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THESIS

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Mention: Physics - Computer Science

Specialty: Imaging

by

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Design and implementation in a production environment of an infographic system applied to digital reprographic techniques.

sustained on October 30, 1992 before the Board of Review:

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Prof. P. MEYRUEIS	Supervisor Professor at ULP Strasbourg
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Dr. F. LAMY	Examiner Doctor in Physical Sciences Director of DALIM Company
Prof. H. SCHMIED	Examiner Professor at ULP Strasbourg

A mes poups,

Quentin et Théophile

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The work presented in this memoir has largely been carried out at the DALIM GmbH research and development center founded and directed by Francis Lamy. I wish to express to him, as well as to the entire management of the company, my gratitude for allowing an employee to go beyond the scope of his duties by bringing together in this work the achievements of four years of professional experience in applied digital imaging.

I would also like to point out that this study would not have taken place without the interest and support shown by the managers of GOLDMANN DRUCK AG who agreed to lend their production environment to the development of the experimental site of our production line. In particular, Frau Ing. Feuchtinger and Herr Ecker should find here the expression of my gratitude for having placed their trust in our project.

I would like to thank especially Mr. Meyrueis, Director of the Laboratory of Photonic Systems, for being my Thesis Director and for advising me and supporting me in the accomplishment of this work.

May Messrs. Goltzene, Mlynski and Schmied be thanked for the honor they have bestowed upon me in accepting to judge this work to which they have encouraged and supported me.

I also wish that the members of the company, DALIM, who have from near or far participated in the realization of this work find here the expression of my thanks. Finally, that Nathalie Monteillet, whose skills in PAO and commitment have largely contributed to shaping this study, recognizes in these lines the expression of my thanks.

Summary FR

Les deux dernières décennies ont laissé libre cours aux constructeurs de stations infographiques pour proposer à leurs utilisateurs des plateformes de développement aux architectures solides et performantes aptes à modéliser puis traiter la problématique de la reprographie numérique.

Jusqu'à très récemment, quelques rares grands constructeurs développant des équipements spécifiques plus fiable que performants se sont ainsi partagé le marché de la pré-impression. Cependant, de plus en plus de sociétés de développement de logiciel choisissent librement la voie de la réalisation conceptuelle puis technique de systèmes de reprographie digitale fondés sur des plateformes standard réunissant les plus récentes innovations technologiques.

Chaque année voyant naître des stations graphiques plus efficaces, il devient indéniable que l'avenir de la reprographie appartient à ce type d'équipement, plus abordable qu'un hardware dédié et surtout plus flexible aux évolutions des techniques.

Or, jusqu'à ce jour, aucune de ces architectures nouvelles n'avait fait l'objet d'une implantation expérimentale au sein d'un système de reprographie traditionnel. Une telle réalisation apparaît utile, voire indispensable pour cerner précisément les perspectives futures qu'offrent ces nouvelles solutions résolument tournées vers l'utilisateur dans le respect le plus strict des contingences de production.

Les travaux exposés dans ce mémoire ont abouti à la réalisation d'un système qui d'expérimentale est passé au stade de la production dès le mois de septembre 1991.

Une première partie situe le problème du traitement numérique de l'image et expose brièvement l'état des techniques employées sur le marché des solutions actuelles.

La deuxième partie constitue une analyse des outils spécifiques à la reprographie suivie d'une étude de leur intégration ans une chaîne de production digitale.

Une troisième partie présente quant à elle l'étude et la réalisation expérimentale de la chaîne de production appuyée sur les choix dictés par les impératifs conjugués de production et de performance d'une imprimerie « numérique ».

Enfin, en conclusion nous présentons une synthèse des travaux en cours assortie d'une analyse critique dessinant les perspectives d'évolution de la configuration mise au point.

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INTRODUCTION

I. INTRODUCTION

Over the past 20 years, computer manufacturing companies have come up with development platforms featuring efficient architectures capable of dealing with digital reprographics challenges.

While some major producers of proprietary equipment—more reliable than sophisticated—share a large market, more and more software development companies opt for the conceptual and technical realization of digital reprographic systems based on ever more effective standard platforms.

It now seems certain that the future of digital reprography belongs to this type of equipment, more affordable than a dedicated hardware and, above all, more flexible to technological progress.

However, until today, inevitably encountering the contingencies imposed by production, none of the new standard architectures had yet been tested in a digital reprographic system. Such an achievement nevertheless seems necessary if one wants to define the future perspectives offered by these new solutions, resolutely turned towards the user while conforming to production requirements. The work exposed in this thesis resulted in the realization of an experimental site that became productive in September 1991.

The first part presents the problem of digital image processing and briefly describes the present state of techniques used in the market.

The second part of this study is devoted to the analysis of tools specific to reprography and, more particularly, to the study of their possible integration into a digital production workflow. A re-creation of the problem of the conversion of RGB standards into CMYK follows the presentation of the development platform used on the experimental site. We then note that the integration of a digital layout system cannot be done without careful adaptation to the performance of input devices (digitalization) and output devices. It follows a comparative study of the various data transfer modes (such as SCSI-Small Computer System Interface bus, GPIB -General Purpose Interface Bus-, Ethernet ....). Finally, a similar type of analysis regarding the various peripherals and their interfaces allows us to establish choices for the transition to the experiment’s successful completion, while controlling the innovation challenges that can occur.

The third part of this paper provides a practical solution to the problem posed by the integration of a third-generation standard architecture workstation into the production line of a printing house. This is why a presentation of the development of the site begins this second chapter.

The chosen site is GOLDMANN DRUCK AG in the Vienna region of Austria. The production imperatives of such a printing house, qualified henceforth as "digital", justify the development as well as the implementation of this creative object-oriented prepress system.

The software used on the workstations is then presented, the format problems are mentioned, as well as the need to exploit the available communication standards.

As far as hardware is concerned, we insist on the need to combine storage and data processing as well as the importance of the evolutionary modularity of the system.

A critical analysis of the solution proposed on the experimental site completes this third part and continues with the subsequent evolution of the site.

We present in a fourth and final part a reflection on the evolution of the installations. For this, we discuss the importance of current standards inherent to the development of pre-press systems such as: XWindows, C ++, Motif. They are indeed the guarantors of portability and easy maintenance of software containing over two million program lines.

To conclude this study, a reflection on the future of the open system in terms of reprography outlines the major points of the specifications of the fourth generation system being developed within our laboratories.

I.

DIGITAL PROCESSING OF PRINTING

I. Digital processing of print

I.1. Definition

If the techniques used in printing have evolved since its invention in 1440 by Gutenberg, the general method remains unchanged to this day: it consists in the reproduction of a document from a matrix.

Depending on the techniques used, this matrix can take various forms: one encounters thus in the form of a photo-engraved plate a technology known as "offset".

This matrix, etched mechanically in the case of gravure reproduction, can also take the appearance of a cylinder. As its production is more expensive than an offset plate, gravure reproduction is essentially used for the production of prints approaching or exceeding one million copies.

An alternative to gravure is flexo-engraving where the support - usually a polymer plate or cylinder - is chemically or laser-etched.

Independently of the reproduction technique, it is in the realization of the matrix that reside the problems that generations of printers at first, then technicians and finally computer scientists, tried to solve.

As a matter of fact, in the field of printing, the reproduction of a matrix is always synonymous with the reproduction of a single color to be transmitted on paper. It usually takes several matrices - usually four - to make a standard print. The number of matrices can however go up to thirty in specific cases such as fabric impressions.

It is to the method of production of these matrices that the present work claims to make a technological contribution.

I.2. : Chronology of pre-press techniques

1440 "And there was light !"

Gutenberg invents the printing press by applying a sheet of vellum on a set of moving characters in relief previously inked. This is the advent of typography in Europe.

1440 - 1930

The concept developed by Gutenberg is still present. The pages of newspapers are printed on matrices made by juxtaposing lead characters, fused together or not, depending on the applications. Pre-press is the name given to the preparation of these matrices.

As soon as 1930,

black-and-white halftone photography is appearing in newspapers. Color reproductions, four times more complex, are reserved for more luxurious prints. The emergence of photographic techniques makes it possible, with photosensitive films, to now make film print masters and use them for the production of the final matrix. Pre-press then consists of the production of the printing films.

As soon as 1960,

the arrival of computer techniques revolutionized pre-print environments, first with the use of imagesetters that relegated lead characters to the rank of antiques, then with the advent of the first consoles for typesetting and retouching graphics (1970s).

1970 - 1990

The pre-print market is booming and devotes to it a lot of equipment, none of which ideally realize text / image integration, usually assembled manually.

As soon as 1990,

The manufacturers of graphic stations are competing with technologies to offer to a market that has become wary because of the profusion of partial solutions, reliable equipment performing in a more or less interactive way text / image integration. We are thus moving towards all digital solutions where even the stage of the development of films becomes obsolete (this is the case of direct engraving).

I.3. : Digital production of a document

I.3.1 : Text processing

The text of a document is always treated separately from the image. Its attributes (size, font, color, etc ...) very different from the pixels of an image allows it to be treated separately by appropriate tools. One of these tools, probably devoted to an even larger diffusion, is the personal computer.. This makes it possible, with a prior storage of fonts, to reproduce from appropriate software about 98% of the current lines / text pages.

These pages generally transcribed on film using a laser photogravure (LINOTRONIC type) are then "mounted" to the image film separations (usually the black film) having undergone a different treatment.

It should be emphasized here that the vector approach of the text, because of its variable attributes, allows the use of inexpensive computer equipment. A typesetting station rarely costs more than 60,000 FF.

I.3.2. : Image processing

At first subject to photographic processing (screening) and then to separation by scanning, the image composition is today still mostly conventionally realized by means of photographic processes and with the help of a pair of scissors and a tube of glue (!).

The digitization of an image as explained in 3.1.2. is a memory consumer. This is why a graphics station dedicated to image processing must combine rapid processing and large storage capacity. This pixel orientation is infinitely more expensive than the vector orientation specific to text processing. A memory space of 40 megabytes, if it is sufficient for the processing of hundreds of pages of text, is only sufficient to store an A4-sized image page.

It follows that the architecture needed to design a graphics station is significantly more expensive than that required to produce the same number of pages of text.

I.3.3. : Text / image integration

It is necessary to open here a parenthesis to clarify what is meant by graphic station. The fact that today many personal computers offer their users tools for creating pages combining text and image leads us to stress the difference that can exist between the generation of a text page embellished with a few images most of them rectangular, and the generation of a catalog type page where five to ten clipped objects are positioned in the middle of a page of text.

The difference in complexity is only relatively imperceptible at the consumer level. The fact remains that the capabilities of a graphic station that can on the creation of a page offer its operator the flexibility and speed of scissors and glue on a traditional assembly are qualities difficult to reconcile with a reasonable investment.

There is now virtually no solution that actually combines text and image since the difference in architecture required for the processing of these two entities makes text processing on a graphics station very expensive. However, the combination of the text and the image for which it is intended is fundamental to the realization of the printing matrix. And the printers today are no longer content with an assembly of films at the end of the treatment to finally see text and image together in the same separation.

Finally, it should be underlined that the text / image combination on the screen must be sufficiently precise to allow for positioning controls.

There is therefore a real need for an interactive, editable and productive image and text digitization model.

I.4. : Solutions available on the market

I.4.1. : "Text" solutions

Remember that we mean here the tools to produce on film a separation called line / text.

This is the vast field of photocomposition that while initially restricted to dedicated systems (Linotype, Berthold, Scantext, etc ...) opens up today to the field of personal computer thanks in particular to the postscript standard.

Thus the photocomposition consoles have in recent years given way little by little to the MacIntosh, less expensive, as effective because based on the same principles of vector modeling of texts, and above all more adaptable to the evolution of techniques.

The disadvantage that these systems encounter in representing on-screen and in real time the same precision of texts and graphics as on the film is compensated by a great productivity and, for the MacIntosh, a great ease of use for control proofs on laser printer.

Finally, it should be emphasized that today the market tends to prefer personal computers to dedicated systems for obvious reasons of cost, flexibility and modularity of investments.

I.4.2. : "Image" solutions

These solutions offered by major manufacturers (LINOTYPE, HELL, CROSFIELD, SCITEX, QUANTEL) all achieve an essentially "pixel" approach to images that can be summarized as follows.

