve document representations on secondary storage.

The interchange facility is used to control the interchange of documents between MFTs.

1.3 Outline of Report

Chapter 2 provides an overview of a logical model for the MFT, including both the user view of the MFT and the internal logical structure, in terms of interworkings among various facilities for different purposes. This chapter also includes a detailed definition of all terminology used in the report.

Chapter 3 provides an overview of text structure models as they relate to the requirements of the MFT. This chapter addresses itself particularly to issues associated with the inclusion of geometric text and pictures in documents.

Chapter 4 provides conclusions.

2. Overview of the MFT

2.0 Introduction

This chapter has two major objectives. The first is to provide the reader with an overall understanding of the general characteristics of the MFT being considered in this report. To this end, Section 2.1 defines the terminology used throughout the report; Section 2.2 discusses the principal features of existing Telematic services which the terminal is to support; Section 2.3 then provides an external user view of the MFT which focuses on typical documents and on the range of operations that an MFT might need to carry out.

The second objective is to provide a unified view of the inner workings of an MFT. Thus, in Section 2.4 a general functional model is developed which is valid over a wide range of terminal functionality. This functional model, together with the user view of Section 2.3, provide the conceptual basis for the definition in Part II of detailed functional requirements for the MFT.

2.1 Terminology

In order to be able to discuss the MFT in a coherent manner, it is important to first have a clear understanding of what the MFT is intended to manipulate, namely text documents. In this section a set of terms will be defined which describe a document, its basic text components, its structure and the various representations of text. The terminology is adopted principally from ISOTC97/ SC18 on Text Preparation and Interchange.

Document: an amount of text that can be treated as a unit by applications, the size being determined by the applications involved. The document is also the basic unit of interchange; an interchanged document may form part of, or be the whole of, a document defined as a unit by the applications. The scope of this report is limited to office documents, which include items such as memoranda, letters, forms and reports, including pictures and tabular material.

Basic Graphic Element: smallest unit of text information. There are three graphic element types: character box elements, geometric elements, photographic elements.

Character Box Elements: graphic elements which are presented within character boxes (small rectangular areas). There are two types of character box elements. Alphanumeric characters include alphabetic letters with or without diacritical signs, numerical digits and fractions, punctuation marks, mathematical signs, as well as space and special letters, signs and other typographical symbols. Pictorial characters are predetermined patterns which are intended to be presented in adjacent character boxes to construct rulings, boxes, logos, diagrams, and other pictures occupying multiple character boxes. Two examples of pictorial characters are mosaic and line drawing characters.

Geometric Elements: graphic elements which are used to construct drawings of various types by a succession and overlay of points, straight lines, arcs, rectangles and polygons.

<u>Photographic Elements</u>: graphic elements which are used to construct images by combining individual picture elements (pixels) into arrays.

<u>Document Content</u>: the presentation-independent information conveyed by a document. The content of a document may include any of the three basic graphic elements.

<u>Document Structure</u>: an abstract architectural view of the content of a document. Two such views are possible, termed the logical structure and the layout structure.

<u>Document Representation</u>: a physical encoding or representation of the structure and content of a document.

<u>Text Object</u>: a collection of graphic elements having meaning and capable of being processed as an entity. <u>Elementary text objects</u> consist of graphic elements of a single type (character box, geometric, photographic) and represent the smallest meaningful collection of graphic elements for a particular application. <u>Composite text objects</u> are hierarchical collections of elementary text objects and other lower-level composite text objects. The document is the highest level in the hierarchy. Figure 2.1.1 illustrates the hierarchy of objects.

<u>Logical Structure</u> (see Figure 2.1.2): relates the content of a document to logical text objects such as chapters, titles, paragraphs, footnotes, tables and figures. It provides one view of the content of a document; an alternative view is provided by the layout structure (see below).

document

↓

composite text objects

↓

elementary text objects

↓

basic graphic elements.

Figure 2.1.1 Hierarchy of Text Objects

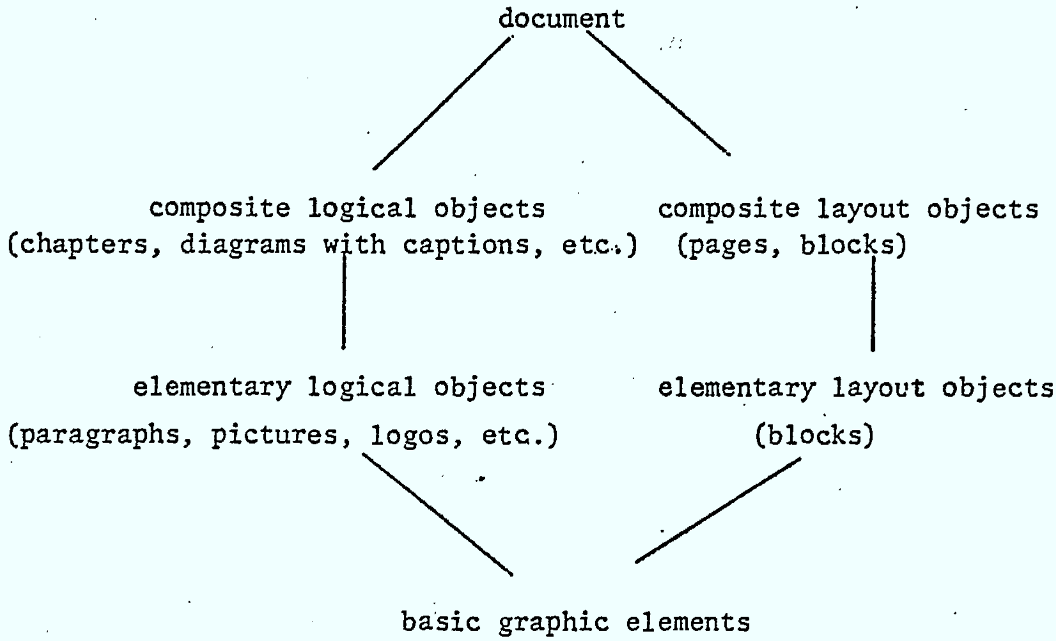


Figure 2.1.2 Two Views of Document Structure

Two types of logical structures exist: generic and specific. The generic logical structure defines a general structure which applies to all members of a document class. (A document class groups documents which can be interchanged accurately within a constrained set of functional capabilities). The specific logical structure defines the structure of a particular document. Both of these structures may be represented as directed graphs with a variable number of hierarchical levels. The generic logical structure may contain cycles, indicating that a particular text object may be repeated many times. (For example, the generic structure of an office memo might include the object "paragraph" only once and indicate that this type of object may be repeated many times in a real memo). The specific logical structure is a non-cyclic tree structure. (For example, the specific logical structure for a real memo, would be a tree, with separate branches for each paragraph).

Either of these structures may consist of elementary or composite objects. Examples of composite logical text objects are chapters, sections, paragraphs, figures, appendices, etc.

Layout Structure (see Figure 2.1.2): relates the content of a document to its positioning and rendition on the presentation media (e.g., screen, printer). While there are many possible logical text objects, there are only two layout text objects below the level of the document. They are the page and the block. The page is a composite text object and is the unit of presentation of the document content, i.e., a document is printed or displayed one page at a time. A page is rectangular and contains one or more blocks. A block is a usually rectangular area within a page. It may be either a composite or an elementary text object. The content of an elementary block is of a single category of graphic element (character box, geometric, photographic). Elementary blocks may be included within other blocks, called composite blocks. Any number of blocks may be superimposed partially or fully, independent of the category of graphic element.

As with logical structure, two types of layout structure exist, namely generic and specific layout structure. These two layout structures have the same interpretation as their logical counterparts, with the restriction that only two hierarchical levels are possible below the document level.

Document Description: contains information for handling a document as a whole. This description is separate from the logical structure, layout structure and content of a document, although it may repeat information in the document content. Examples of information that might be included in the document description are document Id., document origin, and circulation and distribution information.

Attributes: are parameters of the elements of the logical and layout structures specifying characteristics of the elements and relationships between elements. Attributes may be associated with individual graphic elements or with a text object as a whole.

Generic attributes: are associated with elements of the generic logical or generic layout structure. Specific attributes apply to an element of the specific logical or specific layout structure. A specific attribute may override a generic one that applies to the same element. The layout directives of the logical structure may override generic or specific attributes of the layout structure.

Layout directives: are attributes of the logical structure that refer to elements of the layout structure. For example a layout directive may specify that a chapter is to start on a new page, or that a footnote is to be presented at the bottom of the current page. A layout directive can be either a specific or a generic attribute.

Document Representations: a document may have many representations, as defined below and illustrated in Figure 2.1.3.

Device-Specific Representation: the form in which text information is represented during processing by an input or output device (e.g., screen, printer, disc, etc.). This representation will likely differ from one device to another. "Device-specific representation" is a term specific to this report.

Internal Representation: the form in which text information is represented internally within an MFT during processing. This representation will likely differ from manufacturer to manufacturer. "Internal Representation" is a term specific to this report. Multiple internal representations are possible.

Logical Representation: the form in which the logical structure is represented.

Layout Representation: the layout structure of a document may be represented in two ways.

Abstract Layout Representation: a form suitable for editing.

Concrete Layout Representation: a form suitable for imaging. An example of the difference between the two layout representations is the different form a document has before and after processing by a document formatter (e.g., the "nroff" formatter available on UNIX* systems).

Interchange Representation: for interchange purposes, there exists a spectrum of interchange representations: the following three representations have characteristics that are conceptually important.

Text Image Representation (TIR): the form in which the layout structure and content of a document is represented for interchange purposes. It allows an interchanged document to be imaged exactly as intended by the originator, without requiring a reformatting operation. However, the original logical structure is not explicitly present.

*Unix is a trademark of Bell Laboratories.

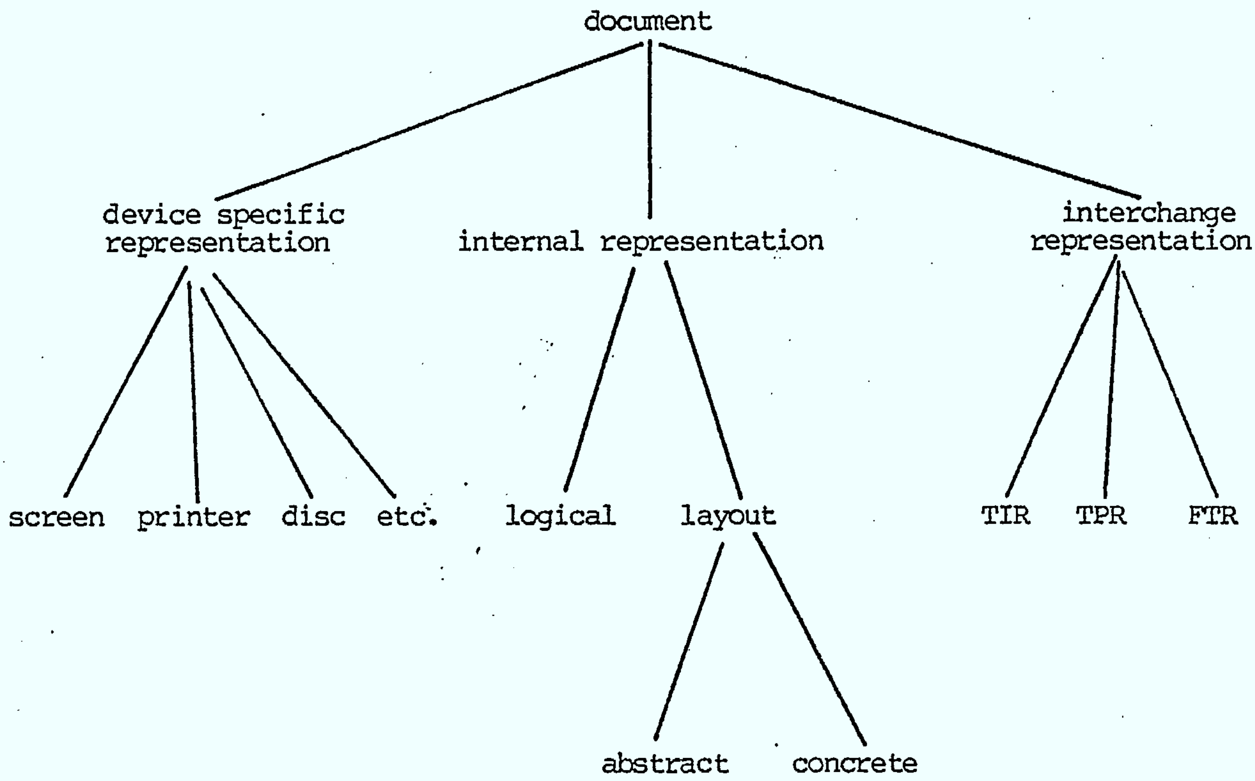


Figure 2.1.3: Document Representations

Text Processable Representation (TPR): the form in which the logical structure and content of a document is represented for interchange purposes. It allows an interchanged document to be processed in a manner that permits the logical structure intended by the originator to be maintained and edited. It includes layout directives but no specific layout elements. Therefore, a formatting operation is usually required when the document is to be imaged.

Full Text Representation (FTR): an extended text processable representation which includes both logical and layout structure. It allows both direct imaging and processing of an interchanged document.

Mixed-Mode: containing or supporting more than one graphic element type, e.g., mixed-mode document or mixed-mode terminal.

Text Processing Function: behaviour of a system related to the transformation of the content, structure or representation of text.

Text Processing Facility: a logically distinct group of functions associated with a related set of text transformations.

2.2 Defined Telematic Services*

A fundamental requirement of the MFT being investigated in this report is that it supports text interchange via an existing or future telematic service. To date, three such services have been defined by CCITT, namely Teletex, Facsimile and Videotex. Each of these services will now be described in terms of their purpose, capabilities and limitations.

2.2.1 Teletex

Teletex is a service which provides communication between terminals which are used for the preparation, editing and printing and interchange of documents containing alphanumeric "character box" text. A fundamental requirement of this service is that when a received Teletex message is printed, the resulting document is identical in content, layout and format to the originator's copy.

A number of CCITT recommendations govern various aspects of the Teletex service. These are:

CCITT Rec. F2.00	-	Teletex Service
CCITT Rec. S.60	-	Terminal Equipment
CCITT Rec. S.61	-	Character Repertoire and Coded Character Sets
CCITT S.62	-	Control Procedures
CCITT S.70	-	Network Independent Basic Transport Service

These recommendations cover all layers of an Open System above the Network layer. The Teletex service is intended to operate over a variety of public networks, including circuit switched data networks (CSDN), packet switched data networks (PSDN) and public switched telephone networks (PSTN). Any chosen network should be reliable and transparent.

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* as of March 1983

2.2.1.1 Teletex Capabilities

Teletex defines a set of basic capabilities which must be supported by all terminals. These include the following:

- the character repertoire (with 8-bit encoding) supports most characters found in Latin alphabets

- the control function repertoire includes the following formatting functions:

  backspace
  line feed
  form feed
  carriage return
  partial line down
  partial line up
  select horizontal or vertical page orientation
  select graphic rendition (turn underline on/off)
  select horizontal spacing (10 characters/25.4 mm)
  select vertical spacing (3,4,6,12 lines/25.4 mm)

- two paper sizes are supported: the ISO A4 representation (210x297 mm) and the North American representation (216x280 mm). The printable area is restricted to the common area of these two representations, namely 210x280 mm. This in turn restricts the number of characters per line in transmitted text to 77 and the number of lines per page to 56 (for vertical page orientation and a line spacing of 6 lines per 25.4 mm).

- the interchange control procedure considers a page of text as the smallest processable unit. Checkpointing and recovery is provided at page boundaries with a window of three for unacknowledged pages. Two way alternate mode of operation is standard.

- the Transport service corresponds to class Ø of the ISO Transport service.

In addition to the required features outlined above, Teletex terminals are permitted to incorporate certain standardized options for which there is an agreed international need. The use of such options would normally be negotiated during session establishment.

The standardized options include the following:

- utilization of the full A4 printable area, allowing up to 60 lines per page
- character spacing options of 12 and 15 characters/25.4 mm.
- different metric values for line spacing (3.175 and 5 mm in addition to the standard 4.23 mm)
- reverse line feed formatting function
- use of additional character repertoires; this would permit the exchange of other forms of text such as mosaic and geometric
- additional session capabilities such as session suspension, two-way simultaneous modes of operation, negotiation of checkpoint window size and arbitrary checkpoint locations

2.2.1.2 Teletex Limitations

The basic Teletex service is intended to support the interchange of alphanumeric documents for imaging on some destination device. This objective corresponds to preserving the layout structure of documents. The Teletex interchange representation, as defined in S.61, corresponds to a limited text image representation (TIR). It is limited in the sense that not all layout information is preserved (e.g., justification) and only a limited number of layout variations are supported (e.g., character spacing, page size, etc.).

No attempt is made to preserve the logical structure of text and as a consequence text interchanged via the Teletex service is not directly editable. An intermediate step - usually involving human intervention - is required to infer the logical structure from the received layout structure and to introduce this logical structure into the stored document via an editing process.

The other major limitation of basic Teletex is that it is a single-mode service, i.e., it supports only alphanumeric text. However, the coding scheme defined in S.61 permits the inclusion of other types of character-coded text such as mosaic, characters, line-drawing characters and geometric commands. It is also amenable to the addition of further control functions such as those for defining the logical structure of text. This flexibility, coupled with the fact that a generalized version of the S.62 control procedure would be suitable for all forms of text, indicates that the Teletex service provides a solid foundation on which to build a mixed-mode text interchange facility.

2.2.2 Facsimile

CCITT is concerned with document facsimile transmission by international communications carried on public networks. It is interested in three types of Facsimile services: Telefax, Datafax and Bureaufax. Telefax refers to a public facsimile service between subscribers' stations connected via the public switched telephone network. Datafax refers to a public facsimile service between subscribers' stations connected via a public data network. Bureaufax refers to a public facsimile service between public bureaux operated by various administrations (e.g., common carriers). Any kind of network may be used for Bureaufax.

Facsimile devices have been classified into four groups according to their functionality. The first three groups of devices are for use over the public telephone network while the Group 4 devices are for use over public data networks. Each group is described briefly below:

<u>Group 1</u>: uses double sideband modulation with no special measures to compress the bandwidth of the transmitted signal. It is capable of transmitting ISO A4 documents at nominally 4 lines/mm in about six minutes.

<u>Group 2</u>: exploits bandwidth compression techniques in order to achieve a transmission time of about three minutes for an ISO A4 size document of nominally 4 lines/mm. Bandwidth compression includes encoding and/or vestigial sideband working but excludes document processing to reduce redundancy.

<u>Group 3</u>: incorporates means for reducing the redundant information in the document signal prior to the modulation process and which can achieve a transmission time of about 1 minute for a typical ISO A4 size document. It may also incorporate bandwidth compression of the line signal.

<u>Group 4</u>: incorporates means for reducing redundant information in the document signal prior to transmission. It uses procedures applicable to the public data network and assumes error-free document interchange. This group is further subdivided into three classes, according to pixel density (resolution) and mixed mode capability. Because this group is the only one which is designed for use with public data networks and which supports mixed-mode operation, it is the only type of facsimile apparatus of interest to this report.

A number of CCITT recommendations discuss the Group 4 Facsimile service. These are:

CCITT Rec. T.0 - Classification of Facsimile Apparatus for Document Transmission over the Public Networks

CCITT Rec. F.160 - General Operational Provisions for the International Public Facsimile Services

CCITT Draft Rec. T.a - Standardization of Group 4 Facsimile Apparatus for Document Transmission

2.2.2.1 Group 4 Facsimile Capabilities

The Group 4 (G4) Facsimile apparatus supports black and white two-level images with a page size corresponding to ISO A4.

Three levels of resolution are possible: 200, 300 and 400 pixels/25.4 mm. The resolution is the same in both the horizontal and vertical directions. The 200 pixels/25.4 mm resolution must be supported by all three classes of G4 apparatus, while 300 pixels/25.4 mm is supported by Classes 2 and 3. The 400 pixels/25.4 mm is optional in all classes. The mixed-mode capability is required only for Class 3.

The coding scheme for G4 facsimile operates on a line-by-line basis.

