Textfax—Principle for new tools in the office of the future

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INTRODUCTION

By taking a closer look at today's office, we observe the following trend: The conventional typewriter is gradually being replaced by word-processors. These may merely be electric typewriters with a storage added or they may take on the form of highly sophisticated CRT workstations featuring screens carrying an entire standard size page and exchangeable storage media. These systems, which originally had been intended for local word-processing, are now increasingly being supplemented by communication functions, permitting direct text communication from one's own buffer to that of a business partner—i.e. to his electronic 'mailbox.' Whenever desired, the recipient can then call up the text from the buffer for reading or, if necessary, for editing and subsequent filing or forwarding. These functions can be summed up under the catchword 'electronic mail.'

First experiments on this have been performed especially in the United States, like those of the Citibank. To permit not only internal, but also public text communication, national and international standards still have to be elaborated, ensuring compatibility of the various products.

Further important elements in today's office, besides text systems, are the numerous copiers and— to the extent to which international standardization progresses— also remote copiers, i.e. facsimile equipment. Copiers and remote copiers are required to duplicate or transmit documents consisting of text and graphics. Here, too, a fusion of individual functions can be observed, as is the case with the remote copier with local copying operation.

Let us enter an office handling, for example, quotations for technical products. In this office, the quotation texts can be generated on the text system, perhaps by using stored text segments. However, the data sheet with photos, diagrams, etc., must be prepared at the printer's in the various versions and kept in conventional files in the office. To mail the quotation copy and the data sheet to the customer, there are two possibilities. Either text and data sheet are jointly enveloped and mailed or, in case the customer happens to have a remote copier of the same type, both can be scanned and transmitted successively by the remote copier. During this process, the text is treated like a graphic and— compared with alphanumerical coding—is transmitted with unnecessary redundancy, i.e. involving too much time.

The previous example shows that, in today's office, it is still not possible to jointly

- Collect
- Process
- File
- Output as hard and soft copy
- Effectively transmit

text and image at the same workstation by using the same hardware and software components.

To be able to do so, new office tools are required. The underlying principle we call Textfax. On the road toward a largely 'paperless' office, we have done some research to work out this principle, trying to specify the functions of these tools and to study ways and means of implementing them.

Developments in the direction of Textfax are

- The printer plotters, where the same matrix printer is used for text and facsimile printout.
- The image processing systems for computer-aided processing of TV images.
- The system named Electronic Darkroom developed since 1970 at the MIT for Associated Press for editing, filing and transmitting of press photos.
- The large printing facilities for electronic photocomposition, enabling above all combined text and graphic processing for ad offices.
- The initial proposals for transmission procedures permitting combined transmission of alphanumerically coded text and coded facsimiles.
- The experimental Soft Display Word Processor from Xerox, which has a facsimile graphic generator to produce business forms or other graphics, that can be overlaid with text from the character generator.

In the following, the performance features of Textfax will first be specified more closely to subsequently go into the first results from two processing runs carried out on an experimental workstation.
PERFORMANCE FEATURES OF INTEGRATED TEXT AND FACSIMILE PROCESSING AND COMMUNICATION

Data entry

Figure 1 illustrates the various possibilities of entering text, handwriting and hand drawings and collecting mixed text/graphic material on paper or microfilm.

The *tablet* is used for inserting hand drawings to be copied into mixed text/image documents. During copying, a separate positioning step is required which is not necessary when writing directly in the softcopy with a light pen or on a touch-sensitive device (TSD) attached to the screen. This way handwritten comments, corrections and signatures can be applied to documents.

In the case of a boss/secretary workstation, e.g., the secretary has a complete system while the boss merely has a tiltable full-page screen with a TSD for handwriting and function selection. The boss can thus apply corrections to the text typed by his secretary and circulars and other sorted mail received electronically can be marked with comments before it is passed on, for example.

The *facsimile scanner* has the same resolution as defined in CCITT recommendation T.4 for Group 3 facsimile apparatus. As a compromise between facsimile quality and data quantity this resolution should suffice for most office applications and represents the standard according to which the documents are processed, filed, output and transmitted at a Textfax station. With a scanning window of approx. 215\times297 \text{ mm}, a page (size DIN A4=210 mm, \times297 mm, U.S. standard=215 mm\times280 mm) in the form of a loose-leaf, a book or a magazine page, is scanned with a horizontal resolution of 1728 pixels per line, and a vertical resolution of 7.7 lines/min. Scanning time per page of about 10 sec. is possible. Mixed documents are entered with 4 to 8 bits per pixel, with grayscale portions after rastering being passed on for further processing with one bit per pixel just like text, graphic and handwritten portions after passing a black-and-white threshold.