A page is represented by a grid of pixels resolved at 120 points per centimeter. An A4 page represents thus a set of 2520 x 3564 pixels.

The composition of such a page from separate images comprises in a more or less rigid manner the following steps:

1. Input, ie digitization of the elements making up the page. These images, usually photographs, are digitized (cf 3.3) in their final positions and magnification ratios - example, 315%, 15 ° rotation. These elements stored on magnetic or magneto-optical media then create a set of files occupying a storage space of the order of 70 megabytes (for the purpose of producing a standard A4 size page).

2. Clipping: each object is clipped (cut-out) according to the location it must occupy on the final page. The clipping information is hereby generally stored in a file called mask or stencil, appended to the file of the clipped object.

3. Composition: each object thus cliopped is in turn loaded on the composition console. These objects are positioned within the final "layout" which, then stored, can be computed to produce the resulting final pixel file.

4. Output: the color separations corresponding to this last file are made on a phototracer. The editing of the text is done later by conventional editing most of the time limited to the black film.

The architecture required for the processing of these images is, for most manufacturers, mostly fixed in dedicated systems rarely used beyond an investment exceeding often 2 million francs.

I.4.3. : Text / image solutions

These solutions are recent and result for the most part from the extrapolation of one or the other of the two all-text or all-image solutions previously exposed.

Text-based systems are now trying to offer image integration solutions. The basic architecture of such systems, however, being of very limited capacity, the performances obtained are directly a function of the level of the material investment made by the buyers.

Note here the wise approach followed by MacIntosh which, rather than engaging its customers in oversized investments, offers with OPI (Open Prepress Interface) an elegant solution to the users. This system makes it possible, by using low-resolution representations of images during applications (Pagemaker, Quark-XPress, etc.), to save the page files with geometric information to authorize an easy creation of the background image on a more appropriate console (LINOTYPE-HELL CHROMACOM for example).

The image-oriented systems have had a different approach. Indeed, with the progress of the postscript standard, all major manufacturers have proposed a solution based on a RIP (Raster Image Processor) capable of transforming text files from other systems in hybrid bitmap or runlength files (see 3.3.2.) to allow the superposition and then the combination with the background image. This method, if it is relatively simple to implement, realizes only a rough combination of text and image since the text or line once present on the console is virtually no longer editable, neither in attribute nor in resolution.

It is therefore a market looking for alternative solutions that initiates the development of new technologies.

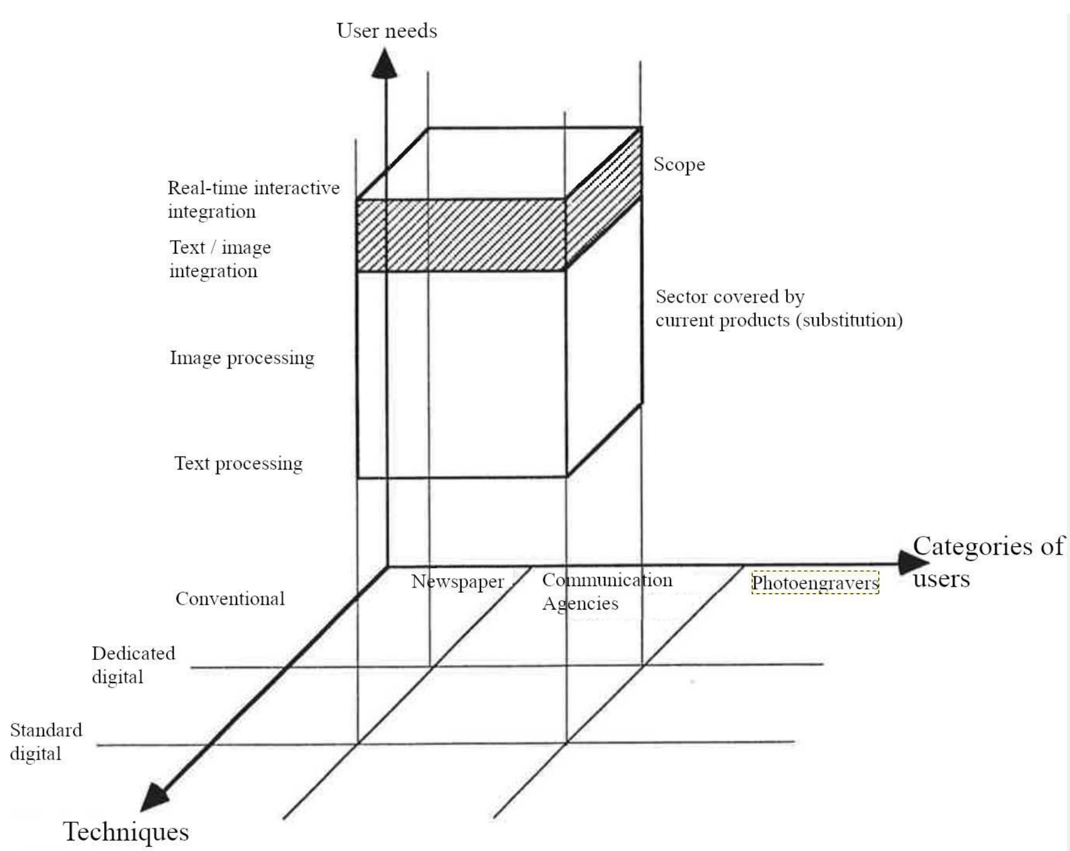
I.5. : Originality of the proposed solution

As the following study points out:

the architecture of the system put in place during our work is intended to bring together, both in terms of software and technology, the advantages of "text" systems and those of "image" systems.

I.5.1. : Market expectations

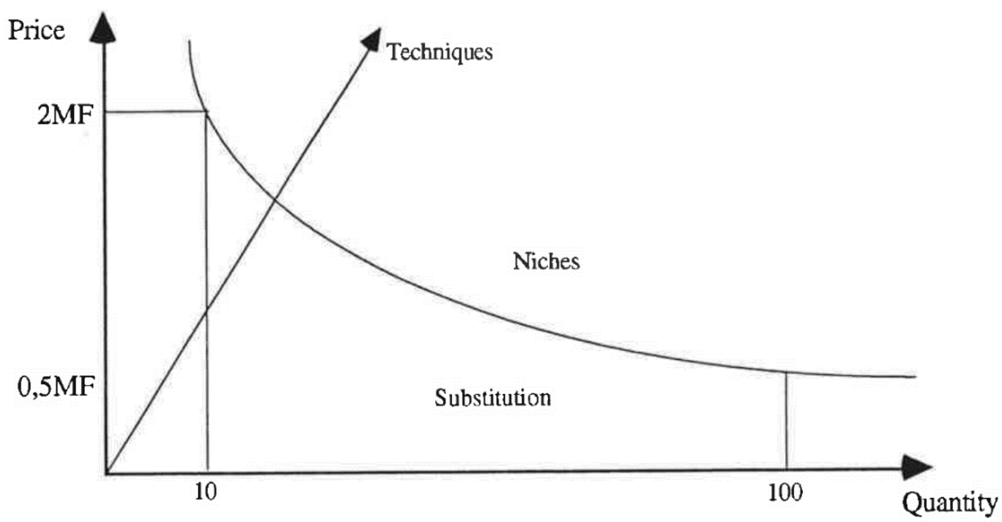
The diagram below illustrates the expected field of application of the proposed photonic technology. The segmentation method employed for this purpose (SCHMIED 1992) takes into account the categories of users, their needs and, finally, various techniques used in the assembly of a printing matrix.



I.5.2 : Positioning of the product

The system presented in our study does not only produce a substitute for existing techniques. The interactive digital method, real time, WYSIWYG that we propose meets an unmet need of the users. They can now edit their pages without restriction and almost until the time of going to press.

For a conventional technique, located above the Price-Quantity curve described below, the system is therefore primarily intended for a niche market.



Like many products with a large software component, it is the expansion of the distribution that, after the launch, will result in a significant decrease in the selling price.

II.

The issue of the creation of a digital production chain

II. The issue of the creation of a digital production chain

II.1 : Heart of the system, the development platform

II.1.1 : Comparative analysis of the benefits of current systems

When searching for a platform for development and production for an infographic system, it is necessary to understand the functions required by the software (DALIM-Litho in our case) as described in 4.1.2.

The originality of this software lies in the desire to reconcile on the same system vector elements and pixel elements.

Whereas a one-color "pixel" rectangle requires for its description a quantity of pixels directly proportional to the unit on which it will be represented, the same vectorial rectangle can be described by three data:

- Lower left corner
- Upper right corner
- Color information

The vector element has the further advantage of offering a description that is independant of the device on which it will be reproduced.

The required workstation must therefore be able to effectively reconcile pixels and vector "segments". It must also offer the possibility to be used in CMYK technology (see 12.1.3.3.).

The table in Figure 1 (TEK 1990) is a comparison of possible technologies at the beginning of 1990.

The choice of the TEK XD88 / 30 station (preceded by the model 4337) is the result of a compromise meeting the previously mentioned criteria.

XD88 3D Workstation Comparison
Price/Performance

	Tek XD88/30	Apollo DN 10000	SGI 4D/80GTB	Hewlett Packard HP835 Turbo SRX	Sun 4/260 CPX
Graphics 2D Vectors/sec. 3D Vectors/sec.	 450K 350K	 1100K 1100K	 400K 400K	 270K 240K	 200K 150K
Processor	Motorola 88000	Prism RISC	MIPS RISC	HP PA RISC	SPARC
Clock Speed	20MHz	20MHz	17MHz	15MHz	17MHz
System Memory	8-176MB	8-128MB	8-16MB	8-96MB	8-128MB
Configured Price Includes 19" display, 300MB hard disk 24 Bit planes, 16MB system memory	$63,950	$99,900 (40 Bit planes, not 24)	$88,900 (48 Bit planes, not 24)	$103,500	$78,000 (16 Bit planes, not 24)

Fig. 1

II.1.2 : The Tektronix XD88 graphic station

The Tektronix XD88s are computer graphics workstations for CAD / CAM users, scientific visualization, animation and high-end graphics software development. The XD88 family represents a real bridge to the interactive visualization systems of the 90s. It includes important visualization functions and conforms to the old market approach: evolution to new levels of performance while retaining compatibility with their current graphic products.

II.1.2.1 : Performance and modularity

The XD88 family (TEK 1990) combines the performance advantages of Motorola's RISC 88000 processor with the multi-processor architecture of the TEK 4300 workstations introduced in October 1987. The CPU side implementation of the Motorola 88000 RISC processor associated on the graphical side to the 68020 gives the XD88 series an unequaled performance for intensive infographic applications. The "super" XD88 / 30 3D graphics workstation provides computing power equal to 17 MIPS and can synthesize 350000 3D vectors per second. This last performance is 450000 2D vectors per second and 20000 shaded triangles per second.

Finally, the modularity of the architecture of this station allows users to choose the computer and graphics levels that exactly meet the needs of their applications. It also facilitates any later extension of these capabilities (memory, disk space, etc ...).

II.1.2.2. : Compliance with existing standards

- The Utek V operating system provides a complete implementation of UNIX System V.3 with Berkeley extensions such as C Shell (G. ANDERSON) and Fast File System (FFS). Utek V complies with the IEEE Posix (Portable Operating System Interface for Computing Environments) and the AT&T SVID (System V Interface Definition) standards.
- An implementation of the X-Windows version 11 system allows users to run 2 or 3D graphics applications in this environment (V. QUERCIA) while maintaining full use of the station's performance.
- A coexistence of the VME communication bus and the Futurebus (according to the IEEE 896.1 - 1987 standard) allows a future evolution (Futurebus) combined with a valuable compatibility with the VME standards.
- For graphic applications, the implementation of the international high performance 3D PHIGS (Programmers Hierarchical Interactive Graphics System) standard as well as the GKS (Graphics Kernel System) 2D standard with the Tek PLOT 10 industrial graphic standard will be highlighted. Finally, the 88000 binary compatibility ensures easy processing of many applications developed for this processor.
- For easy network integration, XD88 workstations support TCP/IP Ethernet and Network File System (NFS) as well as System V Remote File System (RFS) and allow multiple network files and devices to be used in a network.

- A PC / AT emulation allows XD88 stations to support the EGA graphics card applications developed on IBM AT.