G4 Facsimile is still under study within CCITT and no final recommendations are available yet. In particular, the control procedures for this type of apparatus have not yet been defined (they will appear in Recommendation T.C.), but it is likely that they will be compatible with Teletex S.62. In this way, a mixed-mode service supporting alphanumeric text and facsimile would be a natural extension of the existing Teletex service.

2.2.2.2 Group 4 Facsimile Limitations

The G4 Facsimile service supports the interchange of individual pages of information, with provision for identifying when pages are members of a larger document. As the intent is to reproduce at the destination an exact replica of the original - within the limits of equipment capabilities - this service preserves the layout structure of text; the encoded facsimile signal is a form of Text Image Representation (TIR). As the facsimile service is concerned only with entire pages, there is currently no provision for structural elements other than documents and pages. For mixed-mode operation, an extension to the service may be required to support the concept of block.

As the Facsimile service is a page image to page image service with no text processing outside the interchange environment, the concept of a logical text structure is totally foreign to this environment.

2.2.3 Videotex

The basic objective of the Videotex service is to support the retrieval of text by a dialogue with a data base. This service is based on public data, telephone or cable networks and uses standard television receivers suitably modified or supplemented as the terminal equipment, although the use of other equipment is not excluded.

In addition to the basic database retrieval facility, the Videotex service may include facilities for terminal-to-terminal communication, store-and-forward message service between users, transactional services (e.g., electronic funds transfer, reservation systems, etc.), data processing services (e.g., calculations facilites, software downloading) and others.

The following documents are relevant to the Videotex service:

CCITT Rec. F.300	- Videotex Service
CCITT Rec. S.100	- Interactive Information Exchange
CSA Draft Standard T500	- Videotex/Teletext/Presentation Layer Protocol Syntax (North American PLPS)

Document F.300 describes in a general way the characteristics of the Videotex service while documents S.100 and T500 define the coding of text information to be exchanged using the Videotex service. Note that control procedures for exchanging Videotex information remain to be defined.

2.2.3.1 <u>Videotex Capabilities</u>

Videotex is the only service which supports a wide range of graphic element types, including alphanumeric, mosaic, geometric and photographic. It even includes a capability for Dynamically Redefinable Character Sets (DRCS). Such character sets consist of characters whose shapes are defined as arrays of pixels. They may represent alphabetic characters, special symbols, or picture element symbols for constructing fine graphics.

Videotex is also the only service to support the concept of attributes to modify the presentation of graphic elements. For example, T500 provides encoding mechanisms for the following imaging attributes:

- stroke width for geometric drawings
- character rotation
- character path
- inter-character spacing
- inter-row spacing
- cursor style
- character box size
- line texture
- highlighting
- texture patterns for filling rectangles, arcs, polygons, etc.

- color
- blink
- protected fields
- reverse video
- word wrap
- screen scrolling
- underline
- flash cursor

A Videotex database consists of a set of pages, each of which consists of one or more frames. A frame is the smallest unit of retrievable information, and typically might consist of that quantity of information that fills up a physical screen (e.g., 20 lines of 40 characters in North America). Information is retrieved from the database on the basis of pages and possibly on the basis of frames as well. A frame may be considered to be logically equivalent to a page.

2.2.3.2 Videotex Limitations

Unlike the Teletex and Facsimile services which are oriented toward the printed page, the Videotex service is oriented toward the screen display. The concept of page in the Videotex database has no fixed relationship to a particular paper representation, i.e., it need not conform to ISO A4 representation; it simply represents a unified collection of pictorial information. As such, it is closer to the concept of block as discussed in Section 2.1.

Like the Teletex and Facsimile services, the Videotex service is oriented toward preserving the layout structure of text and is not concerned with logical structure. The objective of the service is to reproduce on the terminal screen an exact image of the original picture. The encodings in documents S.100 and T500 define a Text Image Representation (TIR) for text, albeit one that is richer in graphic element types and attributes than the TIF for the other two services.

2.3 User View of the MFT

2.3.0 Purpose and Scope of this Section

In this section we discuss the operations possible with an MFT from the point of view of the user. The purpose is to clarify the range of operations which an MFT might have to carry out and to set the stage for subsequent sections and chapters of this report. The view presented here is therefore an external view of the terminal and the documents it can produce. Subsequent sections and chapters deal with the corresponding internal view and the internal functions and operations necessary in an MFT.

To accomplish this we first discuss the nature of some typical, mixed-mode office documents and the view which the user takes of them. This is done in Section 2.3.1. Then, in Section 2.3.2 we discuss the environment of input, output and remote communications within which a general purpose MFT must operate in order to permit the preparation and transmission of such documents. By a general purpose MFT we mean one which could accomplish any of the tasks that might be asked of any MFT. Some typical examples of less than general purpose MFT's are also described.

Finally, in Section 2.3.3 we discuss a wide range of typical operations which a user might expect to carry out on an MFT in order to create and transmit mixed-mode document..

2.3.1 User View of Some Typical Mixed-Mode Documents

2.3.1.1 The Initial View - The Logical Structure

In this section we describe a number of typical office documents using the terminology of Section 2.1. The purpose is to give some concrete examples of the external view of a mixed-mode document, which the multi-function terminal provides to the user.

Memorandum or letter

Memoranda and letters are probably the simplest type of mixed-mode document frequently used in the office and they normally incorporate the capabilities of two of the basic Telematic services, Teletex and facsimile, and require the use of the two corresponding types of graphic element: character-box and photographic.

The logical structure of a memorandum or a letter usually contains the following text objects:

- letterhead or formal structure at head of a memorandum
- logo

These objects would normally be in photographic mode but, in simple cases, might be in character-box mode.

- date, address and subject
- alphanumeric text of the memorandum or letter

These objects are in character-box mode. The date, address and subject may have to be used for machine filing, sorting and transmission purposes.

- signature block consisting of salutation and name with a signature.

This object is subdivided into two elements: one in character-box mode and the other in photographic mode.

The generic logical structure of a letter or memorandum includes the specification of the above structure for all letters and memoranda that have common properties, e.g., those within a given organization. The specific logical structure consists of the actual contents of a particular example with specific values for address, content and all other elements.

The layout structure of a letter or memorandum consists of the detailed specification of how to arrange the various logical text objects for display or printing purposes. Once again there will be both generic and specific layout structures describing the general ways in which all such documents are to be laid out and the specific layout of each instance of a document respectively.

Forms

Most forms can be expressed in terms of a combination of character-box and line-drawing modes, but more complex forms might require the use of geometric mode as well.

The logical structure of forms include the following text objects:

- title	photographic or character-box (including mosaic)
- field identifiers	photographic or character-box (including mosaic)
- fixed information	photographic or character-box (including mosaic)
- shaded areas	photographic or geometric or character box (including mosaic)
- dividing lines between fields	photographic or geometric or character-box (including mosaic) or geometric
- variable information	normally character-box
- signature	photographic

All of the above objects will have associated with them the generic layout structure of the form. In the case of a form, the specific layout structure does not normally vary from the generic layout structure.

A significant amount of work has been done by ISO TC 154 in the area of forms filling for the purpose of trade document exchange. This work may be applicable to forms in the general office environment.

Reports and long documents

Reports and other long documents are the most complex of office documents and typically require the use of all three of the basic forms of graphic elements for their representation.

The logical structure of a report may contain the following distinct text objects, among others:

- title, author, date, organization and other title page information;
- table of contents;
- abstract;
- headings, subheadings;
- footnotes;
- the alphanumeric text divided into paragraphs;
- bibliography.

All these are in character-box mode.

- diagrams

These are normally in geometric or photographic mode but simple ones may be constructed in character-box mode.

- pictures;
- freehand sketches;
- handwritten, marginal annotations.

These require photographic mode.

- layout directives.

These are directives, which the author creates as part of the logical structure, which specify a logical association between those objects which subsequent formatting operations will have to associate in a layout. These directives are necessary if:

- the author does not intend to create a layout structure himself, or

- the document may be reformatted by someone else, or

- the document may be transmitted or stored in logical form only, without the specific layout structure.

Examples of the information conveyed by layout directives might be:

- Figure 2 is to be on the same page as paragraph 4.

- Start this section on a new page.

2.3.1.2 The Final View - The Layout Structure

The author or originator of the information content of a document normally starts with the logical view of a document as described above. Once that has been created, it is necessary to establish a specific layout for the document. In the case of documents with very strong generic layout structures, such as forms, this may not be necessary. In this section we describe the conceptual way in which an author, or a subsequent formatter, views the layout structure of a document.

The basic unit of layout structure is the page. Within the page the various logical objects are arranged in layout blocks. These are generally rectangular blocks, each containing one or more logical objects, such as a letterhead, a heading, a paragraph or a figure. It is also possible for a logical object to span several layout blocks. Blocks may contain other sub-blocks just as the page contains blocks. The blocks are relocatable on the page in order to permit the creation of a desired layout. Blocks are also superimposable on top of each other. This operation would be used, for instance, to apply a facsimile-mode block containing a signature onto the alphanumeric signature block. It could also be used to superimpose alphanumeric legends on a geometric or photographic block representing a figure.

Thus, the user may view the document as a set of relocatable, superimposable blocks which he assembles in "cut and paste" fashion into a complete document.

The combination of the logical structure with the layout structure represents a complete printable, displayable and editable document.

2.3.2 The Functions and Environment of an MFT

General-Purpose MFT

In order to create a mixed-mode document, a user will need to carry out the following major types of operations:

- Enter logical text objects locally in any one of the basic modes: character-box, photographic and geometric, or any combination thereof.

- Receive, from a local filing system or from remote sources by any of the telematic services, including mixed-mode services, documents, or pages or other logical or layout objects to be incorporated into the new document.

- Having entered or received the various text objects he requires, edit them to produce the logical structure of the new document.

- Format the new document to produce its layout structure.

Once a document has been created, it may be necessary to transmit it by one of the telematic services to a remote machine. Clearly a mixed-mode document can only be transmitted, as it stands, to another MFT. Nevertheless, there will be occasions when either a single-mode part of a mixed-mode document or an entire single-mode document will have to be transmitted to a remote single-mode machine.

These operations are reviewed in more detail in Section 2.3.3. The environment in which a general purpose MFT would operate, with its local inputs, outputs and remote connections, is shown in Figure 2.3.1. It is not envisaged that every MFT would have, or be capable of having, a complete set of connections as shown. Most would have a subset corresponding to the operations specifically envisioned for it. Some typical examples of less general purpose MFT's are discussed below.

Dual-Mode MFT

A MFT capable of carrying out editing and formatting functions of a general purpose MFT but only in character-box and photographic modes would offer a powerful capability to the user, since it would be capable of producing and transmitting any mixed-mode document although it would do so at greater cost because it could not take advantage of the transmission and storage efficiencies of geometric mode. The additional cost would be offset, however, by the saving incurred by not having full geometric capability. Together with an OCR/facsimile reader for paper input and a mixed mode printer for output, this type of machine would offer document creation capability lacking only the ability to edit geometric mode figures.

	INPUT	OUTPUT
LOCAL	Keyboard Geometric input unit Facsimile input (page reader) Facsimile input (writing tablet) OCR Pointing device (mouse) Local storage (disc on tape)	Display - bit-mapped, high-resolution Mixed-mode printer Character-box printer Facsimile output Videotex display or store Local storage (disc or tape)
REMOTE	Another MFT Videotex data-base Facsimile sender Single-mode Teletex	Another mixed-mode machine - general purpose MFT - display only - multi-mode printer Single-mode Teletex Facsimile receiver Videotex terminal

Figure 2.3.1: The Environment of a General Purpose MFT

Mixed-Mode Printers

A very important case of a special-purpose mixed-mode machine is the mixed-mode printer, capable of printing any mixed-mode document. Such a printer could accept input from an MFT or from any of the single-mode telematic services.

A simpler mixed-mode printer might be capable of accepting input in only character-box and photographic mode. Such a printer could accept input from an MFT, but only in the two modes, or from a facsimile sender. Since any geometric display based on a bit map can be converted into photographic mode, a printer of this type would be capable of printing any mixed-mode document, provided that it was first converted to dual-mode form.

Optical Character-Reader Plus Facsimile

In order to enter existing paper documents, such as letters or reports containing both character-box and photographic text, it would be necessary to have a mixed-mode machine with the capability to operate in both character-box and photographic mode on the same page.

The layout structure resulting from input of a document in this manner would consist of blocks of character box text and blocks of photographic text, where the photographic text is that portion of the content that was not recognized as character box. Note that the information contained in the photographic text could in fact be unrecognized character box or a mixture of character box and non character box information. Note also that the blocks comprising the layout structure would be either photographic or character box and would not be superimposed.

Once such material had been entered into an MFT, it could then be converted to editable form by user interaction as described in Section 2.3.3.8. This machine is the input counterpart of the dualmode printer described above.

Forms-Based Terminal

A mixed-mode terminal specifically for displaying and completing forms is another important case of a special purpose mixed-mode machine. Such a terminal would be capable of displaying forms, perhaps using only character-box and photographic modes, or only character-box and geometric modes. The forms could either be stored internally or received, perhaps partially completed, from another MFT. Local input could be constrained to keyboard for completion of the forms.

A more powerful forms-based terminal might also have the capability to create new forms using character-box and one of the other modes.

2.3.3 Typical User Operations and Requirements

In this section we describe a number of operations which a user might have to carry out in creating and sending a mixed-mode document. The purpose is to set the stage for the detailed discussion of machine capabilities that appear in subsequent sections and to illustrate, from the point of view of the manufacturer, the potential range of demands which a general-purpose machine might have to meet.

2.3.3.1 Creation of the Generic Logical Structure for a Class of Documents

The generic logical structure of a class of documents may be either a model known to the user and followed by him without prompting from the MFT or it may be a model known to the MFT which the user is constrained and prompted to follow in entering the specific logical structure. (For instance, a standard letter or a standard report representation.) In the latter case provision must be made within the machine to allow the generic structure to be entered.

Entering and editing a generic logical structure would normally require use of the following input devices:

- Keyboard and pointing device for input of commands and identifiers to define the various elements of the structure and their interrelationships, and for fixed information content. (See Section 2.3.1 for typical lists of elements.)

- Facsimile or geometric input devices for entering logos, letterheads, cover-page designs, etc. In some cases these might alternatively be entered directly as layout structures for specific pages. Standard logo and letterhead patterns could also be stored locally and retrieved on demand, if a facsimile device was not required for other purposes.

2.3.3.2 Creation of Generic Layout Structure for a Class of Documents

There will be a very widespread requirement for generic layout structures to be known to the MFT so as to permit the use of standard letterhead, memo forms, forms of all types and title pages. The generic layout structure must also be carefully linked to the generic logical structure in order to provide for user prompts when entering specific content. Provision must therefore be made in the MFT for entering such structures.

Sources of input would normally be the same as those listed for the generic logical structure in Section 2.3.3.1. Existing layout structures for other classes of documents may also be sources of input (particularly for fixed elements of structure).

The generic layout structure will normally make explicit the location of blocks on pages. Some blocks may be defined in shape and size but otherwise left empty to accommodate eventual specific content. For instance, a signature block or a title block located so as to show through a window in a standard report cover.

2.3.3.3 Creation of a Letter or Memorandum

Letters and memoranda will normally be created within the framework of a generic logical and layout structure. The MFT must therefore be capable of displaying these structures and prompting and constraining the user to follow them.

Entry of the alphanumeric text will normally require the provision of word-processing capability.

A specific MFT may either provide for entry of the alphanumeric text directly into the generic layout structure or it may permit separate entry of this text as a logical text object. In this latter case provision must be made for subsequent formatting of the logical objects according to the generic layout structure.

Where a signature is required, it may be inserted in the document in one of three ways:

- directly, by means of a writing tablet;
- from a facsimile machine reading a signature written on paper;
- it may already be stored in the machine.

When a signature is entered by any of these methods, the user may need to request scaling up or down in size to fit the space provided in the document.

Security problems for signatures used in a mixed-mode environment are discussed briefly in Section 2.3.3.10.

2.3.3.4 Completion of Forms

To complete a form, a user would follow the procedure described below:

- Call up the generic layout structure of the form.
- Enter alphanumeric text directly into the layout structure of the form, probably with automatic cursor movement from one field to the next. Editing facilities would be a subset of the word-processing facilities of the MFT using consistent commands.
- Enter a signature using any of the means described in Section 2.3.3.3.

There are occasions in filling out paper forms when the information will not fit the space provided. In that case one of two approaches is usually followed:

- The information is written on the form overlapping with some other space.

- The information is written on a separate sheet and appended to the form.

Some provision for this eventuality will be required with many electronic forms.

2.3.3.5 Complex Documents Not Requiring Scaling

MFT's will be used widely for the creation of relatively complex documents, primarily reports, which combine a complex generic logical structure with text objects using any of the three basic modes: character-box, photographic, and geometric.

For such documents, the basic level of capability which a user will require is to be able to assemble, edit and format the necessary text objects and layout blocks without the capability to scale any of them up or down in size. This means that the user may combine alphanumeric elements into a document, with figures and pictures entered from any of the sources shown in Figure 2.3.1, but figures and pictures may be included only in their original size. If they originally occupied a full page, they will occupy a separate, full page in the new document.

Normally figures and pictures will be entered or received as a full page, since this is the normal mode of operation for most facsimile and geometric input devices. However, if the content could be included within a block of less than page size, it should be possible for the user to modify the size of the block by trimming unused space. In this case the user could then format the block into a page containing other blocks of any type. This is a trimming and formatting operation, not a scaling operation. Given the capability to superimpose blocks in a mixed-mode document, the trimming operation might not be strictly necessary; other blocks could be superimposed on blank spaces to obtain the same effect.

Creating a document of this type on a MFT can be compared to the normal "cut and paste" mode of creating paper documents that will be reproduced using normal reprographic techniques. A basic MFT, intended for the creation of mixed-mode documents, should incorporate all the capabilities which can be realized using paper "cut and paste" methods.

In creating a document in this way, the author will make considerable use of memory in a variety of ways. First, he will assemble a collection of "bits and pieces": logical text objects and layout blocks obtained from various sources which should be stored as a collection of independent but related items. A system with multi-level filing capability might store these as a number of "documents" in several "file-folders" contained in a single "drawer". Assembly may occur in different sessions prior to creation of the final document. Similarly, there will be a number of stages of intermediate documents before the final one is created. All these must be stored in a manner which provides ready access and convenient assembly.

2.3.3.6 Complex Documents Requiring Scaling

For more sophisticated documents, a user would require a MFT capable of all the operations described in the previous section but also capable of scaling photographic and geometric blocks in size. Thus a figure occupying a full page when entered or received might be reduced to a smaller size in order to incorporate it with other objects in a single page of the new document.

2.3.3.7 Editing Complex Geometric and Photographic Objects

Users will require, in varying degrees, the ability to create and edit geometric and photographic objects and composite objects which combine alphanumeric elements with one or both of these modes. Alphanumeric text, especially in the form of legends, is a necessary part of many figures. The following paragraphs review several different levels of sophistication.

A user, having entered a photographic object, might wish to edit it in several ways:

- By changing its boundaries in a more complex way than by simple rectangular trimming. For instance by showing a portion of it within a circular boundary.

- By blanking out certain portions or by superimposing geometric or freehand material.

- By superimposing legends either with the photographic material showing through, or on a blank background within the object.

The last two of these operations could be achieved by use of overlays referenced to the original block, but it would be necessary to display the photographic object at the same time as the new material was being superimposed.

The above operations might also be required in the case of geometric text objects. The method of overlays is an adequate method of proceeding where a geometric object is available only in non-editable form, as in the case of material received in videotex mode.

There will also be a requirement for editable geometric objects which contain logical substructure. For instance, suppose that a drawing of a house is a part of a geometric object. In editable form, including logical substructure, it would be possible to move the house around in the overall object as an entity. In such cases, legends should be tied to logical objects within an overall composite object (alpha-numeric and geometric).

In constructing complex composite objects, a user might wish to combine all three basic elements: alpha-numeric, photographic and geometric. For instance, photographic material might be contained within geometric figures, such as polygons and circles, which form part of a larger geometric object combined with text.

At the present time, logical substructure of a geometric object cannot be transmitted via the Videotex service. Such capability may be added in the future.