On workstations having to cope with large text volumes of existing documents, *character recognition circuits* can be connected to the scanner. This way texts can be entered with low redundancy and alphanumerical coding, and not as facsimiles, i.e. in raster reproduction. In the case of mixed documents, texts in strange fonts, graphics, handwritings and grayscale images can be either masked via programmable masks or, like unrecognized characters, be entered as facsimiles. In the latter case, undesirable portions of a document to be entered can only be erased afterwards by marking the corresponding spaces in the softcopy with the cursor. In the same manner, unrecognized characters can be replaced subsequently via the keyboard by alphanumerically coded ones. The most frequently occurring fonts, such as OCR-B, letter gothic and pica, should be recognizable.

Via *video camera*, sections from leaf and book material can be entered quickly and conveniently. For example, via function keyboard and screen monitoring, the camera is positioned over the material, and the size of the section determined with the motor zoom. Thus, it is possible to enter details with a resolution larger than the standard resolution. Furthermore, construction permitting, images of three-dimensional objects and persons (e.g. photos of authors) can be entered with one and the same camera. Microfiches are either scanned at the workstation, using a suitable frontal attachment to the above camera, or with the scanner of a central microfilm file containing standard graphic segments, for example.

Hardcopy and softcopy

The softcopy on the screen is required for monitoring input and text/facsimile editing. To feature a full page flickerless with Group 3 resolution, a video monitor with approx. 2,300 visible lines at 60 Hz frame frequency would be required. Depending on the size of image and line return, this corresponds to a beam dwell of less than four ns per pixel, and an output rate of more than 240 Mbit/s. Obtaining such data entails technological problems, above all concerning the picture tube. It is therefore recommended to instead make use of a monitor with approximately 1,200 visible lines and a 60 Hz frame. Selecting vertical format and a 44 cm screen diagonal, a full page with half the standard resolution, i.e. 3.85 lines/mm (=Group 2 resolution) can be shown flickerless in original size with black text on white background.

If half the standard resolution is insufficient, e.g. when editing smaller details, switching to full resolution is possible. In this mode only one-quarter of a vertical format page enlarged by the factor two can be represented. However,
the window, i.e., the quarter section, can be shifted over the entire page, both horizontally and vertically. The video monitor is accompanied by a refresh memory of four Mbit capacity. This corresponds to the number of black-and-white pixels of a complete page scanned with Group 3 resolution.

Hardcopies are produced with a matrix plotter. It should output the mixed text/image documents in standard resolution on regular paper DIN A4 sheets within about 10 sec. per page. As required, a processor-controlled device will cut the sheets from a paper reel of 210 or 215 mm width. Like entering, outputting and processing can be handled simultaneously.

The plotter and facsimile scanner, or videocamera or microfilm scanner can be operated concurrently in the local copying mode. Enlarging or reducing is done via software. The local copy renders text duplication by way of an impact printer's carbon copy superfluous. However, since local copying by coupling scanner and plotter via the processor loses in resolution over conventional office copiers relying on xerographic techniques, a combination of copier and facsimile scanner in one and the same device would be desirable. With local copying, the original is reproduced on the copying paper on a 1:1 scale, whereas entering calls for the original to be reproduced—e.g., on a line-by-line basis on a small CCD line.

**Processing**

The known functions of text editing and processing are to be supplemented by the functions of facsimile processing, to the effect that mixed text/image material can be edited just as well.

Texts are edited in alphanumerical coding, in the form entered via keyboard or character recognition circuits. Only for outputting on the screen or the plotter, and perhaps for transmitting, the text is converted into a facsimile and combined with the image information. However, as the plotter is restricted only in resolution with regard to reproducible type faces, and since the reproduction scale of the characters permits ample variations, the text editing software must allow for corresponding variables. Individual type appearance is thus ensured, right up to text graphics, without the limitations inherent in a printer's type set. Furthermore, the coordinates of facsimile fields must be taken into account in the case of automatic line wraparound and margin adjust of mixed documents.