II.1.2.3. : System architecture

The Motorola 88000 processor provides, with a clock speed of 20 MHz, a computing power of 17 MIPS and 12 MFLOPS.

Four cache memory units (CMMU) totaling 64 Kb maintain the flow of data transmitted to the processor and thus guarantee optimal use of its capabilities. This cache memory system can be extended to 8 CMMU for a total of 128 Kb. 176 megabytes of system memory can be attached to the internal communication bus.

Finally, for disk access and efficient bus use, a card (I/O) manages the inputs and outputs through 8 DMA (Direct Memory Access) channels.

The coexistence of the universally recognized VME bus with the Futurebus combines the performance of an emerging standard with the performance of a new technique.

The graphics part of the workstation is built on the basis of Motorola's 68020 processor running at 16 MHz. It is the VME bus that communicates between 88000 and 68020 through a shared memory technique.

This graphic part is equipped with "frame buffer" controllers that refresh each pixel of this "frame buffer" every 74 nano seconds. The speed of this operation is independent of the number of plane bits of the "frame buffer" therefore particularly suitable for prepress applications that require 24 bit planes.

A technical sheet relating to TEKTRONIX workstations is presented in Appendix I.

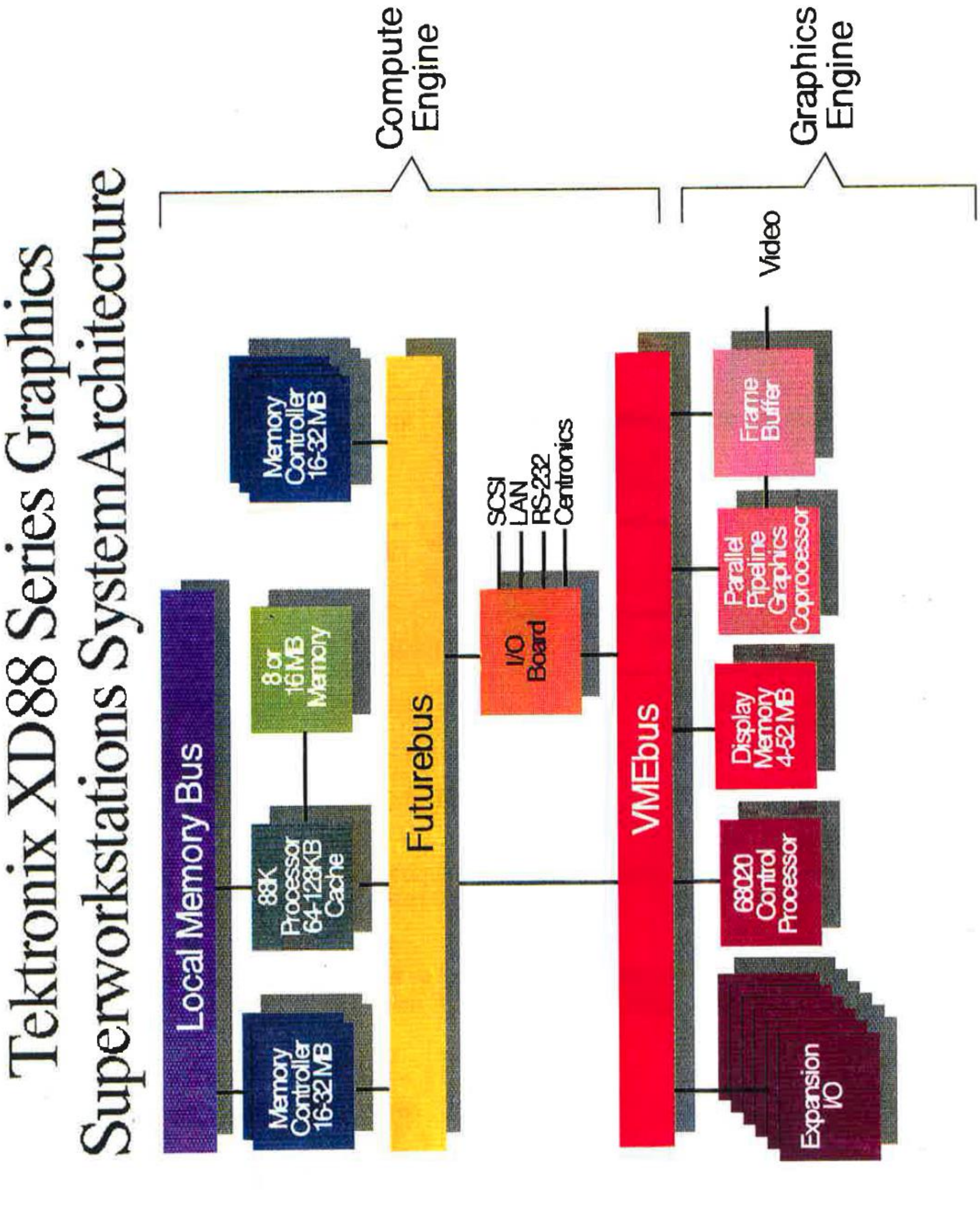

Tektronix XD88 Series Graphics
Superworkstations System Architecture
Compute Engine
Graphics Engine
Local Memory Bus
Memory Controller 16-32 MB
88K Processor 64-128KB Cache
8 or 16 MB Memory
Memory Controller 16-32 MB
Futurebus
I/O Board
SCSI
LAN
RS-232
Centronics
VMEbus
Expansion I/O
68020 Control Processor
Display Memory 4-52 MB
Parallel Pipeline Graphics Coprocessor
Frame Buffer
Video

Fig. 2

II.1.3 : Introduction to the basics of a digital reprography method

The architecture of the XD88 / 30 graphics station previously described, although it provides a working basis adapted to the development of CAD / CAM software, nevertheless reveals some shortcomings for use in prepress.

II.1.3.1. : Color and light

Light, which is one of the many forms of radiant energy, propagates in the form of electromagnetic waves characterized by their wavelength λ and their frequency ν.

Figure 3 briefly recalls the arrangement of the electromagnetic spectrum:

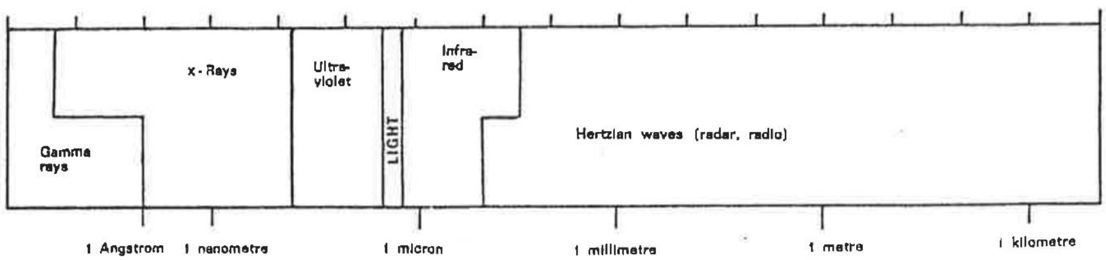


Fig. 3

Thus, the visible electromagnetic spectrum is limited to radiation whose wavelength is included between 0.4 and 0.7 microns.

The spectral decomposition of a beam of white light by a prism – illustrated in Figure 4 – gives us a good idea of RGB (Red, Green, Blue) as the 3 primary colors of light.

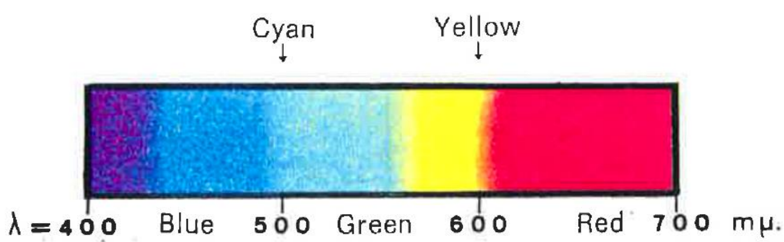


Fig. 4

An additive synthesis of these three primary colors carried out by projection through colored filters of a white light beam leads to figure 5:

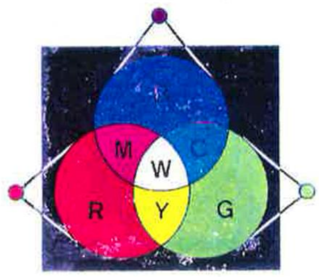


Fig. 5

From this figure 5, we will highlight the appearance of the three CMY (Cyan, Magenta and Yellow) secondary fundamental colors that are defined by C = B + G, M = B + R and Y = R + G.

As for the white "color", it results either from the addition of the fundamental RGB primary colors or from the addition of a primary color and its complement among the secondary ones. This leads us to attribute to each primary color its secondary complement.

PRIMARY COLOURED LIGHT	BLUE	GREEN	RED
ITS COMPLEMENTARY	YELLOW	MAGENTA	CYAN

Fig. 6

More generally, the color space addressed by a conventional type graphic station is a trichromatic space which can be schematised as follows:

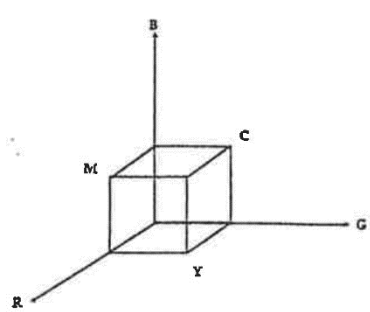


Fig. 7

II.1.3.2. : Color and pigmentation

If one tries to reproduce by means of pigments (of ink) an analysis similar to that mentioned in 3.1.3.1., it leads to the subtractive synthesis of the following colors:

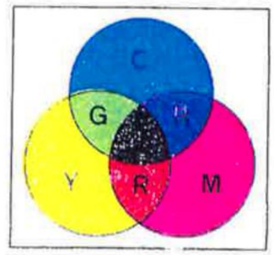


Fig. 8

Thus, the primary primary pigments CMY complement the secondary pigments RGB according to figure 9:

BASIC COLOUR PIGMENT (PRIMARY)	CYAN	MAGENTA	YELLOW
SECONDARY COLOUR PIGMENT (ITS COMPLEMENTARY)	RED	GREEN	BLUE

Fig. 9

II.1.3.3. : CMYK versus RGB

In printing technology, while the use of CMY inks is essential, it is neither sufficient nor suitable for the reproduction of dark hues where the use of a black pigment is necessary.

In fact, mixing the equal quantities of the three basic inks to obtain a dark hue is:

a. consumer of expensive ink

b. long to dry therefore not very adapted to a fast rotation of the offset presses (Fig. 10)

c. unsatisfactory with regard to the quality of the gray tints which all tend towards brown/gray.

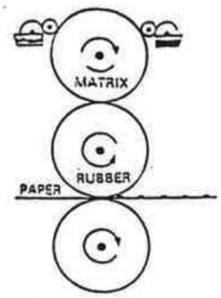


Fig. 10

That is why, in printing, the trichromatic theoretical model must be replaced by the universally recognized CMYK quadrichromy.

This state of the art poses a fundamental problem: that of working in at least * quadrichromic mode on a graphics station operating in trichromic mode (RGB).

II.1.3.4. : Specificity of the system in CMYK operation

The application software processes quadrichromic color data for the reasons given in the previous paragraph. Images are stored in live memory as "four-layer" files (Cyan, Magenta, Yellow, blacK).

The workstation that operates in RGB mode (screen) must therefore process the CMYK information by means of a real-time conversion process.

This feature leads to the elaboration of a hardware architecture illustrated in Figure 11:

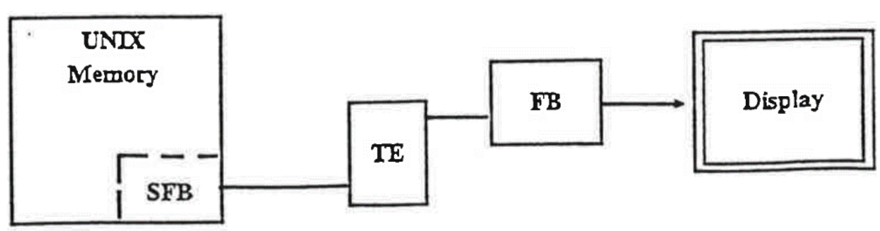


Fig. 11

** We will see later that applications as specific as heliogravure require more colors and can go as far as requiring 10-color models.*

SFB is the "Shadow Frame Buffer" that the operating system technique most commonly designates by NSA (Non Swappable Area). Indeed, the particularity of this reserved area on the UNIX memory is that it must never be stored temporarily on disk (swapped) so that it is always recognized at the same address. The Transform Engine (TE) is a special component providing real-time CMYK <---> RGB transformation (at least 2 megapixels * / second).