2.3.3.8 Creating Logical Structure for an Existing Layout Structure

There will be cases where a document is received in text-image-representation which the user wishes to edit before inclusion in a new document. Before editing can be accomplished in a way compatible with the word-processing facilities of the MFT, it is necessary to insert logical structure. Thus, the user may wish to identify paragraphs and headings as such rather than leave them identified only by their location in the received layout structure. If the received layout structure is not satisfactory, it may require editing as well.

This operation will be particularly common when inputs for documents are received from communicating word-processors or single-mode Teletex machines which are not capable of transmitting documents in text-processable or full-text representation.

2.3.3.9 Transmission to Facsimile and Other Machines

Once the document has been prepared the user may wish to print it locally or to transmit it to a remote machine which may be any one of those shown in Figure 2.3.1.

A mixed-mode machine may be capable of receiving in only one or in any of the mixed-mode representations: TIR, TPR or FTR.

A single-mode machine will be capable of receiving only certain parts of the document in their original mode. However, a facsimile machine, although only single mode, is nevertheless capable of printing the document in its entirety, provided the document is first converted from mixed-mode to facsimile. A general purpose MFT should therefore be capable of carrying out this conversion. Similarly, a general purpose MFT should be capable of transmitting the appropriate parts of a document to any single-mode machine.

2.3.3.10 Security and Complexity Problems with Signatures

When a handwritten signature is used in a mixed-mode machine and transmitted to another MFT as part of a document, either of the MFTs could be used to apply the signature to any other document. Thus it is unlikely that a signature will ever have any significance for authentication purposes in a mixed-mode environment. True authentication can only be provided by electronic, digital signatures. ISO SC20 is studying this and other related security matters.

A further problem with the inclusion of signatures in simple mixed-mode documents was identified in Section 2.3.3.3. It may prove difficult to enter them in the correct size to fit the space on the document since it may not be possible to provide a display on which the user writes the signature directly. A scaling operation would then be required. The effect of this is to require a relatively sophisticated machine even to produce otherwise simple documents such as letters and memoranda. Whether this will prove worthwhile is an open question, especially in view of the security problems mentioned above.

2.4 MFT Functional Model

2.4.0 Introduction

The previous section has made it clear that an MFT does not consist of a single hardware configuration with a fixed set of capabilities. Rather, a wide variety of systems covering many configurations and possessing many different capabilities fall under the banner of MFT. For this reason, no single all-encompassing set of functional requirements can be specified for an MFT. The requirements will vary according to the selected configuration and the functionality to be supported by that configuration. It is important therefore to have a flexible MFT model which encompasses all possible terminal variations. This model can then be used as a consistent basis for defining the requirements of individual terminals.

The general MFT model presented in this section focuses on text processing functions, i.e., behaviour related to transformations of the content, structure or representation of text. Convenience functions such as instructional aids, although useful from a human engineering viewpoint, are not essential to the overall understanding of MFT operation.

2.4.1 MFT Facilities

Individual text processing functions may be combined into logically distinct groups, called facilities. Each facility is associated with a related set of text transformations. An MFT terminal provides up to five facilities, namely text editing, formatting, imaging, interchange and storage/retrieval. Not all facilities need be supported by each MFT, but at least two (interchange and one other) must be supported to some degree by all terminals.

Each facility is considered to be independent, that is the functions associated with one facility do not depend on functions associated with any other facility. The implication of this is that an MFT can be configured from arbitrary combinations of facilities. In practice, certain combinations are more useful than others and consequently may be more frequently found in real implementations. This is discussed further in Section 2.4.2.

Also in real implementations, certain functions may not be totally independent in the sense that a single user command might invoke several functions of different facilities. Such real-life considerations do not invalidate the model; it is always possible to logically view a composite command (one that invokes multiple functions from different facilities) as a series of single-function commands.

In the following, each of the five MFT facilities is defined, the set of text transformations associated with each facility is identified, and examples are given of these transformations.

2.4.1.1 Text Editing

Definition: The text editing facility supports the definition and alteration of the content as well as the logical and layout structure of a text object or document. This facility includes the capture from a local input device (not a communications line) of text content, i.e., the individual graphic elements, along with its type. The type of text being entered may be specified either explicitly or implicitly (e.g., the nature of the input device determines the text type).

This facility includes text entry functions because in general they cannot be clearly separated from text modification functions. This is particularly true in an interactive environment where an operator typically intermingles entry operations such as character entry from a keyboard with modification operations such as text deletion and repositioning. To consider text entry as a separate facility would be to introduce an artificial distinction that is meaningless from the user's perspective.

In the same way, functions related to the definition and modification of the layout structure of text are often inextricably intermingled with functions defining the logical structure. Therefore, they are most appropriately grouped into the editing facility.

Also, since editing includes all functions related to transformations of the logical structure of text, this facility incorporates functions for transforming a document having only layout structure to one having both.

The following transformations are supported by this facility, as illustrated in Figure 2.4.1.

<u>content transformations</u>
(1) graphic elements + structure information => text objects
(2) old objects == new objects

<u>structure transformations</u>
(3) old or no logical structure => new logical structure
(4) old or no layout structure => new layout structure

<u>representation transformations</u>
(5) input device representation => internal representation

<u>Examples:</u> Examples of each of the above transformations are given below:

(1),(3),(5): A common example is the interactive text processing terminal, where alphanumeric text entry is performed by a person via a keyboard and pictures are entered via a facsimile scanner or graphics tablet. The type of text being entered is identified implicitly by the nature of the input device.

(2): The addition/deletion of words/sentences to a paragraph.

(3): A document received from a Teletex terminal has layout but no logical structure. Logical structure could be added by identifying titles, paragraph, etc. This might be done interactively through visual inspection of the document or an appropriate algorithm might be devised to perform the mapping automatically.

(3): Layout directives may be included in the logical structure to improve the chances of maintaining the original document layout.

(3): A geometric diagram is added to a document and a reference to it is inserted into the text. Note that the act of removing the logical structure of a document altogether is a possible transformation.

(4): The interactive definition of the layout structure of a document for later input to a document formatter.

(4): Changing the margin settings of a document.

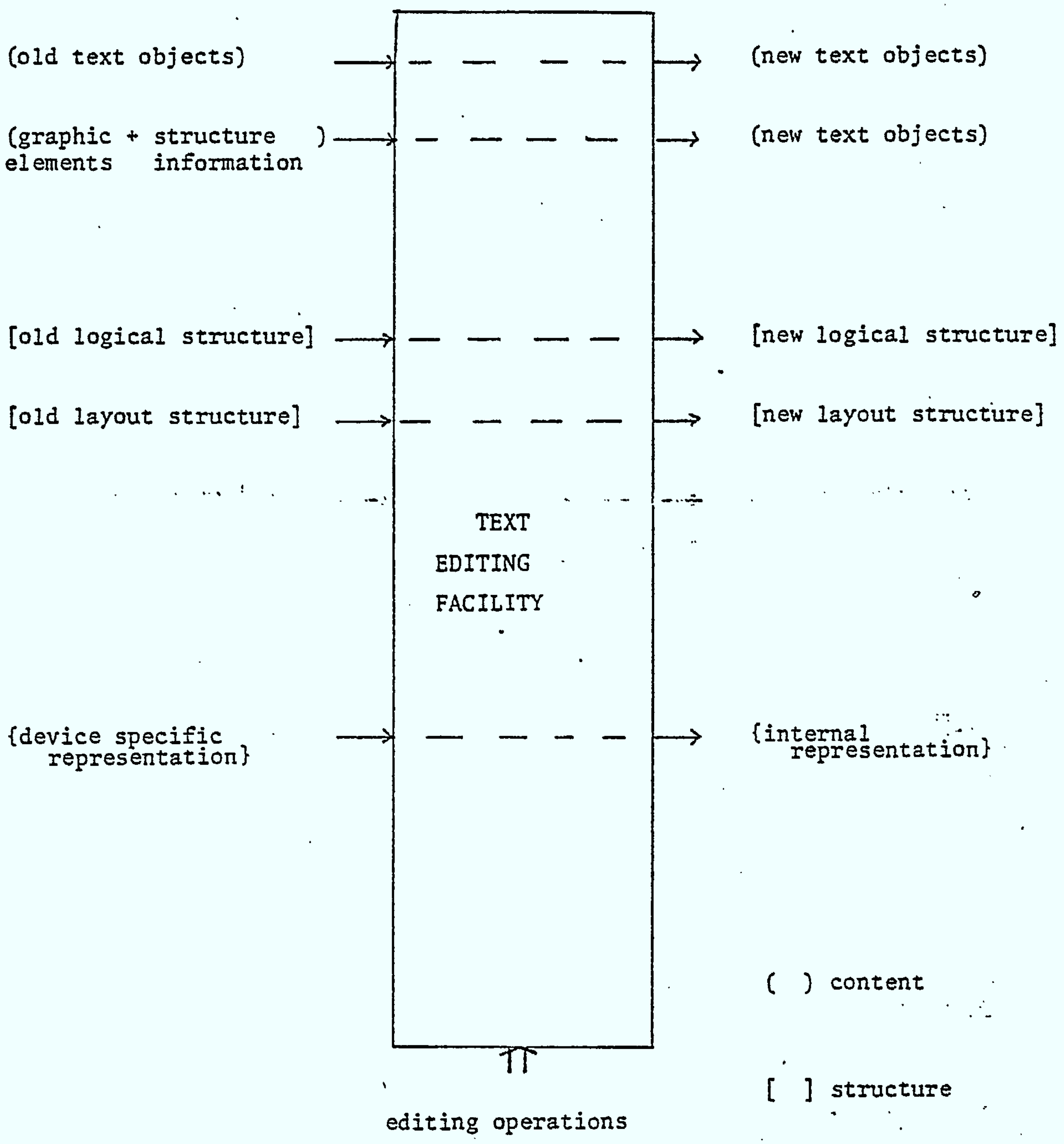


Figure 2.4.1 Transformations Supported by the Text Editing Facility

2.4.1.2 Text Formatting

Definition: The text formatting facility supports the transformation of the logical structure of a document into a layout structure as well as the transformation of an abstract layout representation (one that is suitable for editing) into a concrete one (one that is suitable for imaging). These transformations are illustrated in Figure 2.4.2 and summarized below:

structure transformations

(1) logical structure without layout directives + generic layout structure
=> layout structure

(2) logical structure with layout directives + generic layout structure
=> layout structure

representation transformations

(3) internal abstract layout representation => internal concrete layout representation

(4) internal logical representation => internal concrete layout representation

Examples: Specific examples of each of the above transformations are given below:

(1),(4): A manuscript containing only logical structure is processed by a document formatter according to a generic layout structure definition. The output is suitable for imaging on a typesetter.

(2),(4): This transformation is similar to (1) above, except that the resulting layout structure is constrained by the layout directives present in the text.

(3): An abstract layout representation produced as a result of an interactive editing session defines how a printed document should be formatted (e.g., it defines page size, margin settings, paragraph indentations, etc.) but does not actually position the text in the desired locations. This document description is then filtered through a document formatter which performs such functions as justification, word wrap and hyphenation to achieve a concrete representation of the desired document. This representation is now in a representation that is suitable for imaging. This type of transformation is typical of text such as nroff, Scribe

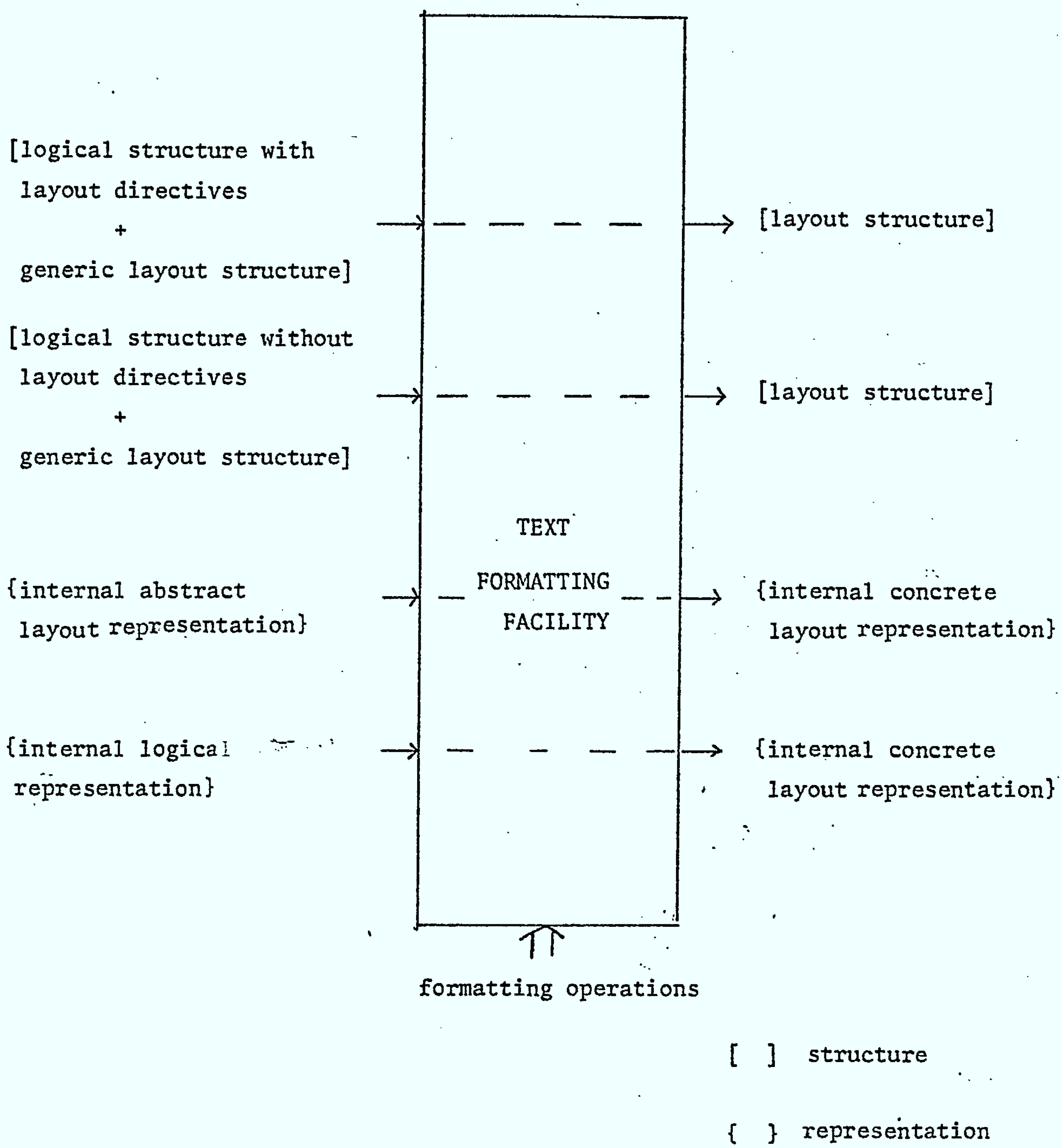


Figure 2.4.2 Transformations Supported by the Text Formatting Facility

and TEX, where document composition is separate from document formatting. See Section 2.4.4 for a more detailed discussion.

(4) The operation described in examples (1) and (2) above may result in the transformation of the document representation within the MFT from an abstract representation to a concrete one suitable for imaging. Whether this transformation is required or not depends on the nature of the internal representations of the two document structures. A situation where a transformation is required is when an equation is represented in logical terms as an alphanumeric character string but in layout terms as a sequence of mathematical symbols.

2.4.1.3 Text Imaging

(Synonyms are text rendition, viewing, presentation).

Definition: The text imaging facility supports the adaptation of a document or text object to the characteristics of a display device (hard or soft copy) and the generation of an image of the text on that device in a way consistent with the document or text object layout structure. Thus, the following transformation is supported, as shown in Figure 2.4.3:
Representation transformation:
internal concrete layout representation => device-specific representation

Examples: During the printing of a document, the information defining the layout structure is translated into print commands which are output to the printer along with the text content. A similar transformation is performed when displaying a document on a video screen. Scrolling and windowing of display are also imaging functions.

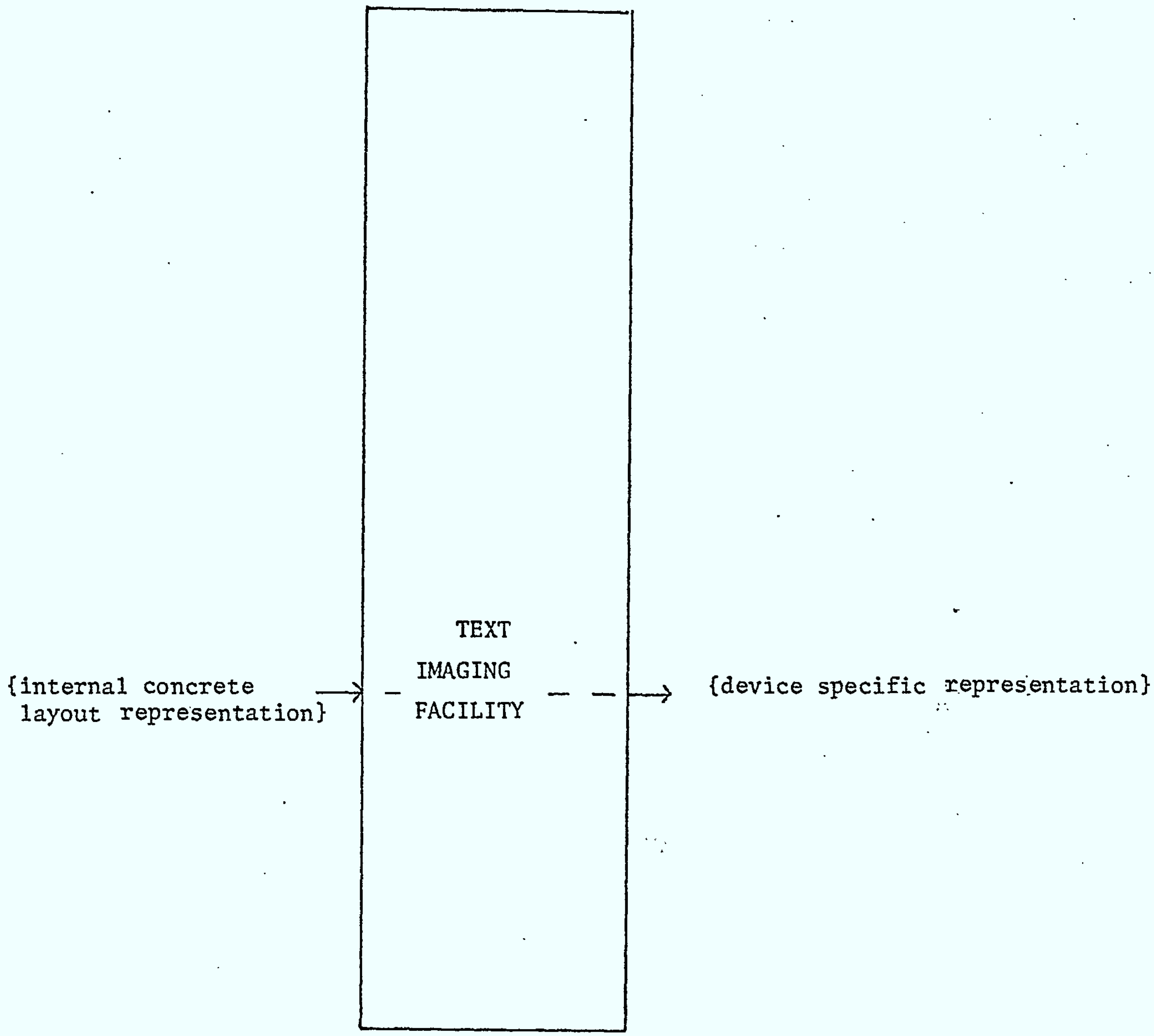


Figure 2.4.3 Transformation Supported by the Text Imaging Facility

2.4.1.4 Text Interchange

Definition: The text interchange facility supports memory-to-memory exchange of mixed-mode text between two MFT's or the exchange of single-mode text between an MFT and any device supporting one or more of the three following Telematic services: Teletex, Videotex and Datafax (Group 4 Facsimile). (Note that this interpretation of text interchange is more restricted in scope than the one used in ISO TC97/SC18, which includes store and forward messaging as well as physical exchange of media (e.g., diskettes)). The interchange facility includes all functions for controlling both the transmission and reception of text.