Compared to conventional text systems, where forms can be filled out only by way of complicated screen masks, filling out forms is considerably facilitated. The actual combination of text and form is now left to the printer's hard-copy. In the case of Textfax, writing can be done on the true-to-original form featured on the screen with signets and preprinted matter. The form can be signed without bothering about the softcopy paper. The forms are stored as facsimiles in the image file from where they are called up if needed.

Figure 2 presents an outline of possible functions of a modular editor for integrated text and facsimile processing.

**Filing**

Digitalized images involve large data volumes. While a DIN A4 page with text, alphanumerically coded, requires approx. 1.5 Kbytes, approx. 0.5 Mbytes are needed for a non-compressed DIN A4 page scanned with Group 3 resolution. On a double-density floppy disk for writing on both sides, roughly 600 text pages could be accommodated, but only two image pages. The previous figures could be increased roughly 10 times by taking recourse to single disk systems tailored to local office implementation. It is therefore necessary to develop efficient compression codes, for filing both black and white images and rastered grayscale images. Depending on image content, compression factors around 10 should be expected. Viewed from this angle, too, the floppy disk and the disk seem to be suitable for short-term filing of facsimiles only. For long-range image filing, one therefore has to avail oneself of either central image data bases with magnetic disk, magnetic tape and microfilm, or develop new image mass storage for local use at the workstation. The videotape might be one way to solve the problem. A two-hour tape should accommodate some 10,000 Group 3 facsimiles. Another way is the optical data disk for $10^8$ bit from Philips, which is capable of storing at least 2,500 Group 3 facsimiles.

In the text file, e.g., on floppy disk, so-called document heads of images and mixed test/image documents are stored. They are prepared and managed like texts. The document head contains a list indicating the files in which the various component parts of the document are stored. Text and image shares can be stored in different media.

**Transmission**

The text/image documents prepared at a Textfax workstation can simply be transmitted as Group 3 facsimiles. To this end—as is the case with the softcopy—text components are converted into a facsimile and combined with the image components to form a full-page facsimile of approximately four million pixels. Implementation of the transmission procedure and the compression code (modified Huffman run-length code) in compliance with CCITT Standards T.30 and T.4 is the precondition for international transmission of text/image documents via telephone network to all Group 3 remote copiers, and their true-to-original output.

Due to the standardized scan/plot speed of max. 1 line/5 ms a maximum transmission rate of 1728 bits/8 x 5 ms = 44 kbit/s with an assumed mean compression factor 8 is possible in traffic with Group 3 facsimile equipment without a full-page buffer. However, over analog lines of the telephone network, transmission can be done at a rate of 4.8 kbit/s only, or 9.6 kbit/s at most. Depending on content, the transmission of a page thus takes approximately 1 minute. Transmission via data networks or future digital telephone networks at a signal transmission rate of 48 kbit/s would result in a transmission time of approximately 10 s, which would be in keeping with the maximum plotter speed.