The need to ensure real-time CMYK <---> RGB transformation involves extremely reduced transfer times mentioned below:

UNIX <---> SFB	>	5 Mbps
SFB <---> FB	>	5 Mbps
Disk <---> UNIX	>	2 Mbps

In fact, the figure of 5 Mbps is roughly given by the refresh rate of a 1024 x 1280 pixel high resolution display:

1024 x 1280 x 5 = 5,243 Mb

A speed of 5 Mbps guarantees a continuous and smooth "scroll" function **.

** Note that the storage of a pixel is done on 32 bits, each channel (CMYK) occupying 8 bits.*

*** Scroll: translation of a screen window on a pixel file in real time.*

II.2. : The standards available for interfacing

Among the various solutions proposed by the manufacturers of graphic stations, there are several types of technologies to ensure the inputs / outputs.

These techniques, with their very different characteristics, make their adoption decisive as regards the performances resulting from their implementation.

The next chapter, if it does not carry out an exhaustive analysis of the available technologies, does nonetheless constitute an overview of the solutions used on the experimental site. Figure 12 summarizes all the interfacing technologies present in our IBK XD88 / 30 station, the most commonly used of which are described below (TEK 1990).

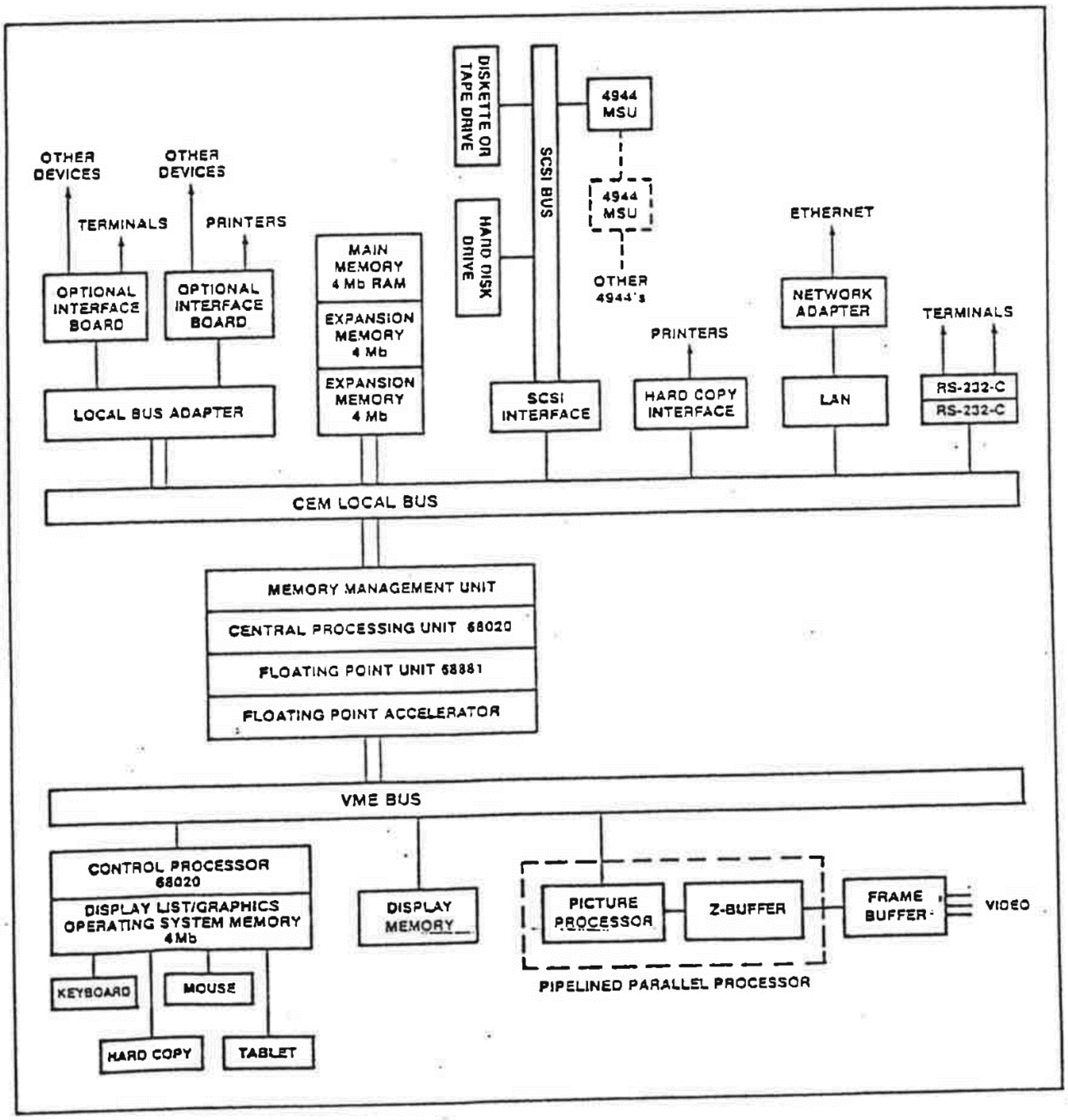


Fig. 12

II.2.1. : Introduction to the Small Computer System Interface (SCSI) bus

II.2.1.1. : The standard

This interface consists of a parallel data bus dedicated to the communication between a maximum of 8 independent devices (see Fig. 13). Originally developed to allow fast and efficient data transfer between a central computing unit and storage unit(s) (disks, tape drive...), the SCSI bus offers graphic stations and more generally personal computers (as opposed to hardware implemented in "traditional" computing centers) a real opportunity for rapid communication between CPU and storage unit.

The purpose of the SCSI interface is to facilitate the integration of small computers and smart devices. This interface, which is suitable for an LSI circuit adaptation, requires only relatively inexpensive hardware but is only operational over short distances in the range of one meter for data transfers not exceeding 4 Mbps.

The commands specific to this interface are very generally independent of the device concerned. This allows the development of "universal" software allowing the control of all devices of the same type.

The appearance of VLSI controllers (FUCHS) now positions these controllers usually inside each device. This trend, as opposed to the older technique of providing expensive logic controllers, now allows access to high-performance peripherals. Indeed, the close interactions between the recording material, the recording mechanism and the recording technique within these peripherals generate real problems of intersymbolic interferences and automatic correction of errors very specific to the chosen technologies. These problems are more likely to be solved inside the device itself by choosing an integrated controller.

In addition, the amount of storage devices is constantly increasing and thus makes the development of interfaces from the communication bus of the central units to each association (central unit - peripheral) complex and specific.

This state of the art calls for the integration of the controller within each device and thus marks the emergence of the central peripherals in succession to the "central units". Indeed, and perhaps even more in the field of graphics stations, it is no longer the computer that constitutes the "center" of the configuration but the whole of the configuration which realizes a production chain whose links functionality is the only responsible for the productivity of the whole. Figure 13 below illustrates schematically the evolution of technologies in the 1980s.

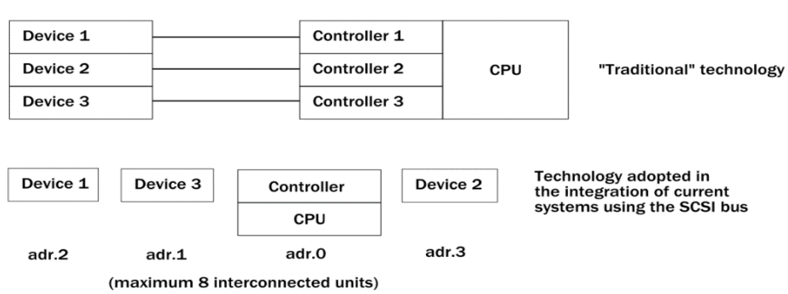


Fig. 13

The SCSI standard, submitted at the X3T9.2 committee meeting, achieves a formalisation with an extension of SASI (Shugart Associates System Interface, 1982).

Among the significant characteristics of the SCSI standard, we will mention more particularly:

→ A differential option of the interface allowing its use in an environment rich in interferential noise for a cable length equal to or less than 25 m (the maximum length of conventional SCSI interfacing is 6 m)

→ A "synchronous transfer" option allowing a data transfer rate of up to 4 Mbps

→ An optional group of so-called "extended" commands whose vocation is to effectively address large capacity storage units (gigabyte order) on 2^{32} memory blocks instead of 2^{21} originally

→ Controls for CPU printers, WORM optical disks, and other disks that do not necessarily use traditional magnetic storage technologies.

These features, which were brought together for the first time in a standard statement, established SCSI technology. Indeed, most of the current peripherals are equipped with these controllers which allows the integrator of current systems to have a wide range of products among which we can highlight in particular:

- fixed hard disks
- removable and pluggable disks
- flexible disks with Bernoulli effect
- flexible disks with closed loop
- optical discs
- tape drives of different formats (Video 8, 9 tracks, etc ...)
- Hybrid systems combining two or more of the technologies mentioned above.

II.2.1.2. : The SCSI switch, derived technology

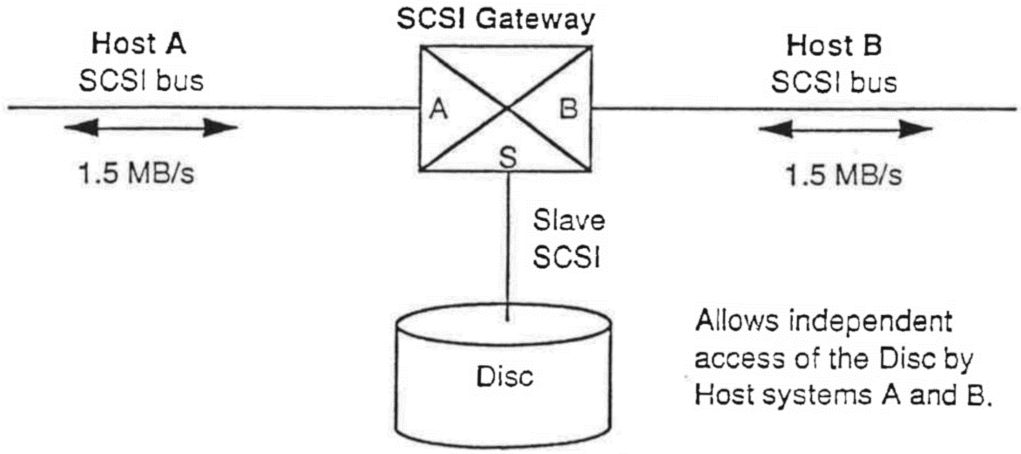
If the SCSI standard allows multiple devices to be connected to a central unit, it does not allow the connection of a device to more than one central unit.

Especially in prepress technology, it is necessary to quickly transfer a large amount of data (images) from one central unit to another.

Example of an A4 format pixel image for a standard print resolution of 120 l/cm:

- number of pixels to "store": 21 x 120 x 29.7 x 120 = 8.98. 10^6 pixels
- however, 4 bytes of 8 bits are generally necessary for the encryption of 4 C, M, Y, K channels. Indeed, 8 bits allow to assign a "depth" of 256 levels to each channel.
- it comes out: image size = 35.9 Mb (Megabytes).