The following transformations are possible, as illustrated in Figure 2.4.4:

representation transformations:

(1) internal representation (logical + layout structure) => FTR

(2) internal representation (logical structure only) => TPR

(3) internal representation (mixed-mode layout structure) => TIR (mixed-mode)

(4) internal representation (single-mode layout structure) => TIR (mixed-mode)

(5) internal representation => TIR == internal representation
(mixed-mode layout structure) (single-mode) (single-mode)

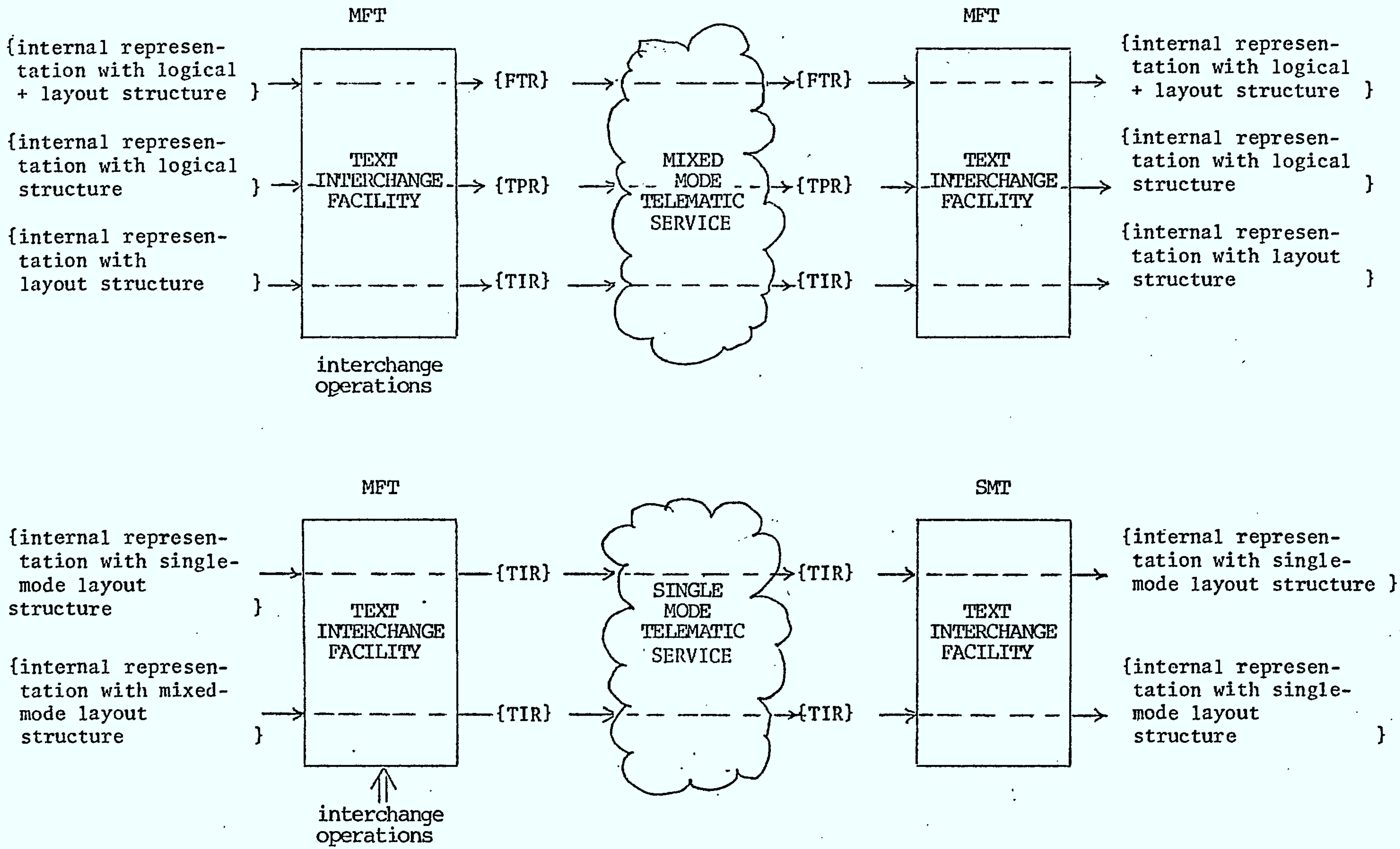


Figure 2.4.4: Transformations Supported by the Text Interchange Facility

Examples: The first three transformations above are used when exchanging text between two MFT's. The third transformation would likely be the most common one for it is sufficient for most business correspondence requirements (e.g., letter including logos, alphanumeric text and a bar chart).

The last two transformations are used when an MFT exchanges text with a single mode terminal. When transferring a mixed mode document to a single mode terminal, only a limited amount of information associated with the graphic element type supported by the destination terminal can usually be preserved in the interchange representation of the text. However, if the destination terminal is a facsimile machine and the sending terminal has a fallback capability allowing the entire document to be transformed into facsimile representation, then all content and layout information may be preserved. Because of the differences between the various telematic services, a different TIR (i.e., a different transformation) may be required for each service.

It should be noted that no hard boundaries exist between the three types of interchange representations; they simply represent points in a two-dimensional space with amount of logical and layout information as the axes. The existing Telematic services all support a limited TIR. One would expect that future telematic services will first support mixed-mode TIR (e.g., mixed mode Teletex) and later add some TPR capability. This will likely result in an interchange representation that is more than either pure TIR or pure TPR, but not quite FTR. Depending on how future interchange representations are defined, they might even be interchangeable with existing Telematic services (e.g., Teletex, Videotex).

2.4.1.5 Text Storage/Retrieval

Definition: The Storage/retrieval facility supports the temporary and long term storage of text objects or documents on a local storage device and the subsequent retrieval of stored information. The storage function includes the assignment of a name and possibly other attributes to the stored text. At least three levels of functionality are associated with this facility:

(1) temporary storage for sake of continuity during text preparation (e.g., during an editing, formatting or interchange operation)

(2) simple filing and retrieval such as what is done currently in offices - possibly with an indexing capability

(3) sophisticated database-oriented text filing and retrieval assisted by a document retrieval system.

The following transformations are possible, as illustrated in Figure 2.4.5:

representation transformations

(1) internal representation => device-specific (storage) representation

(2) device-specific representation => internal representation

Examples: An example of the use of temporary storage is a cut-and-paste operation, where portions of a document are isolated, stored temporarily on disc and then reinserted in a document in a new location.

The most common use of this facility is for the medium term storage of documents as named files on a disc or tape. Document retrieval is the usual first step in an operation involving the editing, formatting, imaging and interchange facilities.

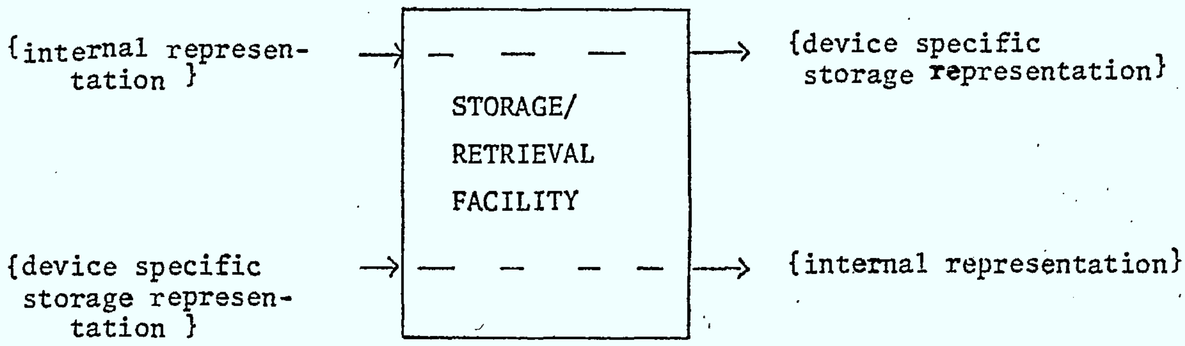


Figure 2.4.5 Transformations Supported by the Text Storage/Retrieval Facility

A more sophisticated use of the storage/retrieval facility is a database server (e.g. videotex information provider) where the only facilities supported are storage/retrieval and interchange. Retrieval requests are received via the interchange facility, processed by a powerful query processor which selects the desired information and returns it again via the interchange facility. An on-line subscriber directory service such as those being proposed by CCG and CNCP for their Teletex services would also have these characteristics.

2.4.2 Facility Configurations

As discussed in Section 2.4.1, not all MFT's need support all five facilities defined above. In fact, the minimum requirement is two, of which one is interchange. While all facilities are essentially independent, practical considerations eliminate some unlikely combinations.

In the following, some of the more likely combinations of facilities are identified by possible hardware configurations.

Configuration 1: (an OCR/fax scanner machine)	interchange editing
Configuration 2: (mixed-mode printer supporting interchange of TIF documents only)	interchange imaging
Configuration 3: (a videotex database server)	interchange storage/retrieval
Configuration 4: (OCR + printer)	interchange editing imaging

Configuration 5: (mixed-mode printer accepting both TIF and TPF documents; TPF documents would be printed according to a predefined layout structure)	interchange imaging formatting
Configuration 6: (videotex terminal)	interchange editing formatting imaging
Configuration 7: (system with keyboard, disc, graphics input device, bit-mapped display, and mixed-mode printer)	interchange editing formatting imaging storage/retrieval

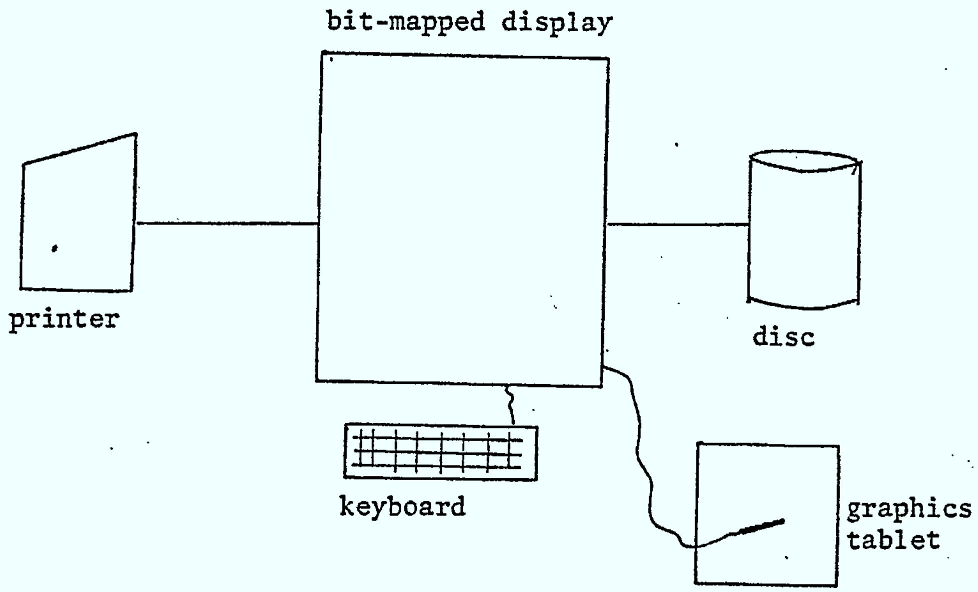


Figure 2.4.6 Configuration of WYSIWYG Text Processor

2.4.3 Examples of Operating Environments

Although a given configuration of facilities will provide the same set of text transformations regardless of implementation, the way in which different facilities interact may vary considerably from one implementation to another. The purpose of this section is to demonstrate by example some of the ways in which facilities interact and text transformations take place.

In the following, three identical configurations of hardware and facilities (corresponding to configuration 7 above) are considered. These configurations represent three quite different but typical operating environments of existing text processing systems. The discussion will serve to illustrate how the general MFT model presented earlier maps successfully to each of these environments.

2.4.3.1 WYSIWYG Text Processor

A WYSIWYG (What You See Is What You Get) text processor is one where an operator sees on a display screen the actual layout of the text as it will appear on a hard copy device. In this environment, most formatting operations take place immediately on the displayed image, thus giving the user instant feedback. The degree to which the final layout can be represented on the screen is technology dependent. The standard 80X24 CRT display is capable only of accurate display of single-spaced, non-proportionately-spaced alphanumeric text. However, with bit-mapped raster displays, it is possible to display virtually any kind of information, including photographic and geometric pictures.

This kind of environment eliminates off-line text formatting; proportionately-spaced text, font changes, highlighting, complex layouts including embedded equations and pictures can all be achieved interactively. The text editing, formatting, imaging facilities are all tightly intertwined.

Consider the configuration of Figure 2.4.6. It consists of a bit-mapped raster display, a graphics printer, local disc storage, a keyboard and a graphics tablet. This system is capable of generating all three types of graphic elements and of combining them in a mixed-mode document. As the user interacts with the system via the keyboard and graphics tablet to create a new document, each user action (the entry of a command or data) is processed by one facility which in turn may automaticaly invoke other facilities. Thus, a single keystroke may result in a chain reaction of transformations.

Some typical actions are described below and the corresponding transformations are identified:

(1) The user gives a command to create a new document of class "office memo". As shown in Figure 2.4.7, this command is processed by the storage/retrieval facility which retrieves a data structure from disc which describes the properties of that class of document. The corresponding transformation is from disc representation to internal representation. This data structure describes both the generic logical and layout structures. The formatting and imaging facilities are then invoked implicitly to generate an initial display image of the document; this might consist simply of the display of initial layout settings such as margins and tab stops.

(2) The user enters a paragraph of alphanumeric text (Figure 2.4.8). Each character is processed initially by the editing facility which translates the character from the device-specific encoding to internal encoding. As each character is entered, an additional step is taken in the definition of a specific logical structure. The formatting facility is invoked implicitly to verify that the character is placed in the appropriate position in the document (functions such as word wrap and hyphenation take place at this stage). As with logical structure, a specific layout structure is progressively being defined with each new character. The imaging facility is then invoked to make each new character visible on the screen. When all the text has been entered, the user must somehow indicate to the system that a new logical object (a paragraph) has been defined. The most unobtrusive way is perhaps to have the Carriage Return key signal the end-of-paragraph condition. This results in the making of an appropriate entry in the internal data structure representing the specific logical structure of the document. The formatting and imaging facilities may optionally be invoked to position and display a visible representation of the end-of-paragraph marker, perhaps in the form of a special character.

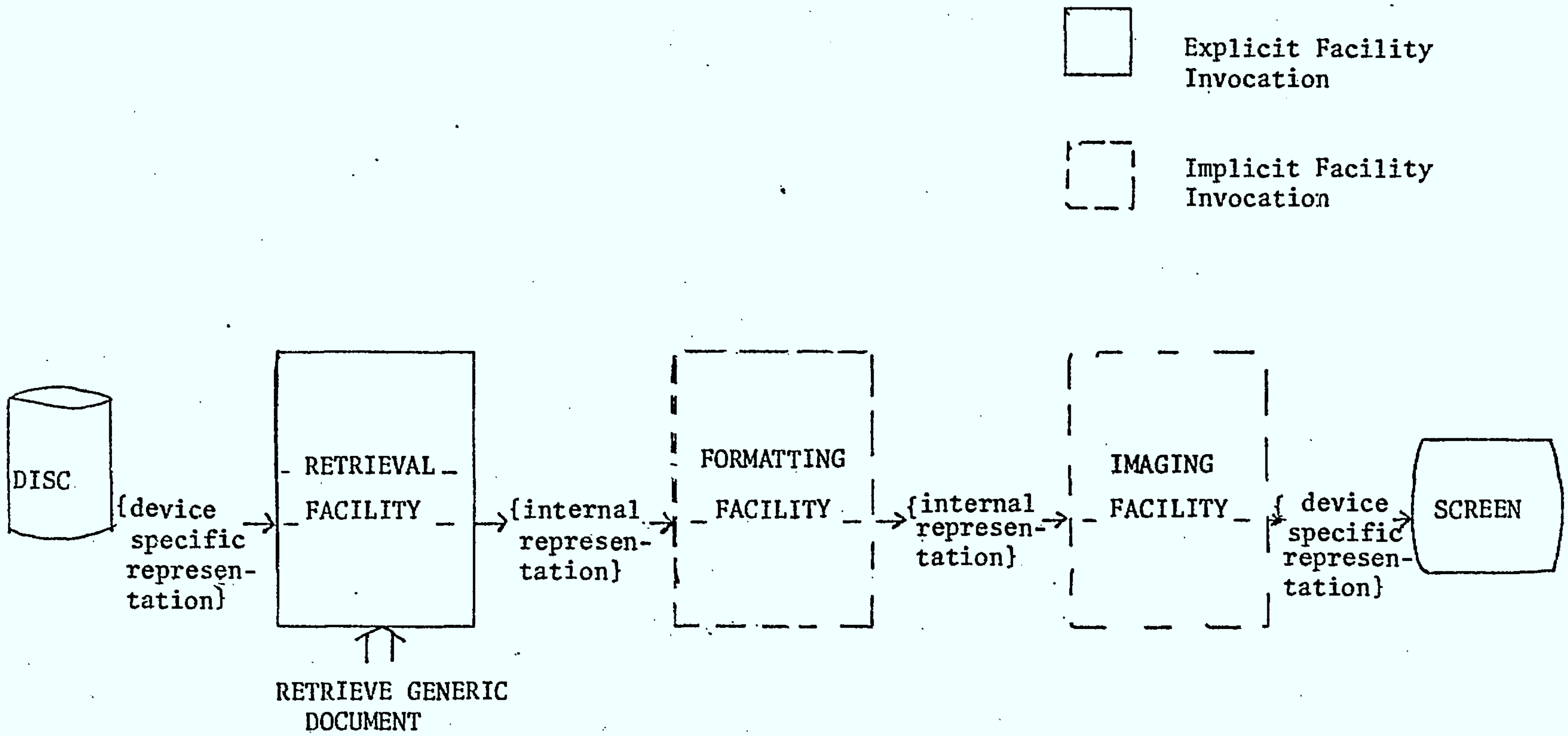


Figure 2.4.7 Transformations Resulting From a "Create Document" Command

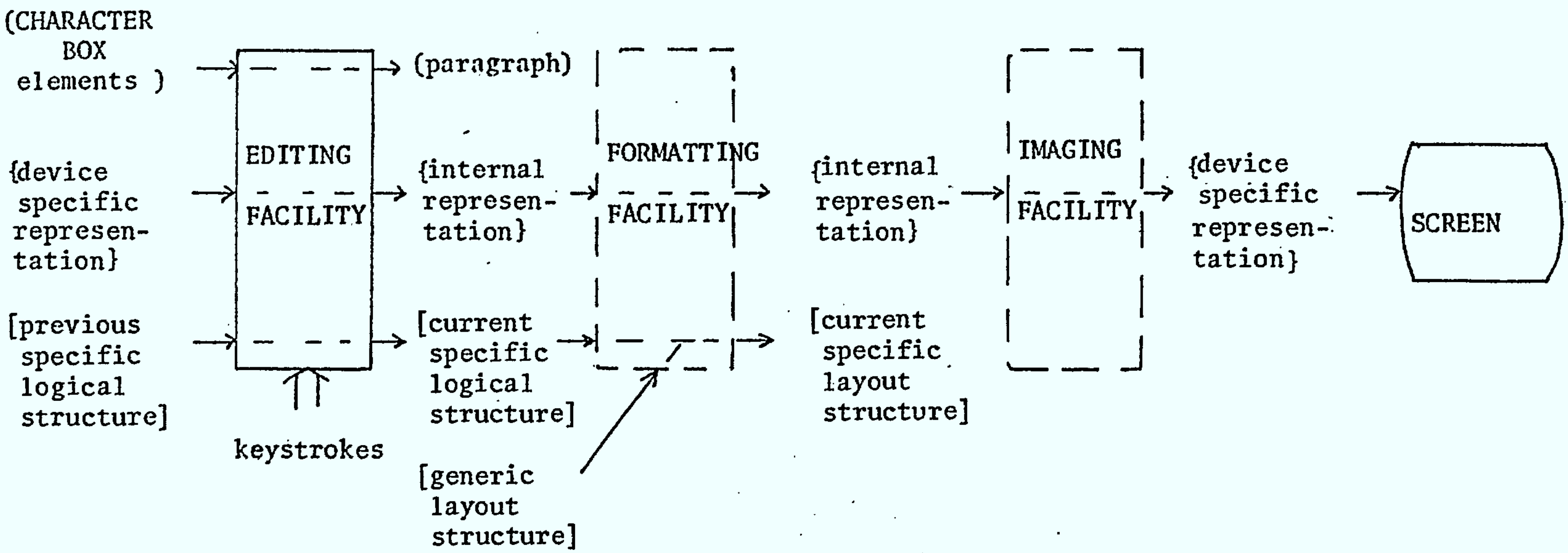


Figure 2.4.8 Transformations Occurring During Entry of a Paragraph of Text.