If a text page is not transmitted as a facsimile, but alphanumerically coded, only approximately 3 s. are needed.
Figure 2—Processing.
<table>
<thead>
<tr>
<th>TEXT</th>
<th>IMAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Alphanumeric code</td>
<td>- Pixel lines compressed with modified Huffman run length code</td>
</tr>
<tr>
<td>- Compatible with text stations</td>
<td>- Compatible with CCITT T.30</td>
</tr>
<tr>
<td>- 96-character set (national)</td>
<td>- Vertical resolution 7.7 or 3.8 lines/mm</td>
</tr>
<tr>
<td>Character set for Latin alphabets taken from a basic table (international alphabet No. 5) and an extension table with special characters and letters</td>
<td>- Horizontal resolution 1728 pixels/215mm</td>
</tr>
<tr>
<td>- ISO 7-bit code</td>
<td>- Any image position</td>
</tr>
<tr>
<td>- Free text formatting on standard size longitudinal and transverse</td>
<td></td>
</tr>
<tr>
<td>- Arbitrary margins, exponents, indexes, single, 1.5 and double line spacing</td>
<td></td>
</tr>
<tr>
<td>- Standard 1/10 inch character spacing</td>
<td></td>
</tr>
<tr>
<td>- Variable character size</td>
<td></td>
</tr>
<tr>
<td>- Variable font</td>
<td></td>
</tr>
<tr>
<td>- Automatic textfax switchover</td>
<td></td>
</tr>
<tr>
<td>- HDLC protocol</td>
<td></td>
</tr>
<tr>
<td>- 7 logical transmission levels</td>
<td></td>
</tr>
<tr>
<td>- No transmission in the opposite direction on the same circuit</td>
<td></td>
</tr>
<tr>
<td>- Transmission on request, addressing in document header (send control protocol)</td>
<td></td>
</tr>
<tr>
<td>- Document header contains answerback code, phone number, distribution, date, Re:; etc</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>Either</td>
<td></td>
</tr>
<tr>
<td>- unmanned, automatic connection setup and transmission from send to receive buffer (mailbox) with automatic dialing and automatic retry parallel to local processing</td>
<td></td>
</tr>
<tr>
<td>- manned transmission setup with telephone and manual switchover between voice and textfax transmission</td>
<td></td>
</tr>
<tr>
<td>- manned and unmanned reception with either automatic storage and indication of &quot;incoming mail&quot; or automatic hardcopy</td>
<td></td>
</tr>
<tr>
<td>- Recall of texts from the incoming mail buffer to the screen for further processing (delete, hardcopy, file edit, handwritten comments, forwarding</td>
<td></td>
</tr>
<tr>
<td>- Virtual image transmission</td>
<td></td>
</tr>
<tr>
<td>- Automatic journaling with document headers</td>
<td></td>
</tr>
</tbody>
</table>

Figure 3—Transmission.
instead of one minute at 4.8 kbits/s, thus entailing substantial savings in transmission costs.

To be able to transmit and receive simultaneously with local processing without interrupting either process, one would ideally need a multipage send or receive buffer. Among the eight CCITT test documents the modified Huffman Code has the lowest compression factor with 5.2 with document No. 7. Correspondingly, the buffers would have to have a capacity of $n \times 0.8$ Mbits.

It is thus obvious that for reasons of economy—i.e. to operate with minimum transmission times and small buffer storages—care must be taken in transmission of mixed text/image documents that text components are transmitted in alphanumerical coding, if possible. Depending on the content of the document, switching between text and facsimile mode must therefore be possible during transmission. The most economical buffer storage capacity has still to be found by way of statistical analyses of the documents arising at the office. Assuming a one-page buffer for a mixed document consisting of text and image at a 50:50 ratio, we would thus arrive at a capacity of about $6 \text{kbits} + 0.4 \text{Mbits}$, i.e. approx. 0.4 Mbits. A page having been sent, sending can only be continued after the receiver has confirmed the empty state of the one-page buffer.

To facilitate text transmission between Textfax and text stations, such as memory typewriters which are mapped out for communication, one should rely on the transmission standard for text stations during the text transmission phase. Corresponding international standards have not been established as yet, but they can be expected within the next few years.

Concerning transmission, seven logical levels which will be outlined by the following can be distinguished.

- The physical level with interface to the transmission equipment with signal and signalling lines for connection setup and cleardown in manned and unmanned operation. If Textfax station and telephone are connected to the same telephone line, signalling during connection setup is required to distinguish between language and non-language transmission (corresponding to the data tone). Also, in the case of conversation-interrupting transmission, the receiver must be signalled the
end of Textfax transmission. Basic CCITT standards for Level 1 are

— Standards V.26 and V.27ter for modems, and V.25 for automatic calling equipment, in the case of transmission via the analog telephone network.
— Standard X.21 in the case of transmission via data networks or digital telephone networks.

• The link level with the code-transparent, full-duplex HDLC protocol for protected transmission of text and facsimile blocks.
• The packet level which is required only in case transmission is to be made via a packet switching network.
• Level 4, which initiates the specific terminal and user-related control procedures for which no standards exist so far. For this control level, control characters must be defined to identify the further transmission procedure as text transmission, Group 3 facsimile transmission or combined text facsimile transmission.
• Level 5 with which the end-to-end logs start out. This level provides for mutual identification of the stations according to duplex capability, character supply (alphabet, font), resolution, compression code, automatic multi-page reception, etc.
• Level 6 as the user level. It comprises passwork check, format selection, form number, beginning and end of a page, if necessary change of transmission direction, etc.

— Level 7 encompasses terminal control functions contained in the transmission code, such as control characters for text formatting (beginning of line, line spacing), change of font, change of character size, image position, text/fax switchover control characters, interrupt signals, etc.