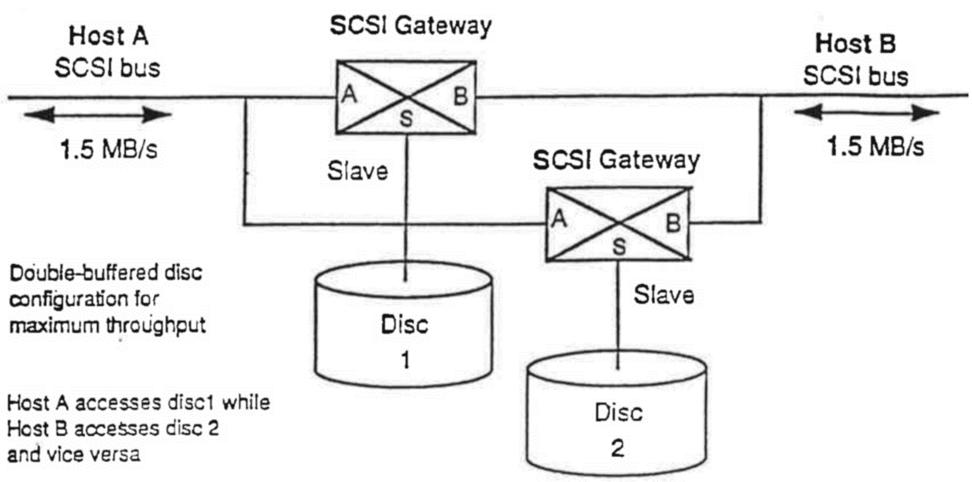
Thus, the scanner digitization unit designated by host A in figure 14 stores its data on disk. The processing unit, that is to say the graphics station (host B in figure 14) must be able to have it quickly.



SCSI Gateway - Single Buffer Configuration

Fig. 14

The switch SCSI more generally designated by "switch" or "gateway" represented in fig. 14 (HlGHWATER 1990) makes it possible to have the contents of one or more (Fig. 15) disks on one or the other of the central units of a configuration.



SCSI Gateway- Double Buffered Configuration

Fig. 15

Figure 16 maps the structure of the SCSI gateway used in Figure 14.

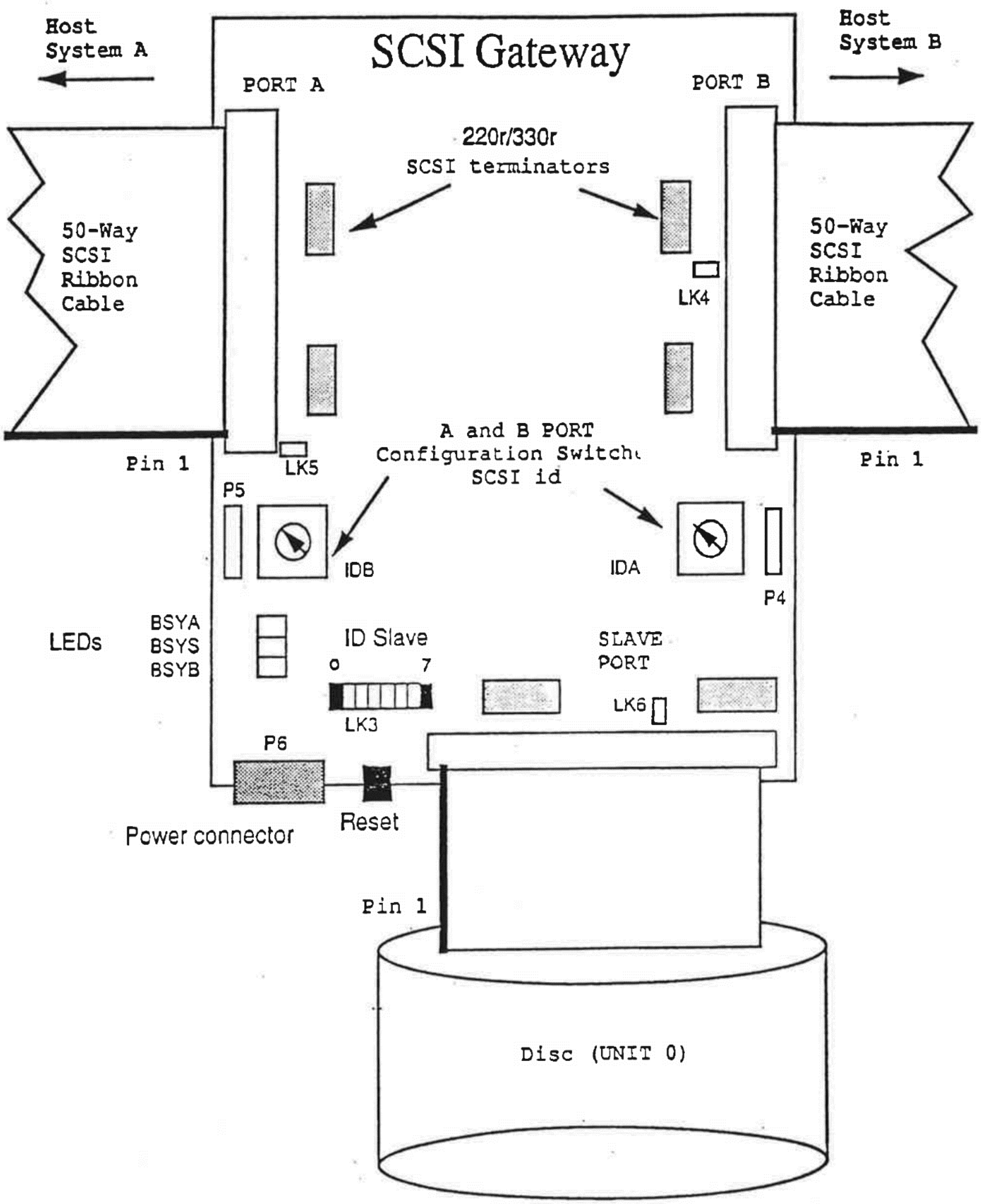

Host
System A
SCSI Gateway
Host
System B
PORT A
PORT B
220r/330r
SCSI terminators
50-Way
SCSI
Ribbon
Cable
50-Way
SCSI
Ribbon
Cable
LK4
A and B PORT
Configuration Switch
SCSI id
Pin 1
LK5
Pin 1
P5
IDB
IDA
P4
LEDs
BSYA
BSYS
BSYB
ID Slave
0
7
SLAVE
PORT
LK6
LK3
P6
Power connector
Reset
Pin 1
Disc (UNIT 0)

Fig. 16

II.2.2. : General Purpose Interface Bus (GPIB) presentation

As well as the SCSI interface, the GPIB interface consists of a bus through which interconnected elements communicate.

Originally designed by Hewlett Packard as HPIB (Hewlett Packard Interface Bus) to enable the control of specific instruments, this interface allows data transfer speeds in the range of 1 Mbps. These performances quickly brought this type of interfacing to the rank of industrial standard (IEEE-488 standard).

The many possible uses of this bus have naturally induced the name of GPIB.

The GPIB bus carries 2 types of messages:

- device-specific messages that include:
  - programming instructions
  - measurement results
  - state of the device
  - data files
- Interfacing messages specific to the communication bus:
  - bus initialization
  - connecting or disconnecting a device
  - initializing a device in local or remote control programming mode.

Devices distributed along the GPIB bus can be transmitters, receivers or controllers.

The transmitter sends messages to one or more receivers. The controller manages the flow of information passing over the bus by sending commands to all the devices. A given device can be receiver, transmitter and / or controller.

The operating principle of the GPIB bus controller is similar to that of a telephone exchange system. The controller manages the communications on the bus. When a transmitter wishes to come into contact with a receiver, the controller puts them in communication and then interrupts this communication once the data transfer ends.

A GPIB interface card allows current CPUs to act as both a bus controller, a device transmitter and a receiver to receive data from the devices.

Although the GPIB bus structure supports the coexistence of multiple controllers, there can only be one active controller at a time (usually the central unit).

It is however this feature distinguishing the GPIB bus from the SCSI bus which allows the extension of a linear configuration (Fig. 17) to a star configuration (Fig. 18) without the addition of a "gateway" such as described in 3.2.1.2.

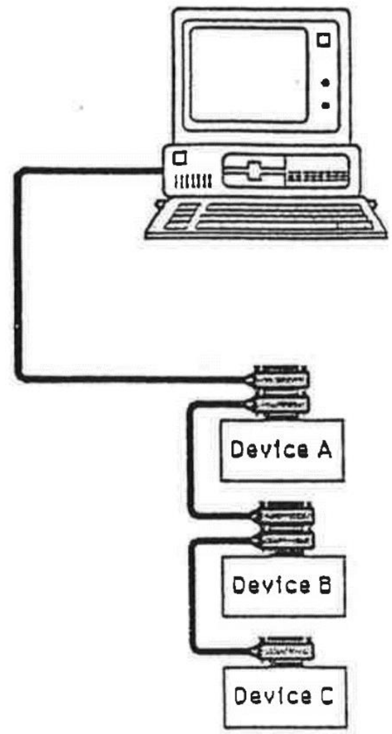


Fig. 17

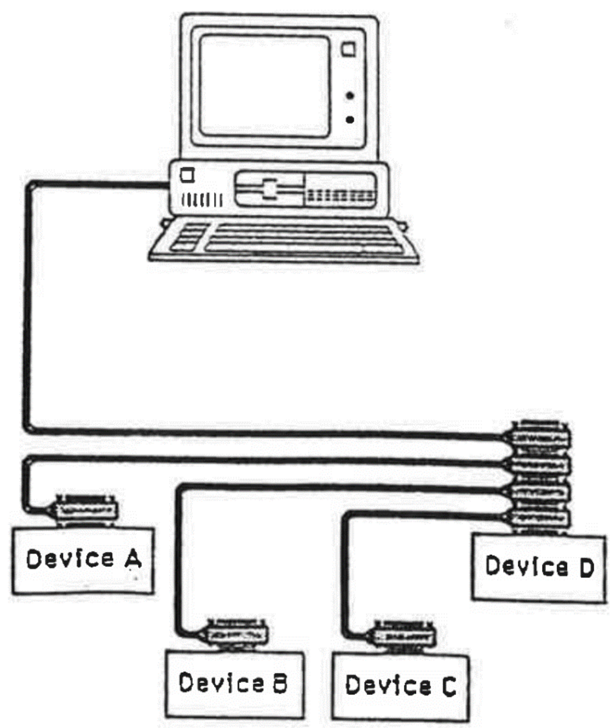


Fig. 18

Finally, among the particularities of this communication bus, we can note more particularly:

- a maximum cable length not exceeding 20 m
- a maximum of 15 devices per bus
- a maximum separation of 4 meters between consecutive devices.

II.2.3. : Presentation of NFS (Network File System)

Developed by Sun Microsystems, NFS allows access to multiple file systems within architectures that can be very diverse. This is how the user of a workstation can access remote storage units, managed by a server or another station. This technique, commonly used in the field that interests us, allows the user to take advantage of very large storage capacities while preserving the computing resources of his own central unit.

Another advantage of this technology lies in the possibility of remotely controlling a calculation on a station physically distant from the unit on which one works.

In fact, it is only the transfer speed on the network that will limit the use made of the latter. Indeed, a file transfer by the network shows in practice a transfer speed at least 5 times lower than in the case of the use of a local device (SCSI for example).

Figure 19 illustrates in a non-exhaustive manner a specific Ethernet configuration.