(3) After entering the text of the memo, the user moves the screen cursor to the bottom of the page. Cursor movement directly affects the displayed image without direct effect on the logical or layout structure of the text. Thus, cursor control commands are processed directly by the imaging facility, as shown in Figure 2.4.9.

(4) The user enters his or her signature via the graphics tablet (Figure 2.4.10). As with alphanumeric text, the user input is processed initially by the editing facility which updates the logical structure and then subsequently by the formatting and imaging facilities to position and display the signature information. Because the signature consists of a different graphic element type, it is represented internally as a separate logical and layout object. Once the signature has been entered, the user may choose to store it as an individual object for insertion into future documents.

(5) Before printing the document, the user decides to justify the text. This is purely a formatting operation and therefore is processed directly by the formatting facility, as shown in Figure 2.4.11.

2.4.3.2 Declarative Document Processor

A declarative document processor is logical structure oriented. The hardware configuration is the same as above. The major operational difference is that the editing and formatting facilities are separate, i.e., they are contained in separate programs which must be invoked explicitly by the user. Examples of document processing systems which can support this two stage approach are Scribe and Scribble. Existing systems of this nature are generally not purely declarative; they support logical structure only incompletely and often include layout information as well.

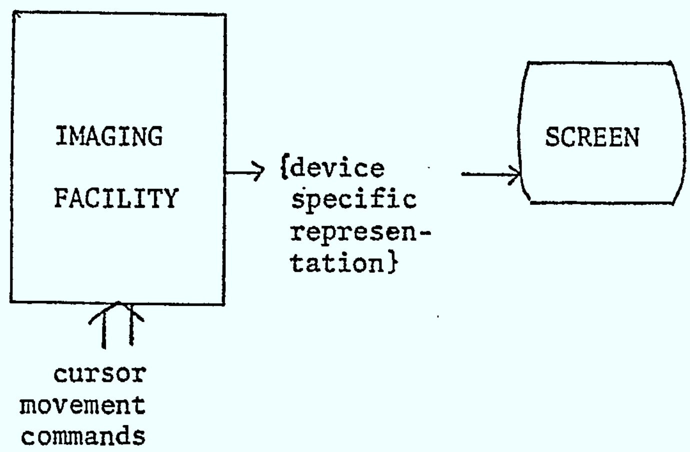


Figure 2.4.9 Processing of cursor control commands

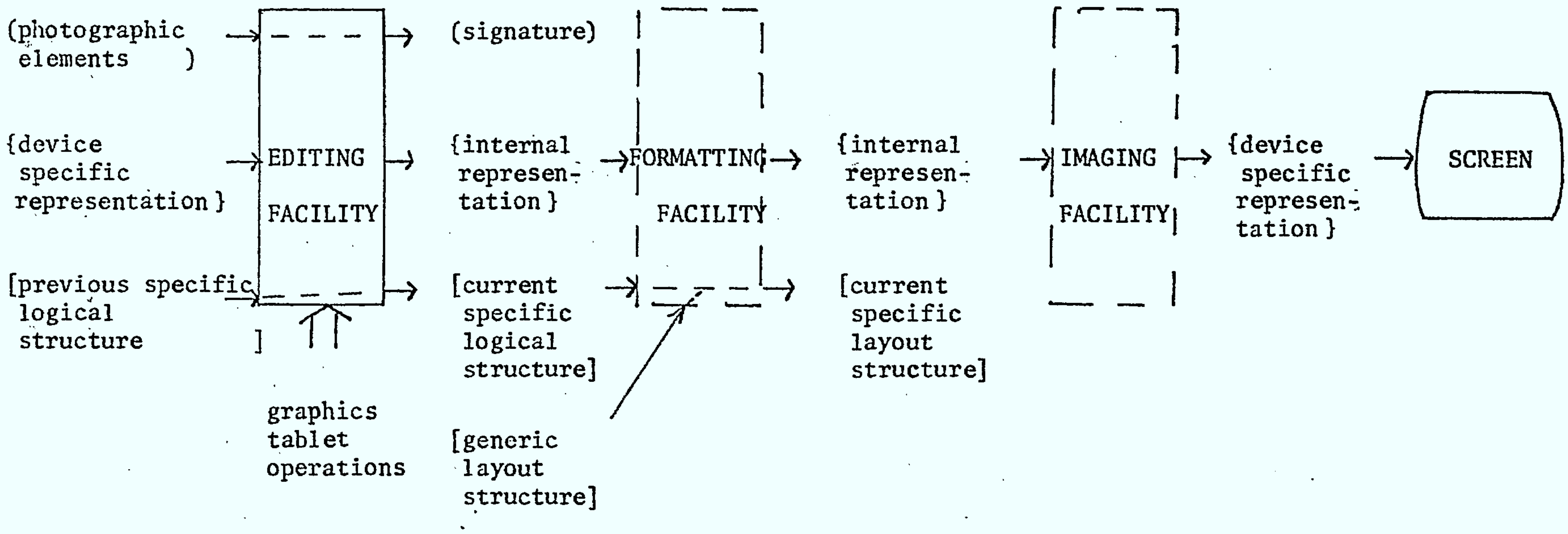


Figure 2.4.10 Transformations Occurring During Entry of a Signature

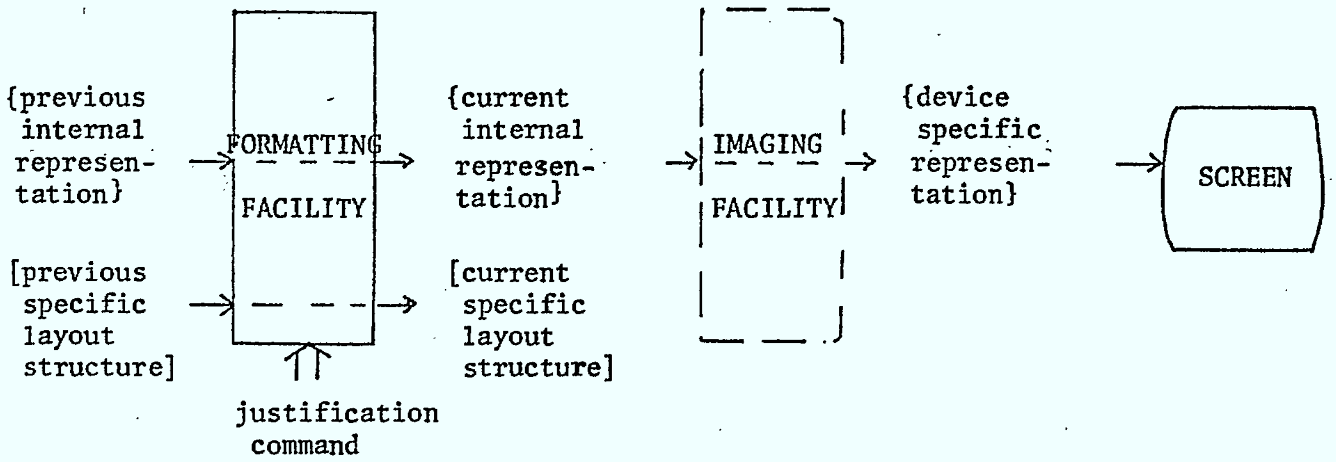


Figure 2.4.11 Effect of a Text Justification Command

(1) During editing (see Figure 2.4.12), the author operates exclusively on the logical structure of text; no control is exercised over the document layout structure at this time. The logical structure of the document is described explicitly through the insertion of markers or tags in the text (hence the term declarative). The existence of a display in the system serves to provide visual feedback to the operator to guide him or her in the correct entry of information. However, the layout of the information on the screen has no direct bearing on the final layout of the document. Of course, the generation of this display requires the presence of formatting and imaging facilities, but these facilities only play a supporting role for the editing facility. The internal data structure controlling the positioning of the text on the screen is not the document's layout structure; it is called here the editor's display structure.

(2) Formatting is handled by a separate program. As shown in Figure 2.4.13, when the formatting program is initiated by the user, the retrieval facility is invoked to load in the "style sheet" containing the definition of the generic layout structure as well layout directives. Next, the retrieval facility loads in the file containing the logical structure. This information is formatted and then imaged immediately on the desired output device or stored as a separate file which contains the specific layout structure.

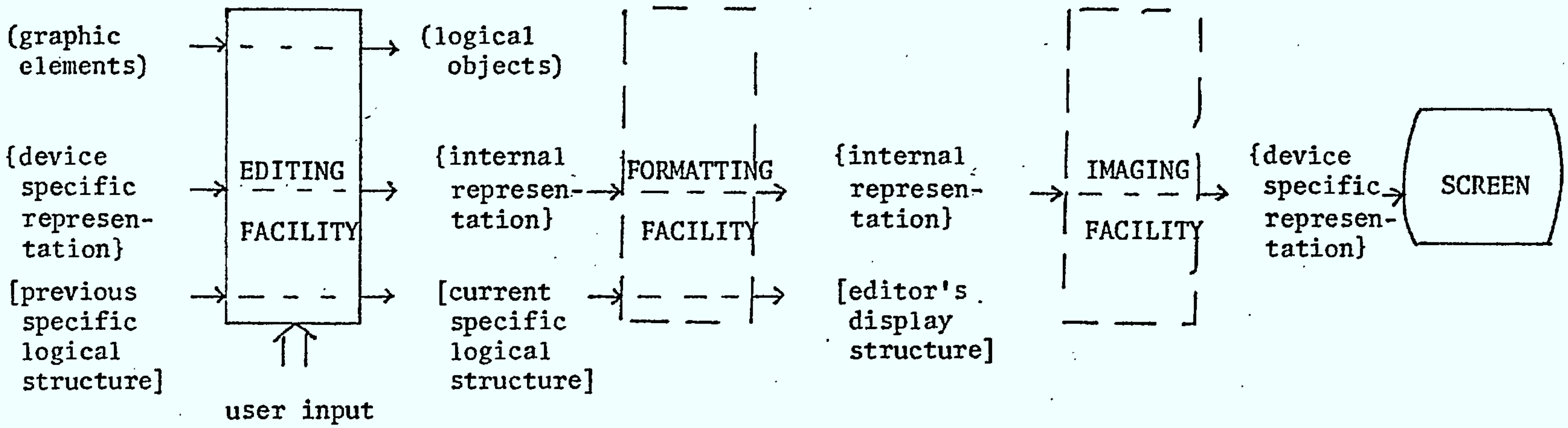


Figure 2.4.12 Transformations During Document Preparation with a Declarative Text Processor

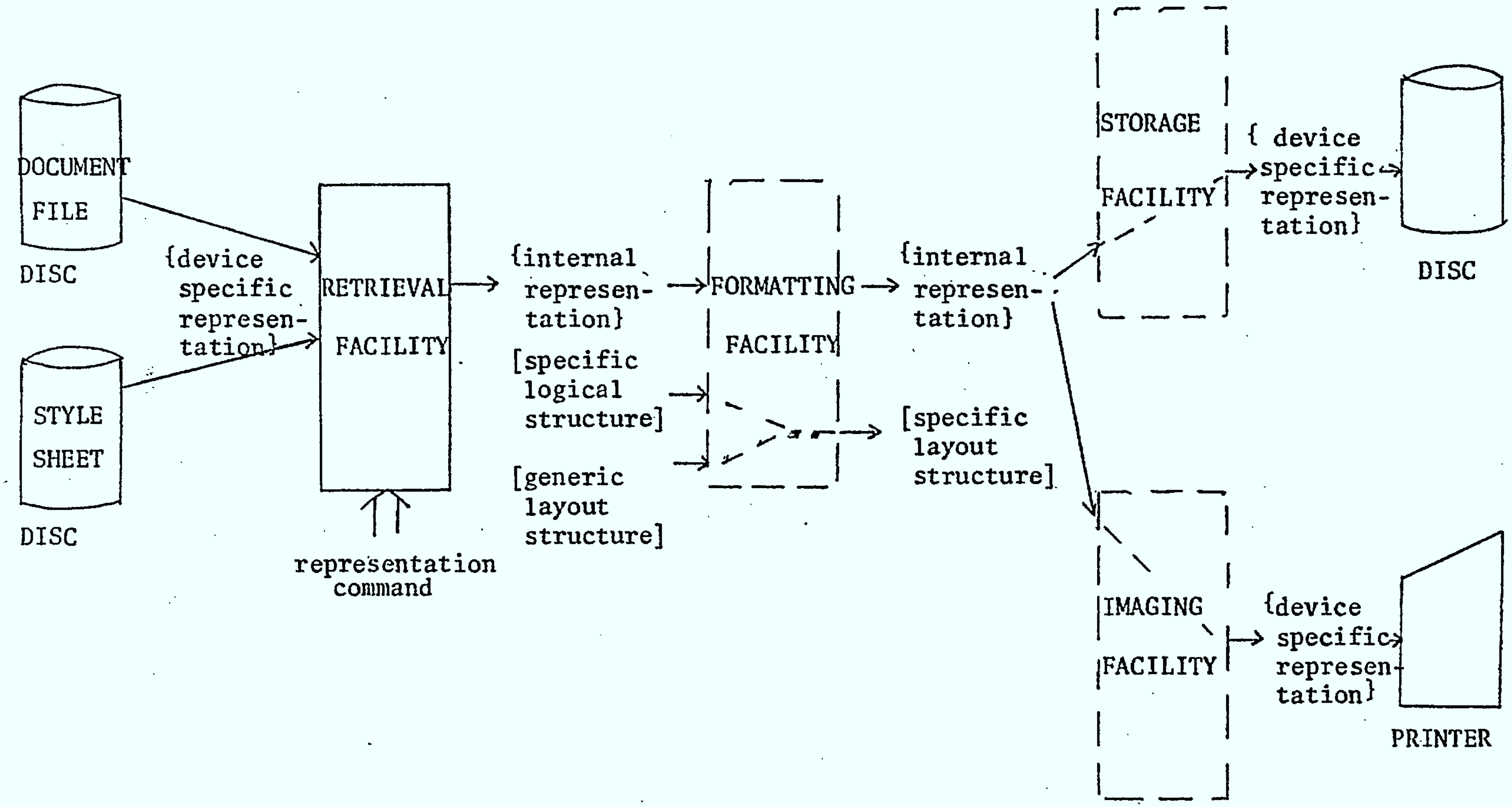


Figure 2.4.13 Transformations During Document Formatting with a Declarative Document Processor

2.4.3.3 Procedural Document Processor

A procedural document processor is layout structure oriented. The same hardware configuration as above is used, but in this case the user never operates on the logical structure of text. As shown in Figure 2.4.14, the user interactively defines the specific layout structure of a document at an abstract level by interspersing formatting commands with text content during document preparation (hence the term procedural). The internal representation of the layout structure generated by the editor is an abstract layout representation. A separate formatting operation is required to generate a concrete layout representation that is suitable for imaging. Examples of document formatters which can operate in this manner are nroff and TEX.

As an example of the difference between declarative and procedural document processors, consider a memo consisting of a title and two paragraphs. The declarative version of the document would simply identify the logical components, namely a title and two paragraphs. The layout information would be derived from the generic layout structure associated with that type of document. The procedural version would include explicit page size and margin setting commands, an explicit command to centre the character string representing the title (it would not be identified explicitly as a title) and "BREAK" commands at the end of each paragraph to instruct the formatter not to enter any more text on the current line, i.e., to enter subsequent text on a new line.

It should be noted that most current procedural document formatters are hybrid systems combining both declarative and procedural features. For example, with nroff and TEX, the file prepared by the user may contain explicit formatting commands such as margin settings, page size, etc., as well as logical markers which invoke formatting macros when the file is processed by the document formatter. In terms of our text processing model, the formatter operates on a document representation containing both logical structure and abstract layout structure. The output is a concrete layout representation.

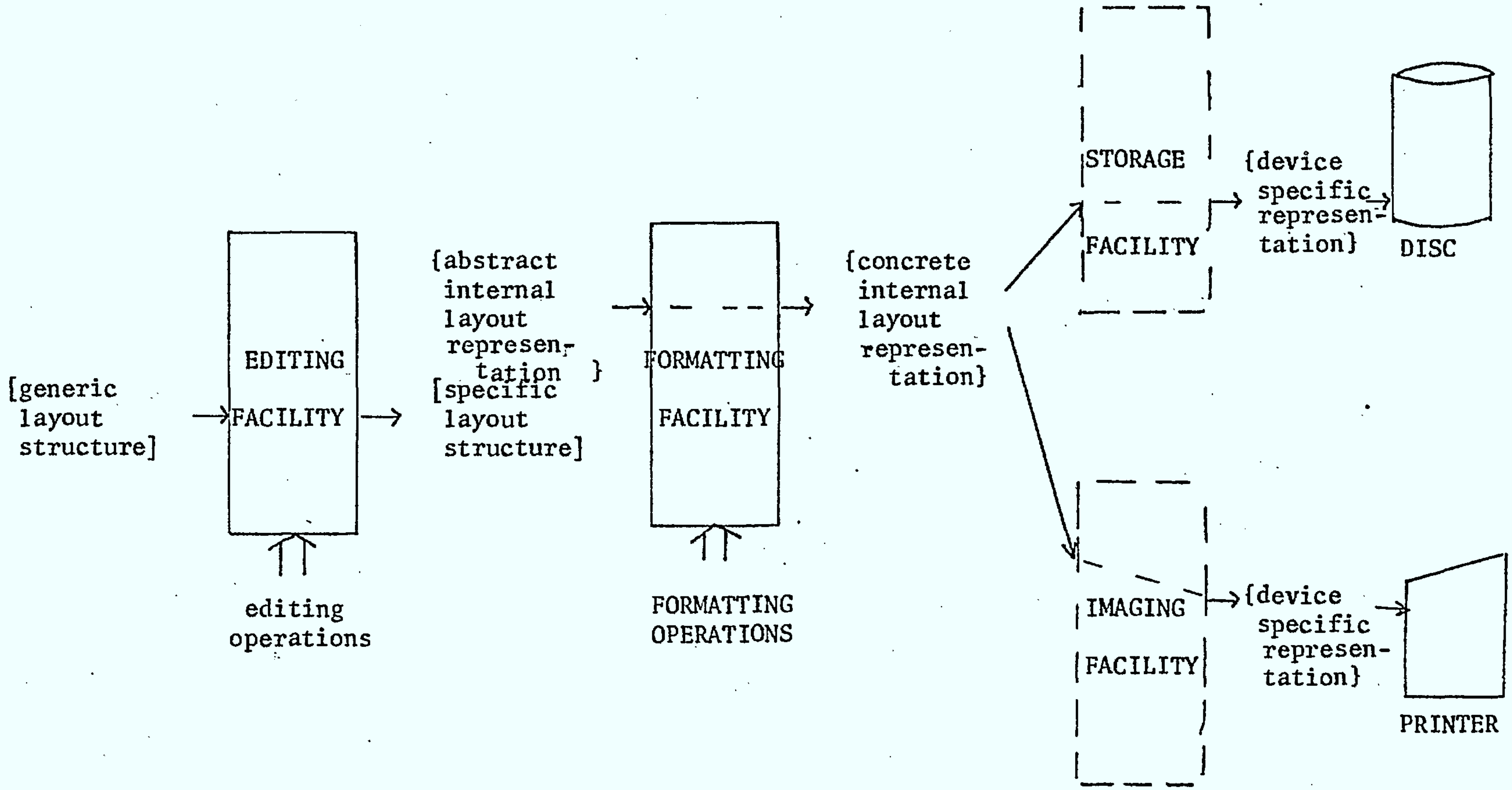


Figure 2.4.14 Transformations During Document Processing with a Procedural Document Processor

2.4.4 Levels of Functionality

The facility configurations identified in Section 2.4.2 are not sufficient in themselves to fully describe the capabilities of an MFT. Within any configuration, there is a wide range of functionality that is possible, depending on the type of graphic element (character, geometric, fax), the type of structure (logical, layout) and the complexity of structure supported by an MFT.