In Figure 3 possible features of transmission services of future Textfax stations are listed. In traffic between business partners using the same forms, preprints, etc., “virtual image transmission” is important. A form, for example, is transmitted only as a name under which it is stored in the sender’s and the receiver’s image files, together with text and position specifications for combined copying of text and form at the place of reception.

FIRST RESULTS

Textfax experimental workstation

After this look into the future, let us now turn to the present state of our research work. In order to determine how the functions of Textfax can be implemented and how they will be accepted by the user, an experimental workstation designed in modular multiprocessor technique, which will incorporate the previously-mentioned performance
Bestellung Nr. 168 320

Fa. TEXTFAX GmbH
8000 Munich 83

Datum: 20.10.1978

Diese Bestellung erteilen wir Ihnen zu unserem unentgeltlichen und unentgeltlichen Bedingungen. Die beiliegende Auftragsbestätigung erteilen wir ausdrücklich zurück.

ppz. H. Huber i.V. Meier
(Ger. Huber) (Meier)

Datums und Auftragsbearbeitung (auf Unterricht angegeben) Ihre Zahlung / Ihr Angebot Pdz.
129400-9583-7012 AZE Schmiedt 793-008 M/A

Von der Verantwortlichen: Beschaffungs-Behörden
Siemens AG
Zentrale Forschung und Entwicklung
Warenannahme
Otto-Hein-Ring 6
8000 München 83

Zur Weiterleitung an: Schmiedt, Raum 1531

Datum: 1.01.1979

Position-MR. Bezeichnung der Lieferung/Lieferung Mengeneinheit Preis DM / Einheit
1 TEXTFAX-SYSTEM TFX 15 mit Aufstellung gemäß nachfolgender Skizze
62000.-

Liefer-
schein
Auftragsbestätigung 1-fach an Siemens AG
ZPE Fl, KA
Postfach 85 27 29
8000 München 83

Rechnung 3-fach an Siemens AG
EBP 2
8000 München 1

Figure 6
characteristics, is to be set up in the research laboratory of Siemens AG. The multiprocessor structure is shown in Figure 4. The first stage of this experimental workstation was essentially the configuration shown in Figure 5, which was used to carry out the processing activities described in the next section.

The configuration in Figure 5 is based on the Siemens microcomputer SME 800 with a 64 kB internal memory and two 250 kB floppy disk drives. Text entry and operation of the workstation are handled by a control terminal. Actual text and facsimile processing is performed on a per window basis on a 512×512 dot plasma display showing approximately one fourth of a standard size page in Group 2 resolution. The Group 2 remote copier HF 1048, attached via a digital interface, serves for data entry, hardcopy output and transmission of text/image documents. The graphics tablet can be used to insert handwritten drawings or comments in the softcopy. This configuration may be viewed as an expansion of the remote copier to include local processing functions for text and image.

An editor permitting the elementary functions listed in Figure 2 to be used on black and white images and rastered grayscale images was prepared for processing and mixing text and facsimile. Images are rastered according to the method illustrated in Reference 9, where different grayscale levels are represented by different dot densities. A special redundancy reduction method was developed offering storage economy combined with a low compute time requirement.

Processing examples

Example 1 in Figure 6 shows an order form filled out at the Textfax workstation. The form, which previously has been scanned via the remote copier and stored in a forms file, is displayed on the screen where it is filled with text in a window-by-window fashion. The start of the text line is marked by the cursor which may be positioned to any dot. Font and character size may be changed even within a line. When the text has been entered in the form, the drawing is recalled from the image file and copied into the order form using the cursor for positioning. The order is now ready for approval. After this, it is transmitted as a facsimile from the buffer of the employee's Textfax station to the station of the
purchasing manager, who signs the softcopy before sending the order on to the remote copier station of the supplier.

Example 2 shows processing of a rastered grayscale image. A photo was scanned by the remote copier, the resultant analog information was digitized with 4 bits per pixel and rastered using a 4×4 dot Dither matrix. Figure 7 illustrates the softcopy of the raster image on the plasma display. The black and white image can now be processed. Figure 8 shows the same head done up with glasses, moustache, data relating to the individual, and the signature. The same procedures may be used for producing wanted persons pictures (composite drawings) on a police workstation.

REFERENCES