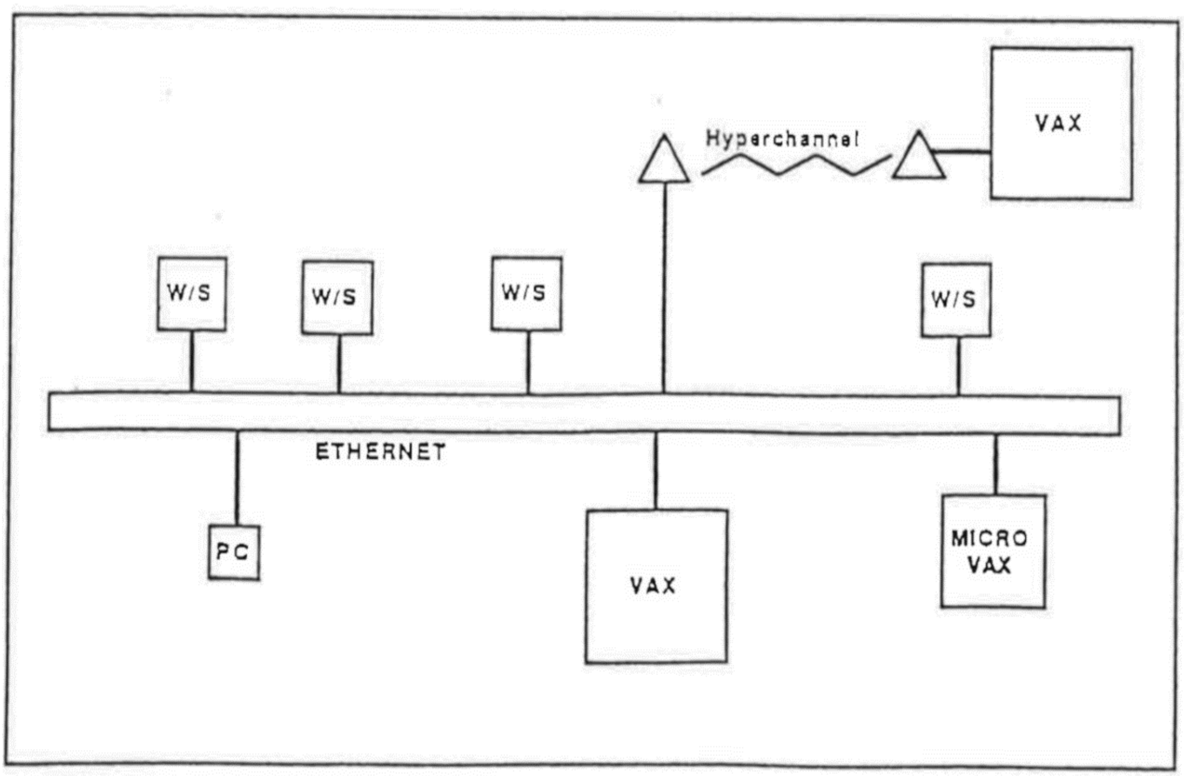


Fig. 19

Finally, it is through their LAN (Local Area Network) interface that most graphics stations can interface with an Ethernet-type network. This interface, practically ubiquitous on any recent graphics station, allows a simple and efficient networking quite suitable for use in graphics processing.

II.2.4. : The "Centronics" type 8-bit parallel interface

It is a very popular interface in the computer world, since it is widely recognized as the preponderant technology for the interfacing of printers. It is for this purpose that this technology is used on the reference site.

II.3. : Input devices (digitization)

II.3.1. : CCD scanners (color)

II.3.1.1. : Principle and performance

At the origin of these scanners, we find the now recognized CCD cell whose function of storing and rendering a pixel line matched with an adapted filtering allows the digitalization of a document in RGB mode.

Flatbed CCD scanners (Fig. 20) can digitize a paper-based document with a resolution of only about 400 dpi or about 157 l / cm or 120 l / cm for a magnification factor of 1.3. Their ease of use (photocopier type) and their good quality of digitalization make it an excellent auxiliary material (transfer speed GPIB close to 200 Kb / s) for documents requiring digitization to the ratio of 1: 1.

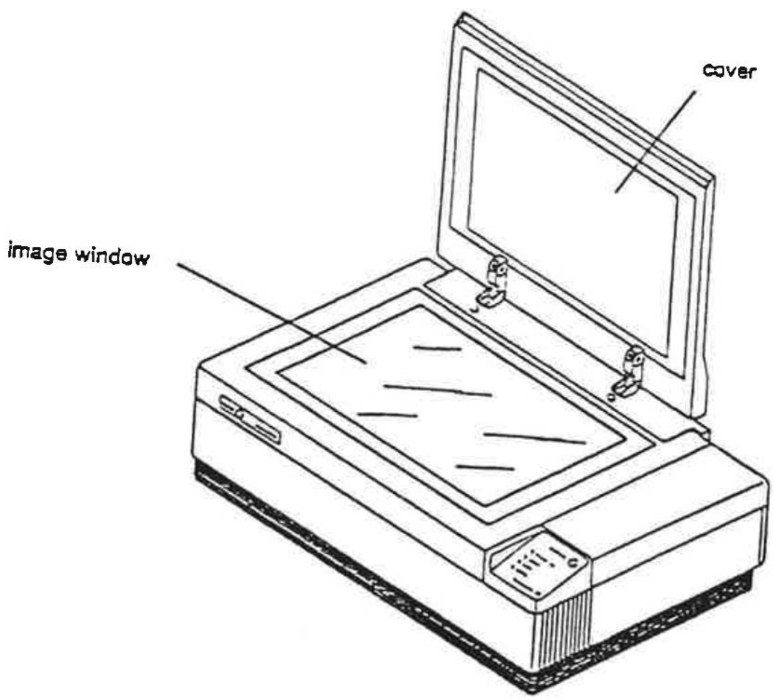


Fig. 20

The slide scanners that make up the "desktop" CCD digitalization cameras make it possible to achieve a maximum digitization of 6000 x 4000 pixels for a 35 mm image.

II.3.1.2. : Usage

Typically implementing 8-bit color coding for each pixel, CCD scanners work only in RGB mode. On the other hand, if the flat scanner can prove sufficient for a digitalization of "paper support" documents in large format, it would be necessary to resort to a CCD digitalization camera for any document of type slide.

The recent arrival on the market of peripherals carrying out 10 to 12 bit coding of the R, G, B channels however arouses a renewed interest for the CCD technology.

This does not preclude the fact that the virtual absence of CMYK integrated coding necessary for reprography relegates these devices to the rank of auxiliary device for use in pure digitalization.

As observed in 2.1. 3.3., the quadrichromic coding of an image is of fundamental utility for reprographic use. CCD scanners, not equipped with a "color computer" such as the one used by the drum scanners, leave to the processing software the task of carrying out this complex conversion.

This so-called "RGB" philosophy is not very productive, given that each pixel image requires in principle a specific color separation. This state of the art reduces the systems based on this principle to an almost figurative role because it is too far removed from the realities of production.

This is why CCD scanners nowadays play only a supplementary role, if not in the case of use for vectorization of lines. This technique based on a gray level thresholding method naturally favors scanner operation in black-and-white rather than RGB mode.

II.3.2. : Drum scanners

II.3.2.1. : Principle and performances

Illustrated in Figure 21 (ASTRUA), the principle of color separation has been adopted for several decades in drum scanners.

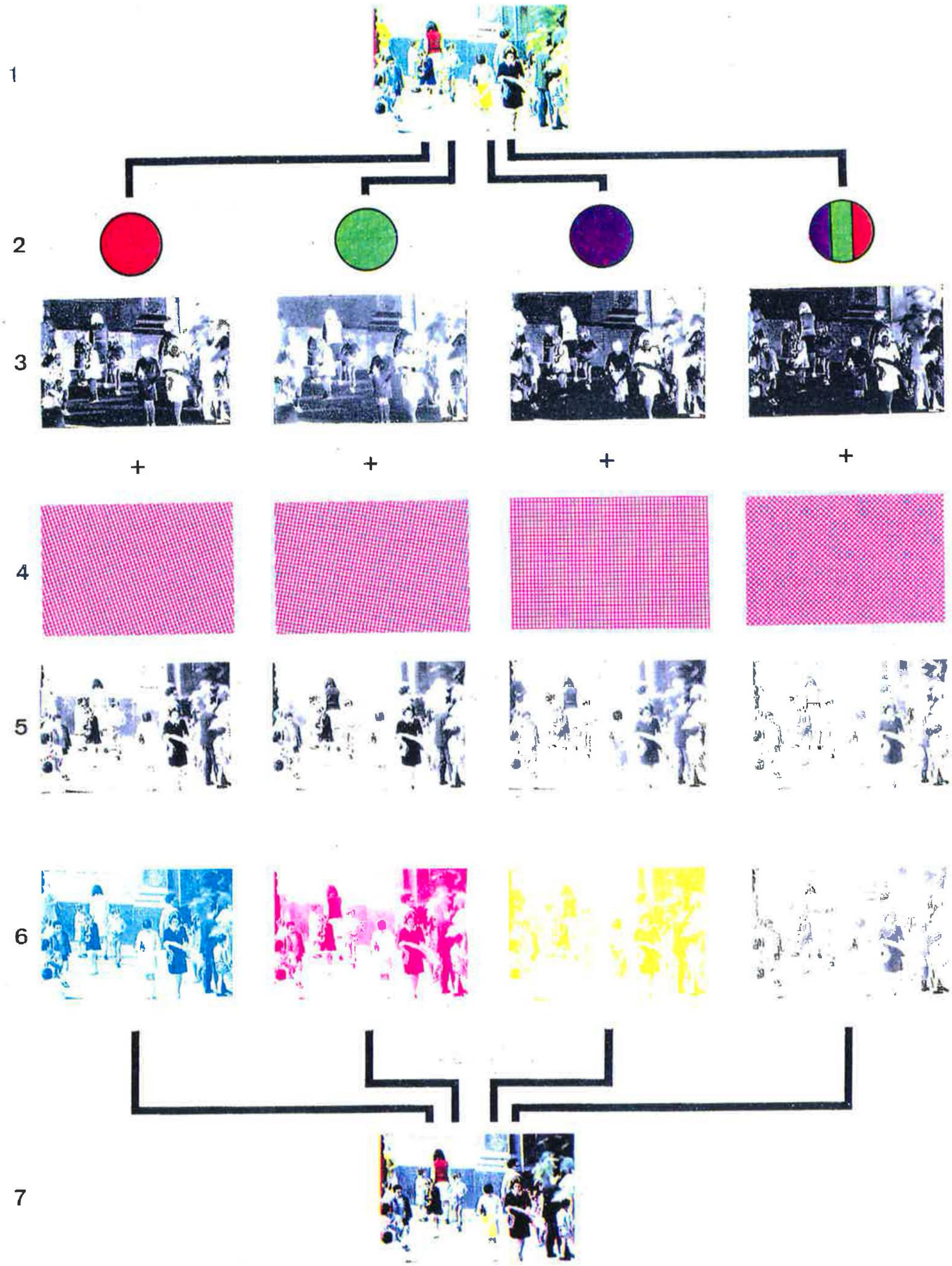


Fig. 21

Color separations for CMYK reproduction are obtained by filtering then screening. Figure 22 shows the selectivity of RGB filters applied to CMY color separation.

	Reading through the filter		
Colour of ink :	RED	GREEN	BLUE
CYAN	1.57	0.5	0.2
MAGENTA	0.2	1.38	0.67
YELLOW	0.02	0.1	1.67

Fig. 22

As can be seen, the Cyan ink also absorbs, in addition to the red color, a significant amount of green as well as a little blue. A similar effect "dirties" also the magenta and yellow inks.

The color correction unit - color computer - of a scanner aims to overcome these drawbacks and to produce separations that can faithfully reproduce all the characteristics of a color document. The photographic frames have given way to the digital frame generators. Furthermore, a He-Ne laser (Fig. 23) used on the SO 608 II scanner of the reference site allows simultaneous analogue (film production) and digital (SCREEN 1989) use.

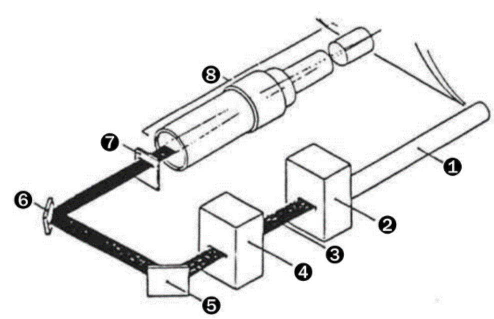


Fig. 23

The use in digital mode generally requires the addition of an input / output decoding unit which channels the signals. This unit works in the input according to the principle illustrated by the Figure 24 diagram, in the output according to Figure 25. The interface created in the context of our study is based on these two basic diagrams.