For example, a fully configured MFT supporting the entry of only character text and the imaging and exchange of character and photographic text differs significantly in functionality from one which supports the entry, imaging and exchange of all three kinds of graphic elements. Another example would be the contrast between a basic screen-oriented word processor which could handle classes of mixed-mode documents of relatively low complexity (having a logical structure consisting essentially of paragraphs and pictures) and a powerful multi-window document processor which could handle a wide range of document classes.

2.4.4.1 Determining the Functionality of an MFT

The process of determining the functionality of an individual MFT may be broken down into the following seven steps:

(1) identify text objects: the functionality of an MFT is in large measure determined by the types of objects it supports. The first step in the selection process is then to identify all possible text objects (along with their attributes) from which a subset may be chosen.

(2) identify text operations: each type of text object has associated with it a set of operations (manipulations) which can be performed on it. The second step in the selection process is to identify all such operations. This set of operations, along with the universe of text objects, determines the functionality of an imaginary all-powerful MFT.

(3) select generic document classes: a useful way of categorizing text objects and text operations is according to generic document class (e.g., letter, report, memo, etc.). The selection of the classes of documents to be supported by an MFT effectively determines the possible range of objects and operations that might be supported. Depending on the variety of document types selected, the choice of objects and operations may be reduced considerably.

(4) select logical or layout structure: if only one structure is to be supported, then the sets of objects and operations are further reduced significantly.

(5) select configuration of facilities: if any configuration but the all-encompassing one is selected, then the set of potential operations will be reduced.

(6) select graphic elements: at this stage, the graphic elements (character box, geometric and facsimile) that are to be supported are selected. At least two graphic elements must be selected for the terminal to qualify as an MFT. This step may not be required if the chosen document classes determine which graphic elements must be supported. At this stage, the set of text objects is finalized.

(7) select desired functionality: this is the act of determining which operations will be supported among all those that are still eligible. For some facilities such as imaging and interchange, the document classes, the choice of graphic elements and the structural complexity will effectively determine the operations to be supported, leaving little or no freedom for further reductions at this stage. However, for a facility such as editing, the remaining set of candidate operations may be larger than is strictly necessary. In this case, there is room for selecting a final subset of operations.

At this point, the functionality of the MFT is fully defined in terms of the text objects to be supported and the permissible operations on them.

3. Text Structures for Multi-Functional Terminals

3.1 Overview

An overview of the different parts of a document structure is given in Figure 3.1.1. The figure indicates that a document consists of the document content on which two kinds of structures can be defined: the logical and layout structures, respectively. In addition a document description is associated with the document which contains some general attributes characterizing the document. A short definition of these terms is already given in Section 2.1. The purpose of this section is to give a more detailed discussion of the possible text structures of documents, which is the basis for requirements definitions.

Because of the large variety of different text structures that may be found for different applications, it seems convenient to characterize large parts of a text structure by attributes. A given text object may be associated with a number of attributes which characterize, each, certain aspects of the text object. For example, a block of character box text may be characterized by the following three attributes: line length, position on the page, and the character font used for display. Attributes are identified by their name. The range of possible values for a given attribute is predefined; however, the actual value taken by an attribute for a given text object depends on that object. In the example above, the attribute values may be 65 characters at 10 characters per inch, at the top of the page, and roman font, respectively.

This chapter is organized as follows: Section 3.2 is concerned with the content of the document description, then the logical structure of documents is discussed in Section 3.3. The remaining sections are largely concerned with the layout structure of documents. The structural elements that apply equally to the three categories of graphic elements (character-box, geometric, and photographic) are discussed in Section 3.4. Then the specific structures for the three categories of text are described in separate sections. The

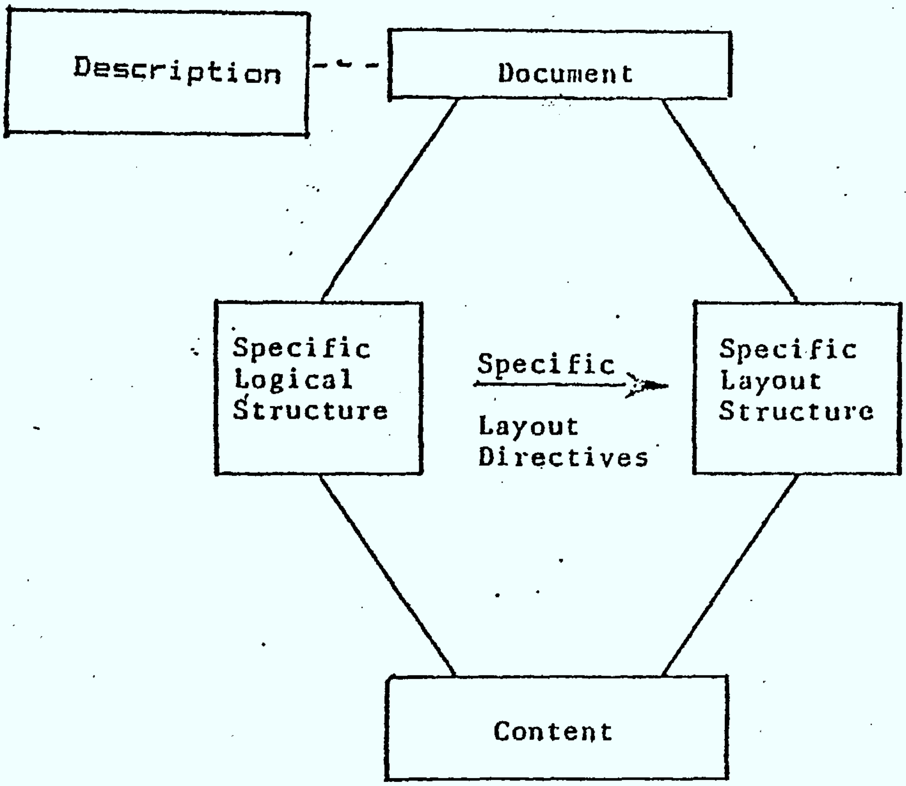


Figure 3.1.1: Relation between logical and layout structures of a document

geometric structures are discussed in two sections. The structures supported by videotex are described in Section 3.6, while Section 3.7 considers logical structures of geometric objects, including some extensions to the videotex structure for better supporting graphics editing. Section 3.9, finally, describes some extensions which could be foreseen to be useful in the future.

3.2 Document Description

The document description contains information for handling the document as a whole, and may repeat information in the document content. The information in the document description may be divided into the following categories:

(a) Identification of the document (Id),
(b) Description of the origin of the document (O),
(c) Information associated with the document for simplifying the storage of the document and its retrieval (S),
(d) Information defining the circulation and distribution of the document (D),
(e) Information required for interchange of the document with other systems (Inter).

The following list defines some possible document description attributes. The list is not exhaustive. A given document description may include any of these attributes (and possibly others), however, none of these attributes are required, they are all optional. (For each attribute, there is an indication to which of the above categories it belongs).

- title (I): a name assigned by the originator to identify the document.
- reference (I): a unique label to identify the document within a document library used by man or machine for further reference.
- owner (I): identifies the current administrator of the document.

- copyright (I): copyright owner's name.
- originator (O): the author of the document.
- last change date (O): the date when the document was last updated.
- subject (S): specifies the subject matter of the document.
- keywords (S): one or more words, assigned by the originator and/or recipient of the document, which should correspond to the content of the document and assist for its retrieval.
- filing reference (S): identifies where a copy of the document may be found.
- file date (S): specifies when the document was filed.
- expiration date (S): a date after which the document may be discarded.
- security (S): access security controls assigned by the primary document owner, e.g. public, private, read-access.
- length (S, Inter): approximate length of the document, including the document description, expressed in number of octets.
- mode (Inter): categories of graphic text elements included in the document content.

3.3 Logical Structures

3.3.1 Logical Structuring Principles

The content of a document is a text object. Let us consider the example of a technical memo. In the simplest case, its content may be considered to consist of a single character-box text object. In general, an elementary text object consists of a number of graphical text elements of a single category, i.e. character-box, geometric, or photographic elements. Alternatively, the content of the memo may be considered to consist of several logical components, such as header and body, and the body in turn may consist of a number of paragraphs and figures. In this case, the whole content and the body are composite text objects and the header, paragraphs and figures are elementary text objects. This is shown in Figure 3.3.1. In general, a composite text object consists of a number of other text objects, either composite or elementary ones.

It is important to note that the detailed logical structure of documents depends largely on the particular application in which the document is used. The following sections, therefore, define a general framework in which various logical document structures can be defined.

An important concept for the definition of document structures is the notion of generic document structure. A generic document structure defines a class of document, and each specific document that belongs to the document class must conform to the logical structure and other properties which are defined by the generic document definition. Taking up the example above, the document class of "technical memos" could be defined by a generic document structure definition; this definition would not only define the logical structure outlined above, but also parts of the content, such as elements of the header, and general layout properties, such as page format, margins etc.. Generic structures and their relation to specific documents are discussed in Section 3.3.4.

3.3.2 Logical Structure of Specific Documents

The logical structure of a document is a hierarchical relationship between text object. On the top of the hierarchy is the content of the document which is, in most cases, a composite text object which consists of a number of components; each component is in turn either a composite or an elementary text object. The logical structure of the technical memo example is shown in Figure 3.3.1.

Further properties of the logical structure of a document are defined by attributes which are associated with the different text objects of the logical text structure. The following logical attributes are commonly found; additional attributes may be added if required.

category of graphic elements: This attributes indicates

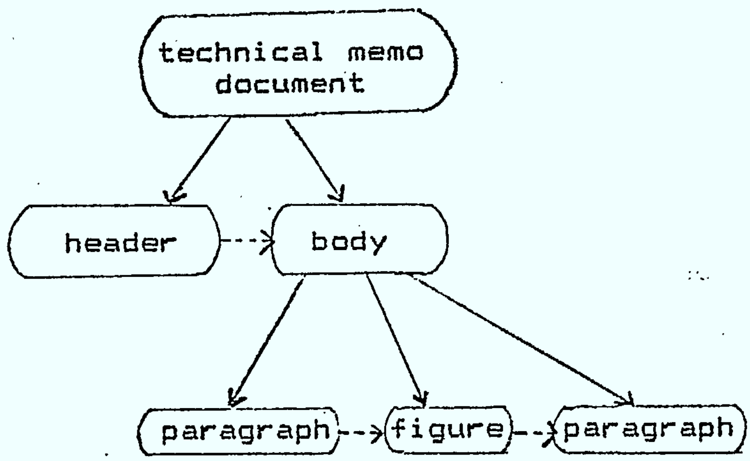


Figure 3.3.1: A possible logical structure of a TECHNICAL MEMO document

which categories of graphic elements are contained in the text object. Elementary text objects only contain a single category.

Size: This attribute indicates the approximate storage space required for the text object.

Type of logical object: This attribute distinguishes between different types of logical objects, such as

- whole document
- chapter
- sub-section
- paragraph
- section heading
- footnote
- annotation
- figure
- graphical signature
- fixtures, such as recurring page headings and footings
- etc.

3.3.3 Layout Directives

Layout directives are a special kind of attribute associated with the text objects in the logical structure of a document. They are attributes that relate the logical structure of the content to the layout in which the content is to be presented on a screen or printed pages. For the techical memo shown in Figure 3.3.2, for example, the layout could be defined by the directives shown in Figure 3.3.3. (It is noted that the figure defines the layout directives informally using the english language; a more formal definition of these directives is given below).

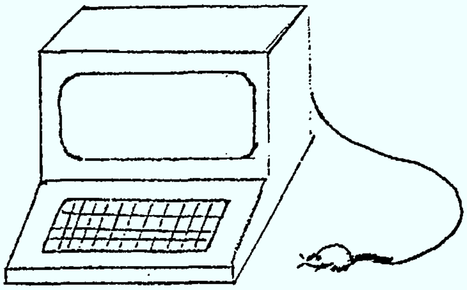
The scope of a layout directive associated with a given text object within the logical document hierarchy is the entire text object including all its component text objects. However, a directive given at a higher level of the hierarchy may be overridden by a directive associated with a component text object at a lower level of the hierarchy. For example, TECHNICAL MEMO 31 March, 1983

TO: Potential users of MFT

FROM: Cerbo - Gateways

TITLE: How to use a MFT

The best way to use a MFT is as an oracle in the morning. After you switch on the power supply, a certain image will appear on the screen, as shown below.



Depending on the category of the image displayed, you will have a character-box, geometric or photographic type of day.

Figure 3.3.2: A TECHNICAL MEMO example

(a) Layout information for all pages:
line length is 65 characters
character width is 10 characters per inch
single line spacing
page numbering at the bottom , centered
right justification

(b) Layout information for the pages after the first one:
fixed heading: "How to use a MFT"

Figure 3.3.3: Example of layout directives for TECHNICAL MEMOs associated with the "document" node

the directives of Figure 3.3.3 could be associated with the text object at the top of the hierarchy representing the entire document, and would apply to the header and all paragraphs and figures of the body. However, if a particular figure of the document consists of two text objects, the figure caption and an elementary geometric text object, the figure caption may be printed with different character fonts and spacing than the remaining part of the document. This could be specified by layout directives associated with the logical text object representing the figure caption. These directives would overwrite the specifications of the directives associated with the entire document.

Some examples of layout directives closely related to the logical structure of the document are given below. In addition, the layout attributes, and layout and positioning commands defined in Sections 3.4 through 3.8 can also occur as layout directives associated with the logical structure of a document.

Some examples of layout directives associated with the whole document:
- Start a new page with each chapter of a technical report.
- Print footnotes on the bottom of the page in which they are referenced.
- Include a figure on the same page where it is referenced the first time, or reserve a complete page for the figure after the point of first reference.

Note: the last two examples require the notion of reference point for footnotes and figures to be defined in the logical structure.

3.3.4 Generic Document Structures

A generic document structure defines certain common properties for a class of documents which must be satisfied by all (specific) documents that belong to this class. Such a generic document structure is usually application dependent, and may be used to maintain the consistency of the documents of a given class with some standard properties specified by the generic structure, or for facilitating the creation of new documents of that class.

Like the logical structure of a specific document, a generic document structure consists of a number of text objects and relations between them. It is often represented by a directed graph, as shown in Figure 3.3.4. Two kinds of relations are distinguished:
(a) The relation "consists of" indicates for a given text object what kind of component text objects it consists of.
(b) The relation "is followed by" defines the permissible sequences of logical text objects within a document. This relation may lead to cycles in the graph structure, indicating that certain text objects or sequences thereof may be repeated. For example, the cycles in Figure 3.3.4 indicate that the body of a technical memo consists of an arbitrary number of paragraphs and figures, in an arbitrary order. However, within a figure, the figure caption always follows the figure proper.

As in the case of a specific document structure, a generic structure is usually characterized by a number of attributes associated with the text objects within the structure. The attribute values defined for a given text object of a generic structure apply to all occurrences of corresponding text objects in the specific documents that belong to that class.

It is important to note that the generic structure of a document class may define certain parts of the content for all the documents of that class. In the case of the technical memo, for example, part of the header content, as shown in Figure 3.3.4, may be defined by the generic memo structure. This facility is important for form processing.

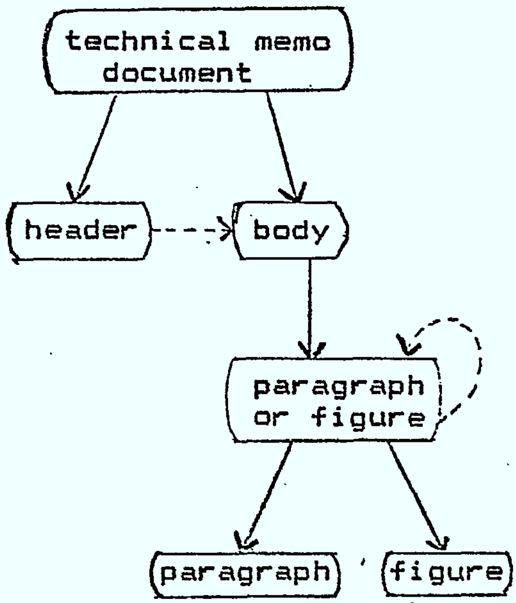


Figure 3.3.4: A generic document structure for TECHNICAL MEMOS

⟶ "consists of" edges
--→ "followed by" edges

The layout attributes of a generic document structure are also called generic layout directives. As for (specific) document structures, they define certain layout properties for all documents that belong to the defined document class

3.4 Common Layout Structures for Character-box, Geometric and Photographic Text

The scope of this section is to provide definitions and rules that apply equally to the different categories of text, namely character box, geometric and photographic. The section is mainly concerned with the dimensioning and positioning of pages and blocks and common attributes for the three categories of text, such as color, are also discussed.

3.4.1. Pages and Blocks

Documents are subdivided into pages. A page is defined as the unit of presentation of document content. It is a rectangular area with dimensions equal to the nominal paper size (A4, or North American format). The positioning of all text is relative to an orthogonal coordinate system. The origin of the coordinate system is currently defined to be at the top left corner of the page, and the horizontal axis (X-axis) coincides with the top edge of the page. The vertical axis (Y-axis) coincides with the left edge of the page. The page can be used in the vertical and the horizontal orientation. When the page is used in the vertical orientation, the vertical axis is along the longer side of the page (portrait format); in the horizontal orientation, it is the horizontal axis (landscape format). An image area is defined as the part of a page which can effectively be used for the imaging of text.

Each page is rectangular and contains at least one block. A block is an area, currently rectangular, within a page with its sides parallel to the sides of the page. The content of a block is of a single category of graphic elements (character box, geometric, photographic).

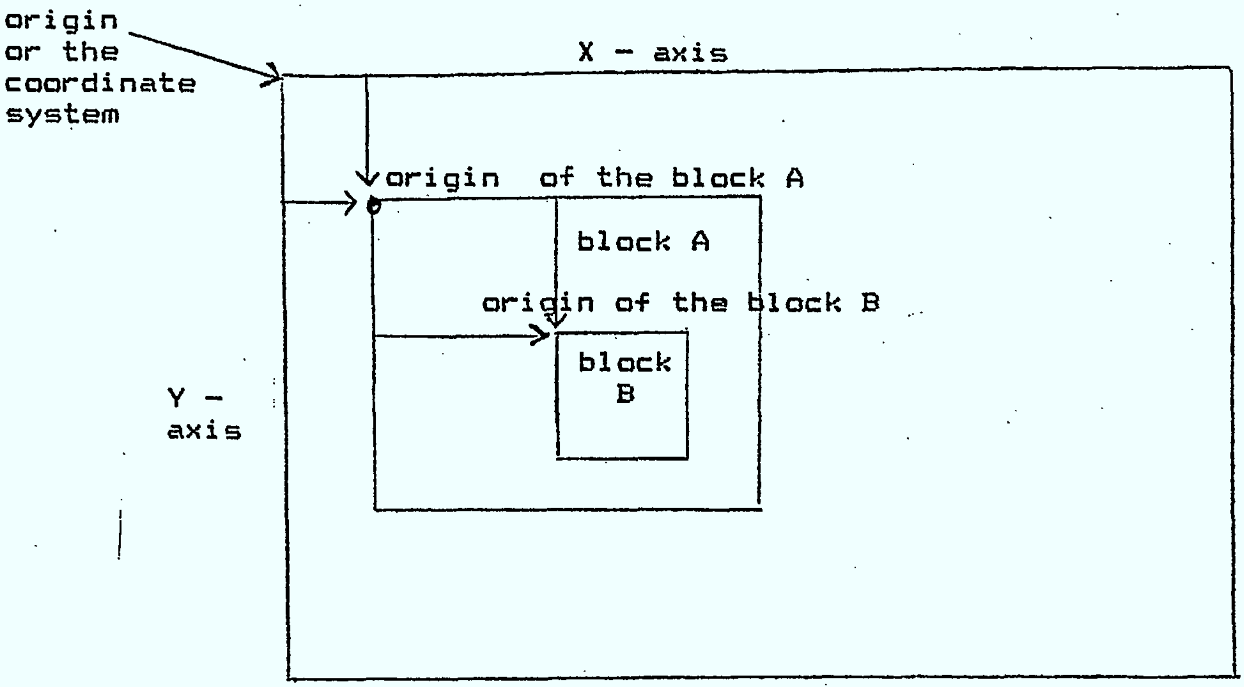


Figure 3.4.1: Example of a hierarchy of blocks and their relative positioning

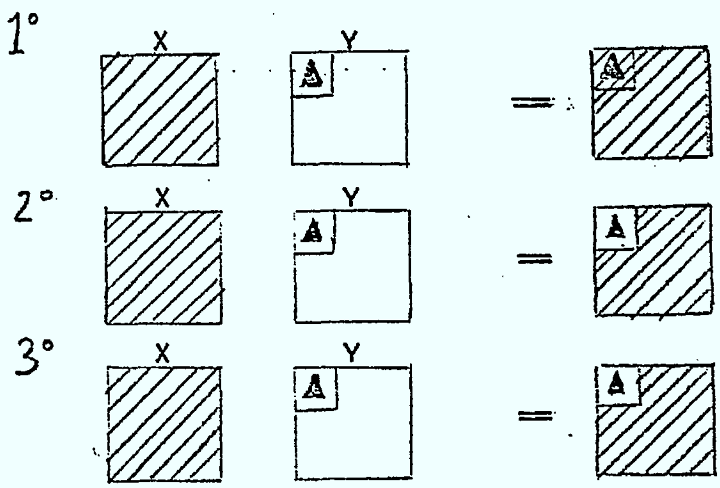


Figure 3.4.2: Different forms of superimposition

A block can also be defined to be part of another block. In a recursive manner, a hierarchy of blocks can be defined. The fact that a given block is logically part of another one is indicated by the use of relative coordinates (see below), relative to the coordinates of the containing block. Overlapping of blocks is possible using relative or absolute coordinates.