Basic diagram of a digital input interface for conventional reprographic scanner

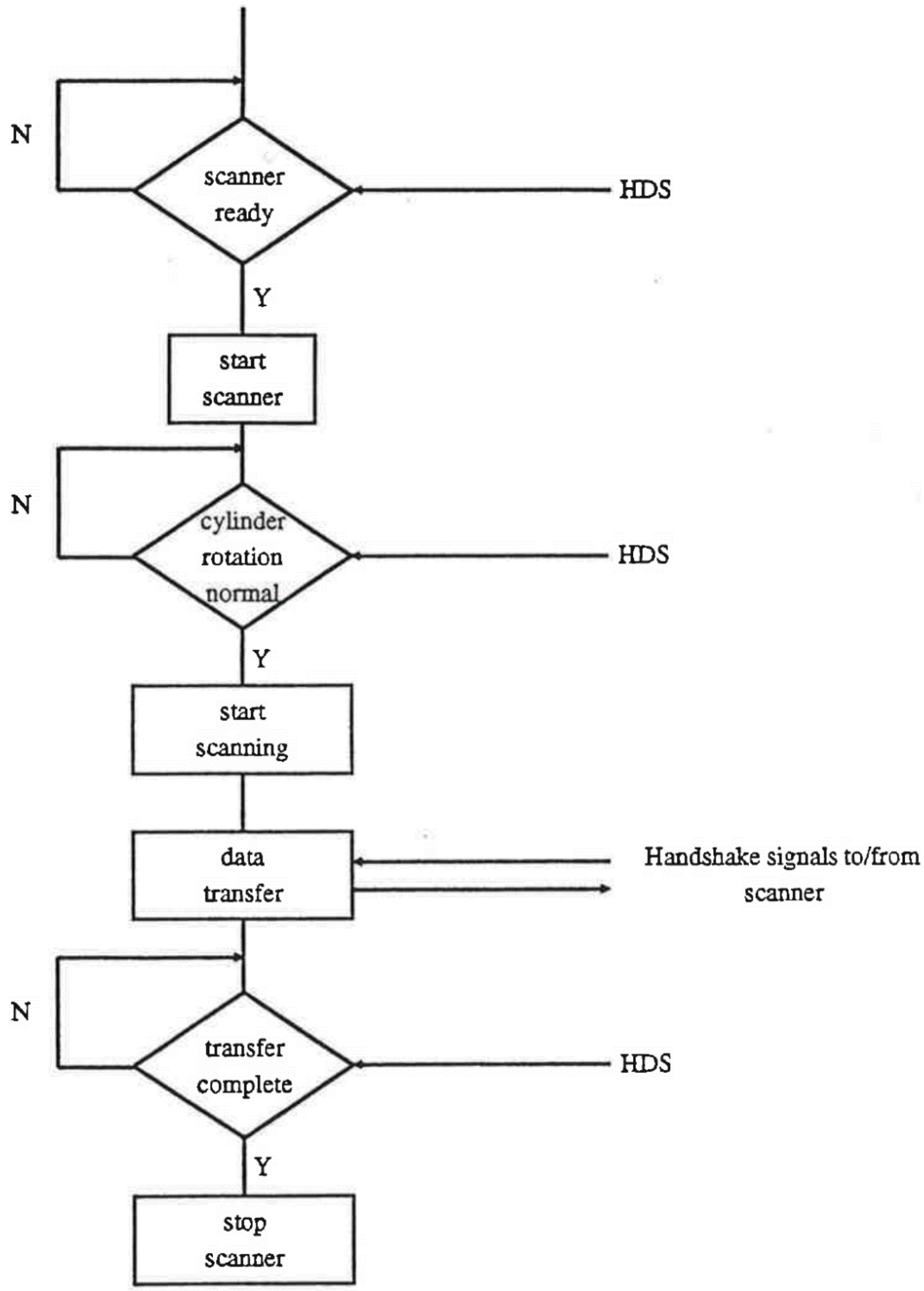


Fig. 24

Basic diagram of a digital output interface for digital reprographic scanner

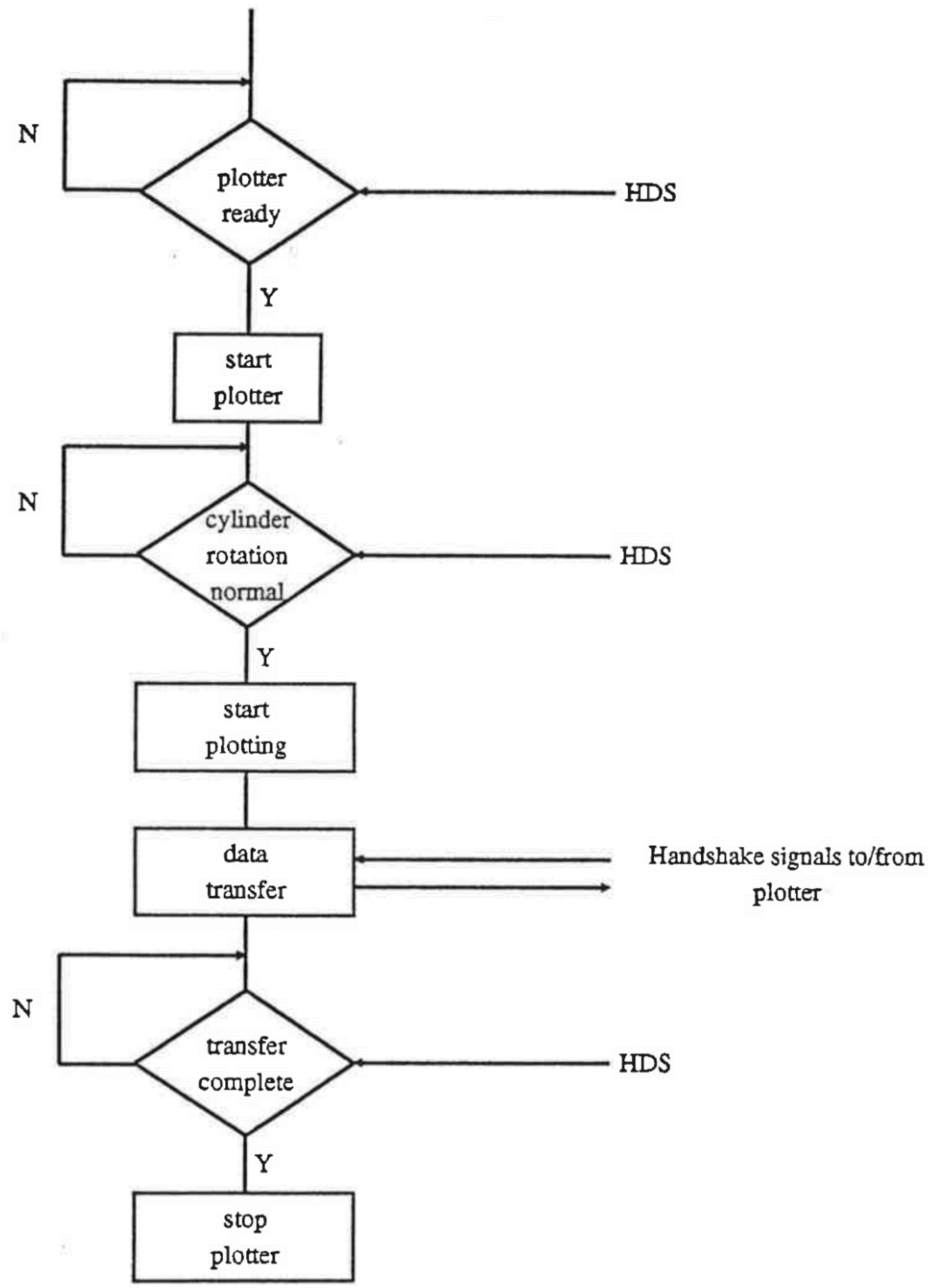


Fig. 25

II.3.2.2. : Use

Pixel data encoded in C, M, Y, K are stored on disk and then transferred to the graphics stations. Chapter 3.2.1.2. is devoted to an exhaustive presentation of the proposed solution.

Note, however, that there is a second possible digital use of a reprographic scanner. This is actually the so-called "line" use. This is based on the principle of coding a run-length pixel line described below in Figure 26.

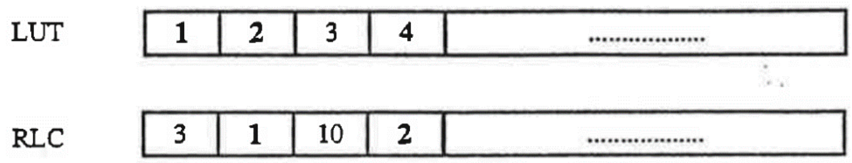


Fig. 26

LUT (Look Up Table) designates the color table, it is actually a list of indexed colors used by the run length file.

RLC designates the run length file itself. Its decoding can only be done using the corresponding LUT file.

The RLC file represented in Figure 26 thus describes a pixel line starting with 3 color pixels of index 1, 10 pixels of index 2, etc.

Such an image coding method is an excellent way to save storage space for describing a file containing few different colors (usually less than 256).

A conventional "text" file in A4 format for example comprising only black elements on a white background can thus be stored despite a very high resolution (of the order of 800 l / cm) on some 50 Kbytes instead of 400 Mbytes in standard storage mode to a depth of 3 bytes (1xR, 1xG, 1xB).

If the transformation of a conventional pixel file into a line file can be done using appropriate software (this is the case on the experimental site), most of the reprographic scanners use a dedicated architecture for this purpose. so-called color "thresholding".

II.3.3. : DTP entries

II.3.3.1. : Definition

Desktop Publishing Systems (DTP) refers to the "Publication Assistée par Ordinateur (PAO) systems generally used by the composition departments of the printing companies. These systems that succeeded the "lead letters" tend to be standardized to - it seems - promote a language tending to take on all aspects of a standard: the PostScript language (BRUES / FOGRA).[9]

This language used by many applications dedicated to pre-printing is the source of MacIntosh's success in the field of reprography. The MacIntosh is indeed in the field of the text a platform with suitable performances and a moderate cost which makes it one of the first machines equiping a modern reprography workshop.

The PostScript language is a simple programming language, interpretable and particularly adapted to the description of graphic objects. Its primary purpose is to describe the appearance of a text, graphic shapes and images distributed on a printed page or displayed on a screen. A program in this language can provide communication of a document description from a composition unit to a printer. This program can also control the appearance of text or graphic elements on a screen. This very detailed description takes into account the slightest attributes of a text and, fundamentally, is totally independent of the device receiving or transmitting information.

Among the interactive description of page and object features, we can highlight the following:

- arbitrary description of objects consisting of lines, arcs, rectangles, geometric curves; these objects can intersect and present holes
- contouring, filling, color assignment operators
- text embedded in the graphic: each letter being addressed as a geometric form, graphical operators can apply to it
- integration of images, synthetic or not, encoding configurable according to the choice of the output device
- system of coordinates supporting all combinations of geometric operators.

One of the originalities - and undoubtedly one of the strengths of the PostScript language - lies in the fact that a page described in this language can be reproduced on a printer, a screen or any other output device after having been beforehand subjected to an interpreter controlling this device.

The interpreter found here converts the PostScript page description to a series of low-level commands describing a device-specific "pixel" or "vector" file.

It should also be noted that most DTP software include a "PostScript output". Thus, these programs can be considered to some extent as program generators. Indeed, every page description is actually a program that can be executed by as many interpreters as there are processes for processing PostScript files.

Finally, we will highlight the peculiarity of the PostScript language which combines creation, transmission and interpretation of files under the sole ASCII text format, thus offering a valuable compatibility between operating systems and machines of different manufacturers.

II.3.3.2. : Limitations

While practically all the features needed for reprography are found in "MacIntosh" applications, there are two main reasons why today they are not used as a main link in a production chain:

- disparities in applications: the relatively low cost of a MacIntosh station has encouraged many service companies to offer many programs that are theoretically suited to reprography. If some seem actually to stand out (Adobe Illustrator, Pagemaker, Photoshop, Colorstudio, Quark-Xpress ...) there is none that combines all the functions essential to reprography (masking, positioning, separation and retouching, etc ...). This results in a complexity of information processing since any page or page element is likely to require up to five successive treatments dispensed by five different applications, each better suited in a specific domain.

- limitations due to the platform: literally victim of its success, MacIntosh reveals serious difficulties to rise to the rank of graphic station. Indeed, its architecture originally planned to support weak RAM memory units often limits its memory to 32 Mb. That's why even the latest in the MacIntosh family - the IIfx model with a 12.5 MIPS processor - can not, despite its 16-bit SCSI2 interface, claim to provide a high level of productivity in an application area where the platform must be able to offer "real time" over a minimum of 50 Mb.