3.4.2 Attributes of a Block

The following attributes can be associated with a block. They relate mainly to the positioning of the block within the page.

Block dimension: The size of a block is given in terms of its dimensions in X and Y directions. A block must lie completely within the page.

Block position: The block position within the page or within another block is currently specified in terms of the coordinates of the top left corner of the block, as shown in Figure 3.4.1. Positioning is specified in either of the following ways:
- in absolute coordinates within the page, or
- in relative coordinates, that is relative to the position of another block. (This defines the hierarchical relation between the blocks).

Mode of superimposition: Any number of blocks may may be superimposed, partially or fully on a page. Three ways of superimposition are currently distinguished, as shown in Figure 3.4.2. A block Y superimposed on a block X is considered as an example.
- In the first case, the block Y is defined transparent; therefore the part of block X overlapping with Y is visible.
- In the second case, the block Y is defined opaque; therefore block X is only partly visible.
- In the third case, the part of block X where block Y overlaps has been deleted before the overlapping.

The difference between the second and third cases is appearent for text processing: only in the second case, the whole contents of block X becomes visible again if block Y is deleted

Type of graphic elements: This attribute defines the category of graphic text elements contained in the block.

Origin offsets: Two attribute values define the coordinates (in vertical and horizontal direction) of the "origin". This origin can be used in different ways for the different categories of text. In the case of character box text, it determines the top and left margin for the positioning of the text elements within the block.

3.4 3. Positioning of Elements within a Block

Most rules for the positioning of text elements that are common to all three categories of graphic elements are related to the concepts of pages and blocks, as described in Sections 3.4.1 and 3.4.2. Most additional rules are dependent on the category of text concerned, and are described in the respective sections below.

There is, however, the concept of a current position (also known as "cursor") which is used for all three categories of text elements. The position of a given element is usually defined in terms of the current position, which is the result of the display of the previous text element. The display of each text element affects the current position in a particular manner, which is dependent on the particular text element being displayed. The detailed rules that affect the current position during the display of text elements are described below in the respective sections on the different categories of text elements.

3.4.4. Common Imaging Attributes for Elementary and Composite Text Objects

The purpose of these attributes is to specify general imaging characteristics for the different kinds of text. The following common attributes are defined: color, flashing, blinking, high-lighting and resolution. However, these attributes are not always applicable to hard copy devices.

Color: The colors of a text object may be defined in terms of the RGB (Red, Green, Blue) color system. The color is either directly defined by its RGB components, or it is determined from an index into a color look-up table (LUT). The number of colors in this table and the number of colors that can be displayed simultaneously on the screen are hardware-dependent. Colors can be applied to the foreground and background, as well as to the text elements. Transparent color and grey scale intensity are defined.

Flashing: The flashing attribute indicates that the object is to be flashed at a predetermined rate: it means that the object periodically alternates from its specific color to the background color.

Blinking: The blinking attribute indicates that the object periodically alternates between two colors. The time period of each color can be selected.

High-lighting: This capacity provides the ability for displaying character boxes in different intensities and for drawing the perimeters of rectangles, arcs and polygons in either block or as a line in the background color.

Picture resolution: Picture resolution is defined as the number of picture elements (pixels or pels) per inch in the vertical and horizontal directions. It is important to note that the coordinate specifications for the positioning of blocks and graphic elements are given independently of the picture resolution. (Picture resolution is an attribute that is mainly applied to complete pages; although different resolutions for different objects and/or blocks within a page are not excluded).

3.5 Character-Box Text Structures

3.5.1 Elementary Character Box Elements

Considering the logical structure of an elementary text object of character-box category, the content of the object is a sequence of characters box elements including positioning commands. As already pointed out in Section 2.1, character box elements may be partitioned into

(a) alphanumeric characters, and

(b) pictorial characters.

Alphanumeric characters include alphabetic letters with or without diacritical signs, numerical digits and fractions, punctuation marks, mathematical signs, as well as space and special letters signs and typographical symbols. Pictorial characters are predetermined patterns which are intended to be presented in adjacent character boxes to construct rulings, boxes, logos, diagrams, and other pictures occupying multiple character boxes.

Character box elements are usually defined in terms of character sets. A number of predefined character sets exist which can be selected (possibly by default) by the application. Specific character sets are defined for Teletex and Videotex, as explained in Section 2.2. Examples of pictorial character sets are mosaic picture characters and line drawing characters.

In addition, it is foreseen to allow for dynamically redefinable character sets (DRCS). This means that the meaning of the character coding representing the image to be displayed in a box can be dynamically determined by the application. A typical case where this facility may be useful is the design of a logo for which special graphical effects are required.

For the predefined character sets, there exist usually several fonts. A given font defines the image to be displayed in the character box for each of the characters in the set.

The different character fonts vary in the artistic design and in the overall outlook, such as roman, italic, bold face, etc.. For certain fonts the width of the character boxes is variable, depending on the particular character to be displayed.

3.5.2 Layout Structures

The layout of character-box text objects is determined by rules that are specific to the category of character box text, and certain general rules that apply to all categories of text objects. The latter rules are explained in Section 3.4. This subsection describes those general layout rules specific to character-box text, and Section 3.5.3 contains a discussion of the positioning commands that are part of the text content and determine layout properties of the text in relation with the rules discussed here.

In summary, each character box element is contained in a small rectangular area named character box. A string of character boxes forms a line and successive lines are combined to constitute the contents of a text block.

More precisely, each alphanumeric or pictorial character is imaged within a character box. The character box is partitioned into an upper and alower part by the character base line. The upper part is usually used for the display of upper case characters. A pictorial character is assumed to extend over the entire character box. The intersection of the base line with the character box (see Figure 3.5.1) is commonly used as reference point for the positioning of text elements within the block. However, the lower left corner may also be used for this purpose.

The height and width of a character box, and the position of the base line depend on the font design of the character set concerned. The height and base line position are the same for all characters in a given font design. Depending on the font design, the width of the character box is the same for all characters (what is is called constant

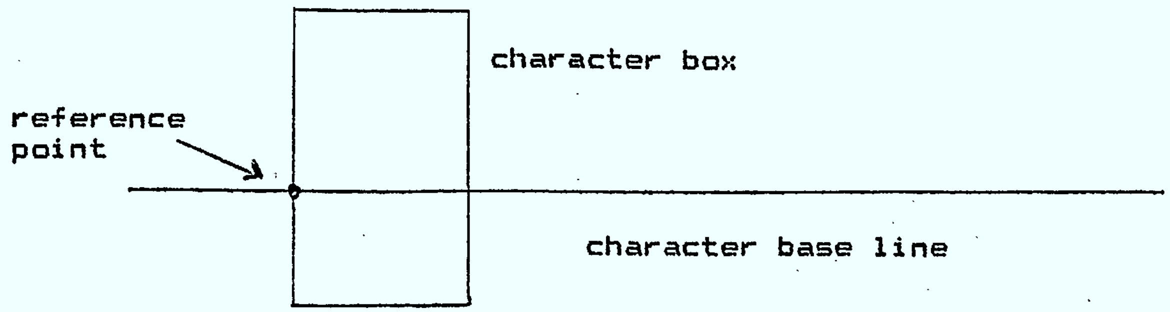


Figure 3.5.1: Illustration of character box and character base line

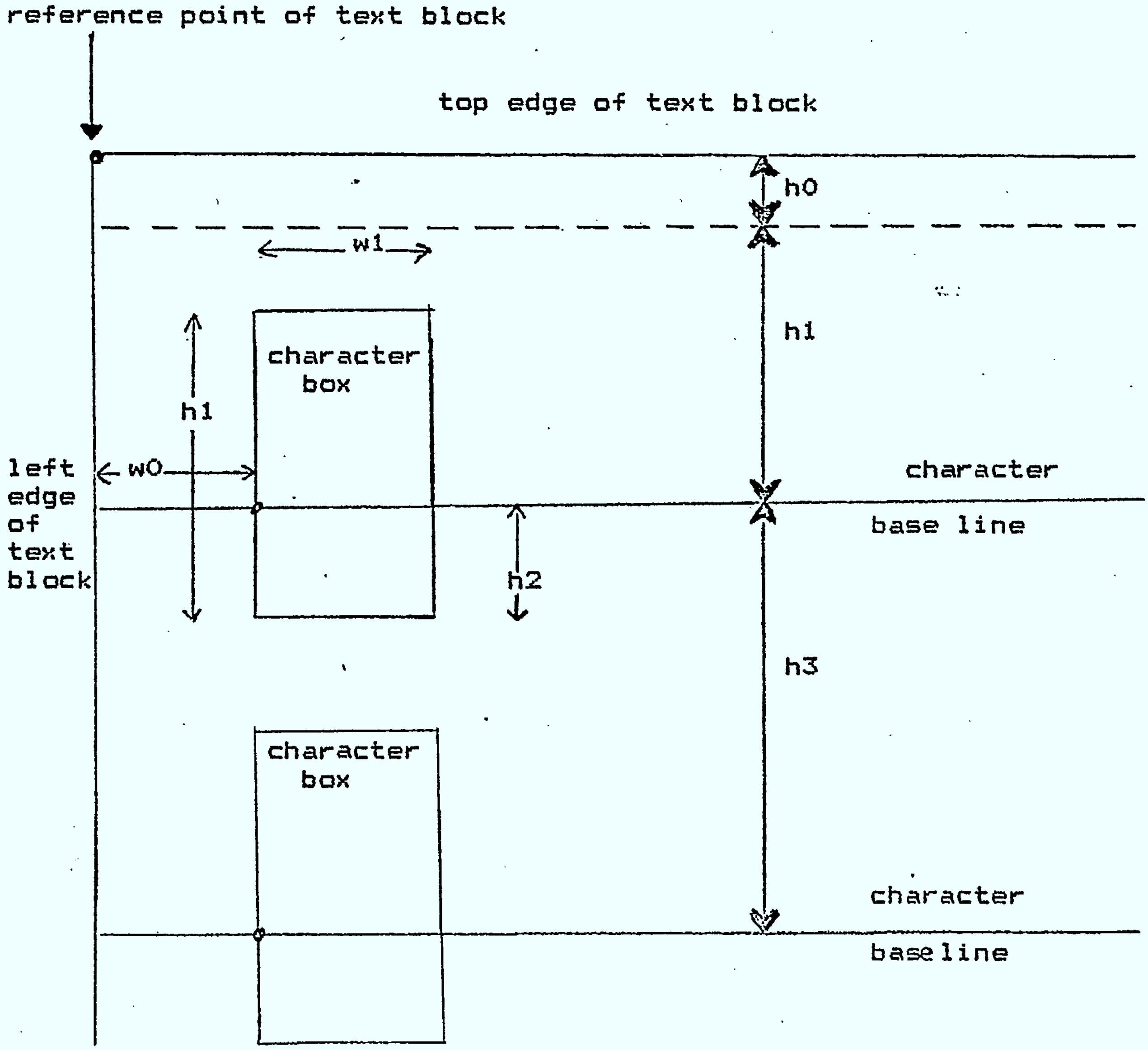


Figure 3.5.2: Example of positioning of character boxes

pitch), or varies from one character to another (called variable pitch). A line is a string of character boxes arranged horizontally within the text block, and aligned on the character base line. The distance from the reference point of one character box to the reference point of the next one may be equal to, greater than or less than the nominal width of the character box.

The overall layout of text elements within a block is governed by a number of layout attributes which are explained below. An overview of some of these attributes is given in Figure 3.5.2. The attributes may be associated with a text block, or a page. In this latter case they apply to all text elements that are laid out within that page, block or sub-blocks thereof. The attributes may also be associated with the logical structure of the text, in which case they are called "layout directives" (see Section 3.3.3). Finally, these attributes may also be specified by abstract layout commands, as explained in Section 3.5.3.2.

The following is a (not necessarily complete) list of layout attributes for character-box text:

Origin offsets (see w0 and h0 in Figure 3.5.2): The horizontal and vertical origin offsets, already mentioned in Section 3.4.2, are defined in relation with the character box size, as shown in Figure 3.5.2.

Character box size (see w1 and h1 in Figure 3.5.2): The height and possibly the width of character boxes is defined. Alternately, in the case of variable pitch, the width may depend on the particular characters.

Character base line offset: The character base line offset from the lower edge of the character box is defined (see h2 in Figure 3.5.2).

Character spacing: In the case of constant pitch, the spacing between consecutive characters is defined. Typical values are 10, 12, or 15 characters per inch. A distinction between contiguous and separate character display may also be made. In the case of separate character display, characters may be separated by a border of background colour, the width of which may be specified.

Line spacing (see h3 in Figure 3.5.2): Various values for the line spacing may be selected, such as 3, 4, 6, or 8 lines per inch.

Line length: The line length may be given in terms of number of character boxes per line.

Character path, character orientation and line progression: Figure 3.5.2 shows the simplest situation where lines go from left to right and characters are oriented in the usual way. However, it is possible to specify different situations. The character box orientation relative to the coordinate system may be specified by an attribute as 0, 90, 180, or 270 degrees. The character path defines the direction in which character boxes are advanced for successive characters. Possible attribute values for the orientation of the character path are 0, 90, 180, and 270 degrees relative to the coordinate system. The line progression, finally, defines in which direction (relative to the coordinate system) successive lines progress on the page. The possible attribute values are 90 and 270 degrees for a character path of 0 or 180 degrees, and 0 and 180 for a character path of 90 or 270.

Word wrap: This attribute, which may take the values ON or OFF, indicates whether word wrap should be used for the layout of alphanumeric text which is structured by words separated by spaces and other punctuation marks.

Justification: This attribute, which may take the values ON or OFF, indicates whether the lines within the block should justified on the right according to the specified line length.

3.5.3 Positioning Commands

As pointed out in Section 3.4.3, the positioning of text elements on a page or within a block is determined using the concept of "current position" (also called cursor). As explained in Section 3.5.2 above, the current position is usually automatically updated for each character that is displayed, moving the current position along the character path from one character box reference point to the next on the same line, and at the end of a line to the beginning of the next line. In addition to this implicit movement of the current position, the character box text may include explicit commands that change the current position. These commands are called concrete positioning commands (also known as "format effectors") and must be distinguished from abstract layout commands, which are commands for a formatting facility. A formatting facility transforms text commands containing abstract layout commands into a text structure containing concrete positioning commands, and full layout information for imaging, as explained in Section 2.4.1.2.

3.5.3.1 Concrete positioning commands

The following is a (not necessarily complete) list of concrete positioning commands that can be used in character-box text objects.

Current position backward: Moves the current position one character box to the left in the current line.

Current position forward: Moves the current position one character box to the right in the current line.

Current position down: Moves the current position down the distance of one line spacing.

Current position up: Moves the current position up the distance of one line spacing.

Current position home: Moves the current position to the upper left hand character box within the current block.

Current position set: Moves the current position to a specific place which is defined by a horizontal and vertical positioning attribute contained in the command.

3.5.3.2 Abstract layout commands

The following is a (not necessarily complete) list of abstract layout commands. The purpose of such commands is to provide information that can be used by the formatting facility (see Section 2.4.1.2) to determine the concrete layout structure of a document.

1 - left margin
2 - right margin
3 - character pitch
4 - word wrap
5 - justification
6 - top margin
7 - bottom margin
8 - line spacing
9 - page numbering, page number positioning etc.
10- fixtures for top and/or bottom of pages, such as headings, footings etc.
11- paragraph format specifications, such as indentation of first line

It is to be noted that these layout commands are related to the positioning attributes of blocks described in Section 3.5.2. For example, the left and right margin are closely related to the horizontal origin offset and the line length attributes.

3.6 Geometric Text Structures

3.6.1 Overview

A geometric text object, or simply called "drawing", is made out of a number of elementary geometric elements of various types. A drawing is defined as a succession and overlay of these geometric elements. The distinction between layout and logical structure is sometimes difficult to be made for a geometric text object. For instance, such characteristics as initial and final drawing positions of a line can be considered to be part of the layout structure. In fact, these two positions are necessary to draw the line and must be present in an image form. But these positions are also required when the line is to be rotated during the processing of the drawing.

Five elementary elements are defined: POINT, LINE, ARC, RECTANGLE and POLYGON. A geometric drawing is characterized by its position relative to the "current position" (see Section 3.4.3) or in absolute terms. The final drawing position of a text element is taken as the current position for subsequent text objects.

The (absolute or relative) position of a geometric text element is defined by two coordinates X and Y. The coordinate specifications are based on a cartesian coordinate system and a numbering scheme between 0 and 1. Coordinate values are specified as fractions of this range.

3.6.2 Geometric Text Elements

The following subsections define the different types of geometric text elements. It is to be noted that no character-oriented elements are included here, since such kind of text is usually considered of category character-box. However, the flexible processing of geometric diagrams including descriptive elements in character-oriented form may require the definition of a type of geometric text element that supports character information.

3.6.2.1 The POINT

A point is characterized by its position. The POINT command sets the current drawing position to the position of the point element. A dot may be drawn at the given position (visible point) or not (invisible point).

3.6.2.2 The LINE

A line element is characterized by two positions: the initial drawing position and the final drawing position, as shown in Figure 3.6.1. The LINE command draws a line between these two positions. The initial drawing position can be omitted in the command; in this case the current drawing position is taken as initial drawing position. At the completion of the drawing, the final drawing position becomes the current drawing position.

3.6.2.3 The ARC

An arc element is a part (eventually the whole) of a circle. It is characterized by three positions: the initial drawing position, an intermediate position and the final drawing position, as shown in Figure 3.6.2. The intermediate position can be any position on the arc between the initial and the final ones. In the case of a full circle, the initial and the final positions coincide and the intermediate position is "opposite" to the initial/final position and defines the diameter of the circle.

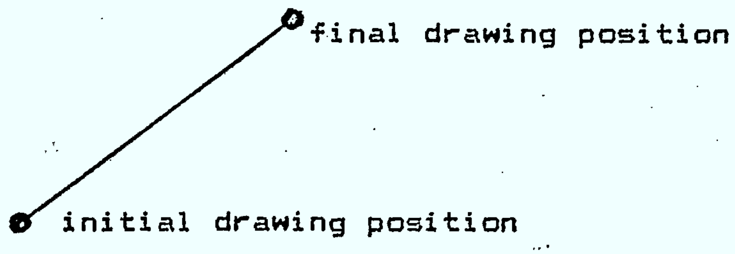


Figure 3.6.1: A LINE element

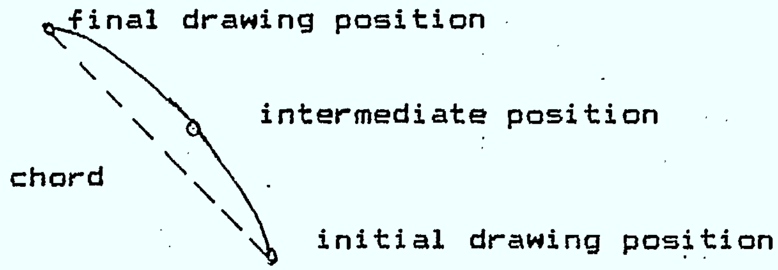


Figure 3.6.2: An ARC element

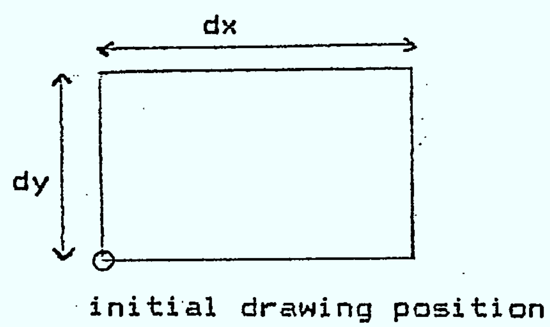


Figure 3.6.3: RECTANGLE element

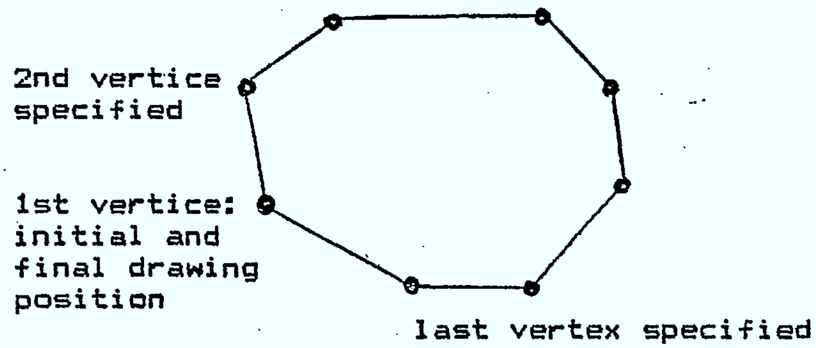


Figure 3.6.4: A POLYGON element

An arc and the chord joining the initial and the final points define an enclosed area which may be filled according to the current texture pattern (see Section 3.6.3).

The ARC command draws an arc given by three positions. If the initial drawing position is omitted, the current drawing position is assumed as initial position. The intermediate position is always given relative to the initial position and the final position is given relative to the intermediate position.

3.6.2.4 <u>The RECTANGLE</u>

A <u>rectangle</u> element is a rectangular area specified by an initial position, a width dx and an height dy, as shown in Figure 3.6.3. The RECTANGLE command draws a rectangle element given by the initial drawing position, the width and the height. If the initial drawing position is omitted, the current drawing position is taken as initial one.

The rectangle may be optionally filled in the current color with the current texture pattern.

3.6.2.5 <u>The POLYGON</u>

A <u>polygon</u> element is a polygonal area defined by a series of vertices. An implicit closure is assumed between the initial drawing position and the last vertex specified, as shown in Figure 3.6.4. The POLYGON command draws a polygon given by its vertices. Each vertex is specified by a relative displacement from the last vertex. The first vertex is the initial drawing position. If it is not specified in the command, the current drawing position is assumed.

The polygon may optionally be filled with the current texture pattern. The maximum number of vertices in a polygon may be limited by hardware. Polygon edges may not cross each other.

3.6.3 Imaging Attributes

Color, flashing, blinking and high-lighting have already been defined as common attributes of text objects in section 3.3.5. Some specific attributes for geometric text objects are the following ones:

Line texture: The line texture attribute indicates the style of the image of a line. It is also used for arcs, rectangles and polygons. The following values can be taken by this attribute: solid, dotted, dashed and dot-dashed.

Texture pattern: Different texture patterns can be selected for filling the area of rectangles, arcs and polygons. The following patterns are available: solid, vertical hatching, horizontal hatching, cross hatching and several user-defined patterns.

Logical pel size: This attribute determines the line width of geometric drawings. It determines the width dx and height dy of the logical pel.

3.7 Logical Geometric Text Structure

3.7.1 Introduction

As pointed on in Section 3.6.1, the logical and layout structures of geometric text objects are closely related. It is important to note that we consider here only the logical structure of a drawing (which may be part of a document), but not the overall logical structure of a document, as discussed in Section 3.3. The logical structure of a geometric drawing is also closely related to the processing of the text structure, in particular graphics editing which is usually based on image transformations such as rotations, translations and scaling.

A pure image form is not very suitable for implementing these image transformations. Problems are due to the fact that the logical hierarchy is only based on relative coordinates. Moreover there is no way of specifying that different blocks have the same content without repeating this content. For example, to translate a polygon, it is possible to modify the initial drawing position if it is specified in absolute coordinates. However, this translation can have effects on following geometric elements if they have been defined using relative coordinates. Conversely, it is difficult to move several geometric elements with a single image transformation.

Consider the following example: an apple tree with 20 apples is shown with a house. The user would like to translate the tree with an interactive graphics editor. Of course, the apples have to be translated too, but not the house. This is possible, if the apples are defined in coordinates that are relative to the tree, and if the house is defined in absolute coordinates. But there is no way of defining the apples are 20 occurences of a same object. To change some detail of the structure of the apples, if is necessary to modify all apples. This difficulty could be avoid by defining <u>subpictures</u>, or more generally by introducing <u>geometric</u> <u>model</u>.

3.7.2 <u>Geometric models with object hierarchy</u>

Geometric models describe objects with inherent geometrical properties. Typically, a geometric model must allow the development of three types of programs and combination of them:

a) programs that create and modify the model by adding, deleting and replacing information in it,

b) programs that traverse the model and extract information in order to construct a display image, and

c) programs that traverse the model and extract information for further processing.

Most types of geometric models are based on hierarchical structures. Hierarchies of text objects are very common because most objects can be considered to be composed out of several parts or component objects. The model of an object specifies which components are present and how they are related to one another.

An object hierarchy may be created for the following purposes:

- constructing complex objects by selective and repetitive use of elementary objects,
- storage economy by storing only references to objects,
- simplification of the modification of the object on the basis of its component structure.

For example, the apple tree mentioned above may be constructed by using the same apple component repetitively, thus simplifying its creation and possibly reducing the required storage. A transformation of the apple tree object would automatically transform all apple occurrences.

3.7.3 Macros and Subpictures

The North-American Videotex presentation level protocol contains a MACRO feature which provides the capability of executing sequences of picture description code upon command. A MACRO can be used to define a sub-picture which may be reused several times. However, the Macros feature has no parameter mechanism, which limits its usefulness for the implementation of geometric models.

3.7.4 Geometric Segmentation

Geometric segmentation is a good method for defining hierarchical structure for geometric drawings. The method can be implemenmted with the three primitives CREATESEGMENT, CLOSESEGMENT and INVOKESEGMENT. (These terms are taken from the Status Report of the Graphic Standards Planning Committee of SIGGRAPH-ACM). All commands defined between the CREATESEGMENT and CLOSESEGMENT primitives are used to draw a subpicture, called a segment. Within a segment, sub-segments may be defined using again the primitives CREATESEGMENT and CLOSESEGMENT. Thus a hierarchy of segments may be formed.

A segment is characterized by an initial drawing position which is specified in the CREATESEGMENT primitive. For the highest level segment in the hierarchy, this initial drawing position is given in absolute coordinates. For the other segments in the hierarchy, it is given relative to the initial position of the parent segment. Each segment is identified by an unsigned integer. Commands in the segment scope cannot refer to absolute coordinates. Translation of a segment can be easily perfomed by a graphics editor by modifying the initial drawing position of the segment.

A segment can have attributes, such as the following:
- color
- texture
- initial drawing position

The value of these parameters are defined when a segment is invocated by the command INVOKESEGMENT.

This method of segmentation leads to relatively simple structures. However, it allows for a basic hierarchical object structure which is acceptable for geometric text processing.

3.8 Photographic Text Structures

3.8.1 Geometric coding versus facsimile coding

A picture is a two-dimensional distribution of continuously varying, or discrete values of, optical densities and colors, preferably on a flat surface. There are two major classes of coding methods for such pictures: geometric coding and photographic coding. Text objects using geometric coding have been discussed in Section 3.6. Facsimile coding, discussed in this section, is characterized by the coding of optical densities and possibly colors of individual points, which are called picture elements (or pixels, pels). For example, a black and white photograph is represented as a rectangular array, formed by sequences of pels which are either ON (black) or OFF (white) along image lines. Successive image lines are displayed at a right angle to the direction of these lines. Grey scale or color facsimile elements are briefly discussed in Section 3.8.5.

3.8.2 Facsimile resolution

There are four basic categories of document facsimile apparatus. Only the fourth one (Group 4) is concerned with communication over public data networks. Group 4 apparatus is classified into three classes according to the picture element density and mixed-mode capability, as shown in the following table. Resolution is equal horizontally and vertically. The standard scan line length of 219.5 mm has the following number of pels for each resolution:

- 1728 pels for a 200 pels per inch resolution
- 2592 pels for a 300 pels per inch resolution
- 3456 pels for a 400 pels per inch resolution.

The basic page size is A4.

3.8.3 Coding method

The coding scheme for Group 4 facsimile is a two-dimensional line-by-line coding method in which the position of each changing picture element on the current or coding line is coded with respect to the position of a corresponding reference element situated on either the coding line or the reference line which is immediately above the coding line. After the coding line has been coded, it becomes the reference line for the next coding line. The reference line for the first coding line in a page is an imaginary white line. (Coding schemes for grey scale and for color images are for further study).

A changing element is defined as an element whose "color" (i.e. black or white) is different from that of the previous element along the same scan line, as shown in Figure 8.3.1(a).

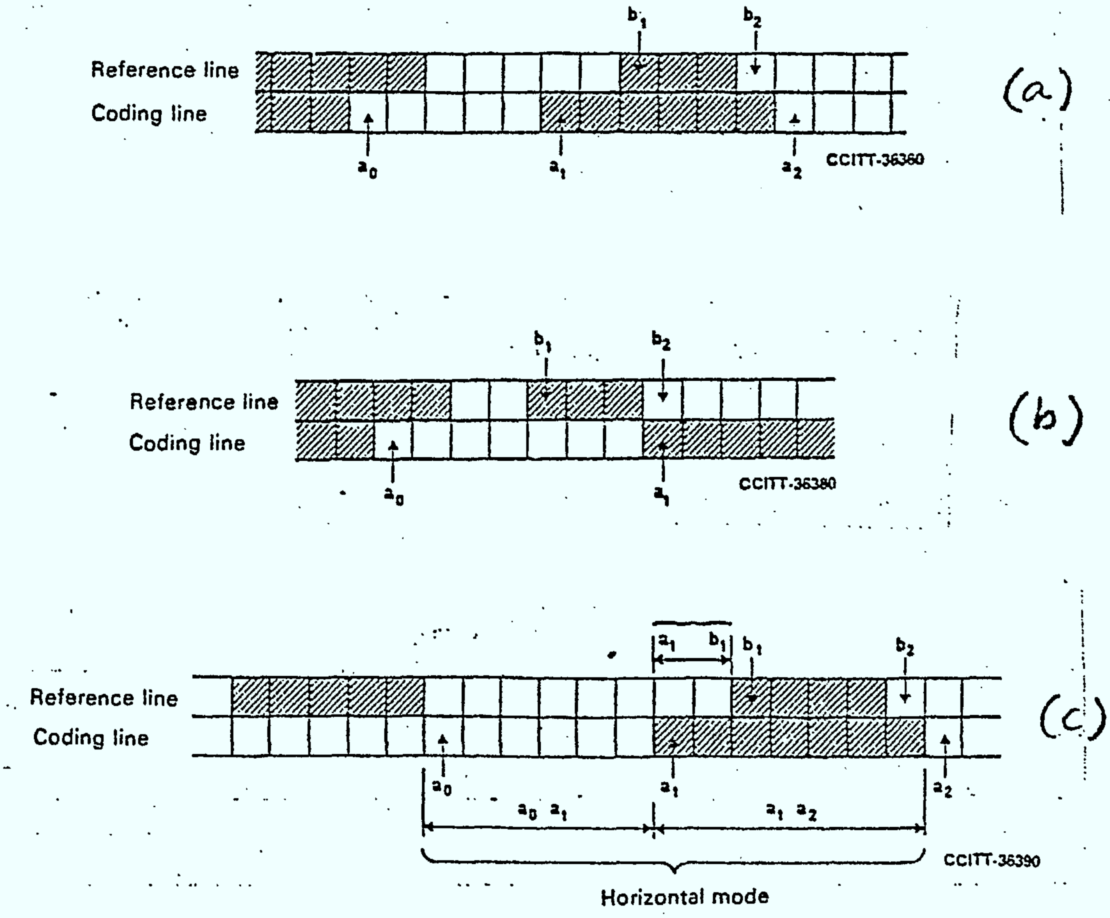
3.8.4 Coding modes

The following three modes have been defined for Group 4 facsimile to code the position of each changing element along the coding line:

a) Pass mode:
This mode is identified when the position of b_2 lies to the left of a_1. See Figure 3.8.1(b)

b) Vertical mode:
When this mode is identified, the position of a_1 is coded relative to the position of b_1. The relative distance $a_1 b_1$ can take on one of seven values $V_R(0)$, $V_R(1)$, $V_R(2)$, $V_R(3)$, $V_L(1)$, $V_L(2)$ and $V_L(3)$, each of which is represented by a separate code word. The subscripts R and L indicate that a_1 is to the right or left respectively of b_1, and the number in brackets indicates the value of the distance $a_1 b_1$.

c) Horizontal mode:
When this mode is identified, both the run-lengths $a_0 a_1$ and $a_1 a_2$ are coded using the code words $H + M(a_0 a_1) + M(a_1 a_2)$. H is the flag code word 001 taken from a two-dimensional code table. $M(a_0 a_1)$ and $M(a_1 a_2)$ are code words which represent



a_0 The reference or starting changing element on the coding line. At the start of the coding line a_0 is set on an imaginary white changing element situated just before the first element on the line. During the coding of the coding line, the position of a_0 is defined by the previous coding mode. (See § 4.2.1.3.2.)

a_1 The next changing element to the right of a_0 on the coding line.

a_2 The next changing element to the right of a_1 on the coding line.

b_1 The first changing element on the reference line to the right of a_0 and of opposite colour to a_0.

b_2 The next changing element to the right of b_1 on the reference line.

Figure 3.8.1: Examples of facsimile coding

the length and "color" of the runs $a_0 a_1$ and $a_1 a_2$ respectively (see Figure 3.8.2(c)) and are taken from the appropriate white or black run-length code tables. (For more details, see CCITT Recommendation T.4).

3.8.5 Grey scale and color pictures

The incremental mode is a videotex feature introduced for geometric elements to describe an image by a series of short elements. This feature provides the same possibilities as the repetitive use of geometric commands (see Section 3.6.2), but with a much more compact code. This mode is applicable to points (INCREMENTAL POINT), lines (INCREMENTAL LINE), and polygons (INCREMENTAL POLYGON). Only the INCREMENTAL POINT will be discussed here because of its ability for photographic coding.

The INCREMENTAL POINT command allows an image to be described point by point. This feature is used for drawing photographic type images. A rectangular active drawing area must be previously defined. This area is divided into a grid of logical pels. The color of each pel is individually specified. The first parameter of the command is an unsigned integer which specifies the number of consecutive bits which make up the color specification for a single pel. Sequences of such color specifications are then coded in the following data bytes. The INCREMENTAL POINT command is defined in a manner independent from the hardware implementation.

The INCREMENTAL POINT capability provides a rudimentary photographic feature. The advantages of such a feature are the ability to support colors and its hardware independence. However, the amount of data required by such a feature is often prohibitive.

3.9 Future Extensions

A general and multifunctional text structure must be designed in such a way that it could be expanded and modified without too much trouble. The problem is to forecast the directions where such a text structure will need expansion. Nevertheless, the extensions described below can be identified.

3.9.1 Color Photographic Elements

The design of a more comprehensive facsimile standard is still for further study. In particular, grey scale images and full color images should be supported. Run-length encoding could be used. The major problem is to define hardware-independent interchange formats. This is particularly difficult, because of the large number of color choices and color system implementations.

3.9.2 Three-dimensional geometric objects

Projections of three-dimensional (3D) geometric objects can be produced with the operations described in Section 3.6.2, and can be considered as an image form of 3D drawings. But, there is no way of defining a picture in 3D coordinates. Consequently, it is not possible to perform three-dimensional operations (editing) on the objects. In fact, we have to consider that character-box text structures and two-dimensional geometric text can exist in image form and processable form that have common information. Geometric elements are image-form elements but they are also elements of a logical structure, for example the structure based on segmentation presented in Section 3.7.4. The processing of photographic elements is very limited and does not imply a logical structure different from the layout. For three-dimensional drawings, the image form corresponds to a file of geometric elements (called display file in Computer Graphics), which is in two dimensions. The processable form must be a file of three-dimensional elements. Positions must be specified with three coordinates. It is often convenient to keep both forms, but the image form has to be modified each time the processable form is modified.

3.9.3 Limited computer animation

Blinking and flashing operations can be considered as a very limited form of computer animation. As this feature is very useful, especially in computer-aided instruction, commands for less limited computer animation are desirable (positions and orientation changing in time).

3.9.4. "Sound text"

Voice is probably one of the future major media for computer input/output. It is therefore desirable that the defined text structures could include the category of "voice text" in the future. More generallly, "sound text" could be considered, including for instance high quality music.

4. Conclusions and Recommendations

4.1 Conclusions

This report has laid the conceptual foundation for the specification of functional requirements for a range of multi-function text communication terminals (MFT) that can utilize existing and emerging Telematic services in an integrated fashion. This conceptual foundation consists of the following components.

1) A coherent terminology for describing text and text processing. The terminology is derived principally from ISO TC97/SC18 material on Text Preparation and Interchange, but has been refined to achieve greater clarity and consistency.

2) An overview of the characteristics of defined Telematic services, namely Teletex, Videotex and Datafax (Group 4 Facsimile).

3) An external user view of the MFT which describes in general terms the typical documents and operations supported by different equipment configurations. The MFT will be required to support both single- and mixed-mode office documents consisting of character box, geometric and photographic elements. Document complexity will vary considerably, ranging from simple office memoranda to forms to complex reports. Among the operations to be supported are document creation, editing, storage, retrieval, display, printing and interchange.

   This user view represents the authors' initial perceptions of general MFT requirements and provides a context for the more detailed requirements which will be presented in Volume II of this report.

4) A functional, block-diagram model which provides a conceptual view of the MFT. This model is general in nature, is suitable for a wide range of terminal configurations, and includes all major aspects of text processing and interchange.

This model describes an MFT in terms of five facilities which encompass the major areas of MFT functionality, namely editing, formatting, imaging, interchange and storage/retrieval. Each facility is associated with a related set of text transformations which alter the content, structure or representation of text.

5) An office document architecture which views documents in terms of two structures, a logical structure which conveys the semantic meaning of a document, and a layout structure which governs the presentation of a document on an imaging device. This architecture is based principally on the work of ISO TC97/SC18, but includes extensions to support logical geometric objects.

4.2 Recommendations for Further Work

Recommendations are as follows:

1. Develop detailed specifications of the functional text processing and interchange requirements for the MFT, including the following aspects:

a) Develop criteria for selecting document classes; this is still an open question in ISO TC97/SC18.

b) Select a range of document classes appropriate to the MFT environment.

c) For each facility, identify generic functional requirements that apply to all document classes.

d) For each selected document class, identify functional requirements specific to each facility and each class.

e) For the interchange facility, develop the framework of a protocol which satisfies the stated requirements and which takes into account national and international protocol development activities.

2. Design and develop a prototype multifunction terminal to demonstrate the feasibility of the concepts and to provide a working model for evaluation by Canadian industry.

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DUE DATE

	201-6503		Printed in USA