II.4. : Output devices

II.4.1. : Color printers (proofers)

Due to the high cost of the traditional final page proof, the arrival of digital processing in reprographic technology promotes a generation of color printers able to reproduce almost ideally what will be the final printed document (BRUNE / FOGRA).[10]

II.4.1.1. : Thermal printers

The operation of a thermal printer is based on the principle illustrated in Figure 27:

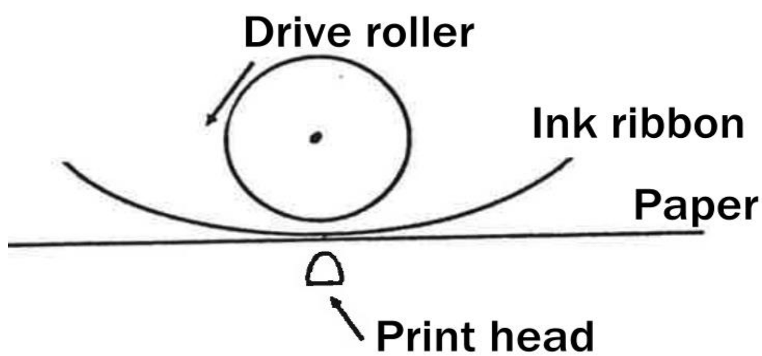


Fig. 27

An inked ribbon of three (RGB or CMY) or four (CMYK) fundamental colors respectively communicates in three or four successive passages on a print head its coloring to the paper medium triggered by the same movement.

The printhead made up of micro-cells ensuring a resolution of 300 dpi (or about 120 cells per centimeter) allows, by means of an optional screening procedure, to approach the result that one would obtain with a classic print process.

It is the heating of the cells of the print head which ensures the fusion and then the printing by contact of the ink of the plastic film (inked ribbon) with the paper.

Some printer models such as 4Cast (Dupont) use an intermediate polymer roll that transports ink from the plastic film to the paper support.

The results obtained are very variable. Indeed, an expensive technique such as that used in 4Cast, if it ensures a near perfect "photographic color" rendering, is hardly applicable in printing because of the absence of construction screening such as that used in printing and described in the chapter. 2.3.2.1. in figure 21.

That's why we preferred the Mitsubishi G650 at the reference site. This printer which has technical characteristics comparable to the 4Cast (300 dpi) is however Centronics interfaced instead of SCSI. In addition, the cost price of a copy is much lower than that of 4Cast. This is why the software screening technique used in the heart of this printer is more justified than on a 4Cast.

The reasons for this choice are described in more detail in Chapter 3.2.2.1. of this work.

It should be noted, however, that the G650 model, optionally combined with a videoprocessor - see figure 28 - allows the fast reproduction of a screen (1280 x 1024 pixels).

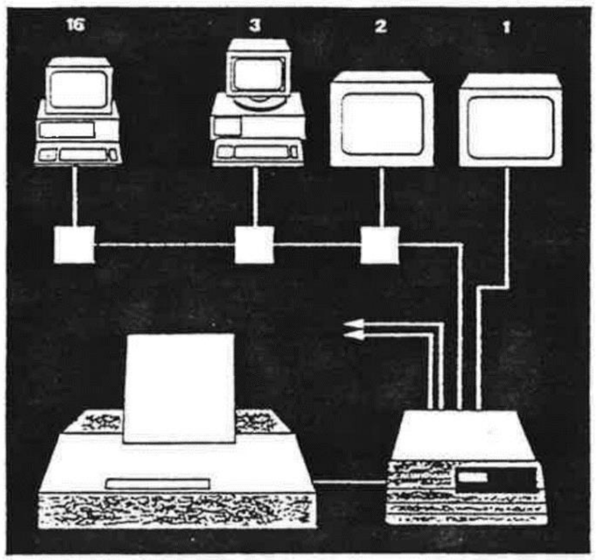


Fig. 28

II.4.1.2. : Inkjet printers

The technique used by inkjet printers is illustrated in Figure 29:

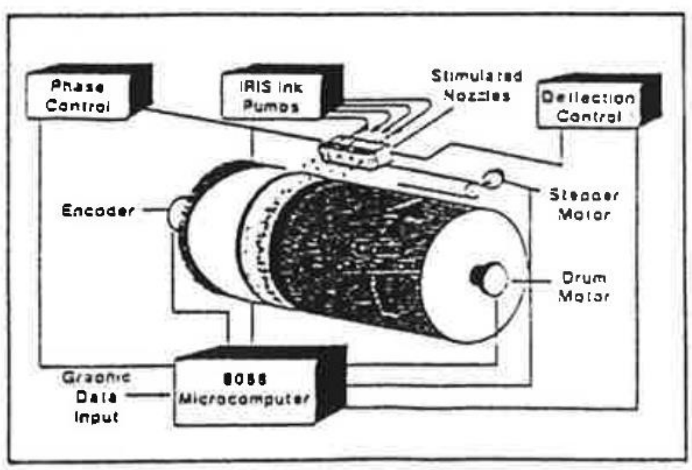


Fig. 29

Four electrostatic injectors (CMYK) eject the ink droplets (of a diameter of 15 microns) which, captured by an electrostatic field, are drawn onto the carrier cylinder of the paper to be printed.

Among the advantages of such a technology, it is necessary to emphasize a very large format which, combined with a great flexibility of modulation of the color injection, allows at a low cost (less than FF 1, - / A4 copy) a possible use of software screening.

Finally, among the specificities of this technology note:

- a crystal modulated injector for each fundamental color
- pumps regulate the flow of ink with an accuracy of 1%
- logical control ensured by CPU
- the use of multiple paper media, fabric and various plastics.

The current weakness of this technique, however, lies in the interfacing. There is indeed currently no interface standard for these devices. This is why each commissioning requires a specific development that is difficult to justify in view of the constant progress of competitive techniques.

II.4.2. : Ektachrome outputs

II.4.2.1. : CRT film recorder systems

The operating principle of such systems is based on the RGB color model described in section 2.1.3.

It is in fact, from a tri-color separation of an image file in red (R), green (G), blue (B) sub-files, to reproduce with a digital analog converter a digital image on a photographic film.

Figure 30 describes the technique used within such a "camera":

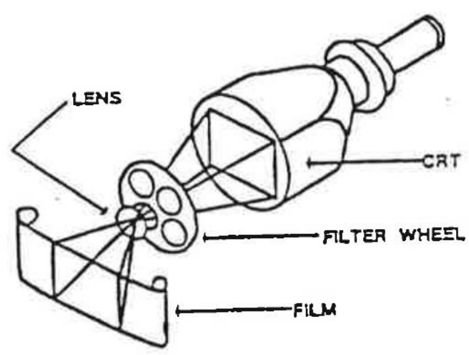


Fig. 30

This figure of principle details the three fundamental elements of the device: the cathode ray tube, the three RGB filters and the camera itself.

The cathode ray tube, connected by its electronic deflection system to the analog card of the device, produces a succession of horizontal lines (2000, 4000, 8000 or 16000) whose modulated intensity describes in three sequences (R, G, B) the content of the image. The three sequences R, G, B are obtained by rotation of the wheel carrying the three basic filters. Thus, the red component of the image will be exposed while the wheel carrying the filters filters the light from the CRT using the red filter. At the end of this sequence, the filter rotates and it is then to the green component of the image to be exposed through the green filter. After the repetition of this procedure for the blue component of the image file, the film is exposed to reproduce all the colors of the processed digital image.

The use of a cathode ray tube for image reproduction, however, poses serious geometry problems. Nevertheless, after repeated optical and electronic adjustments, it is possible to obtain a correct geometry of the image described by the electron beam on the surface of the cathode ray tube. These delicate settings are, however, likely to be altered by external factors such as temperature fluctuations, ambient electromagnetic field variations (presence of another cathode ray tube, etc ...) or vibrations.

<u>Main characteristics :</u>

- use of standard photographic film formats
- short exposure time (8000 lines in less than 3 minutes)
- simple GPIB interface to connect
- because of the Gaussian shape of the intensity curve of the electronic spot, the actual resolution of a camera of this type is less than 8000 lines since each pixel is "influenced" by its neighbors (antialiasing effect).

II.4.2.2. : Recording cameras not using CRT

These cameras use light from a halogen-white light source, which, transported by optical fiber, arrives on a mobile deflection mirror sweeping the surface of the ektachrome film with a beam of light.

The reconstruction of the image is also done by filtering white light according to the additive principle R, G, B.

Figure 31 schematises the operating principle of such a camera.

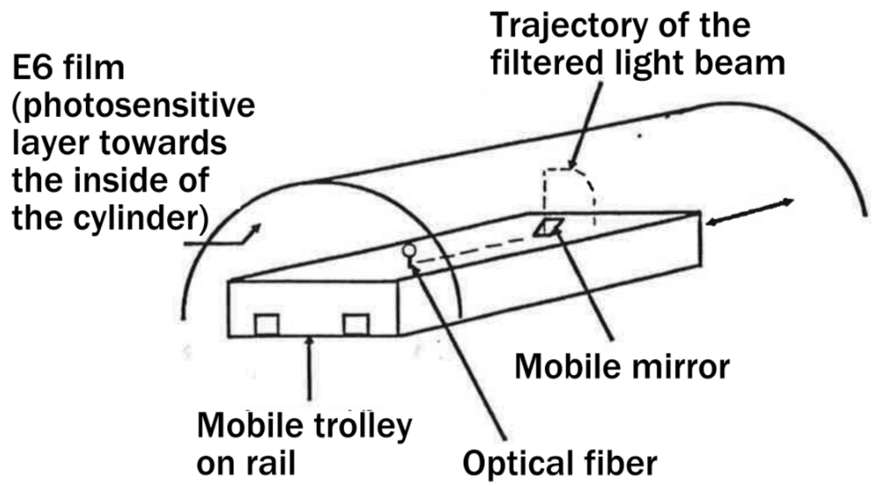


Fig. 31

This technique, combined with an automatic film transport system, makes a camera of this type (FIRE 1000 from Cymbolic Sciences) an autonomous machine freed from the problems of calibration and geometric correction of the images coming from the use of a cathode ray tube.

<u>The main characteristics to be noted are:</u>

- resolution of 50 lines per millimeter (l / mm)
- maximum image size of 220 x 240 mm
- scanning speed: 10 lines per second (l / s)
- light source: 75W Xenon arc lamp
- maximum exposure time: 18 mm (for 220 x 240 mm)

II.4.3. : Film plotters

II.4.3.1. : Functionalities

The film plotter is the last link in a printing production line. Indeed, the production of films bearing the separations C, M, Y, K precedes the manufacturing of plates intended for offset presses.

Even today, many film plotters are coupled to an input scanner to produce directly (without digital intersection) color separations. The new products, however, respond more to the need for flexibility of digital installations and therefore have similar configurations to those shown in Figure 32 (SWIFT / SECMA).[12] The descriptive sheets of the SG 608 II scanner are collated in Annex II.

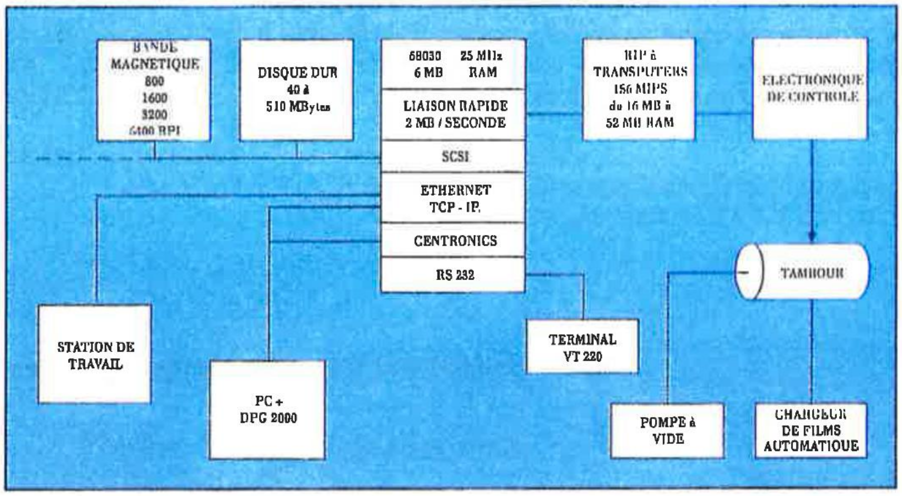


Fig. 32

The availability of standard interfaces on a film plotter of such a design (SECMA International SWIFTLine in this case) allows a relatively easy operation within the framework of a digital production chain. This integration is illustrated in Figure 33:

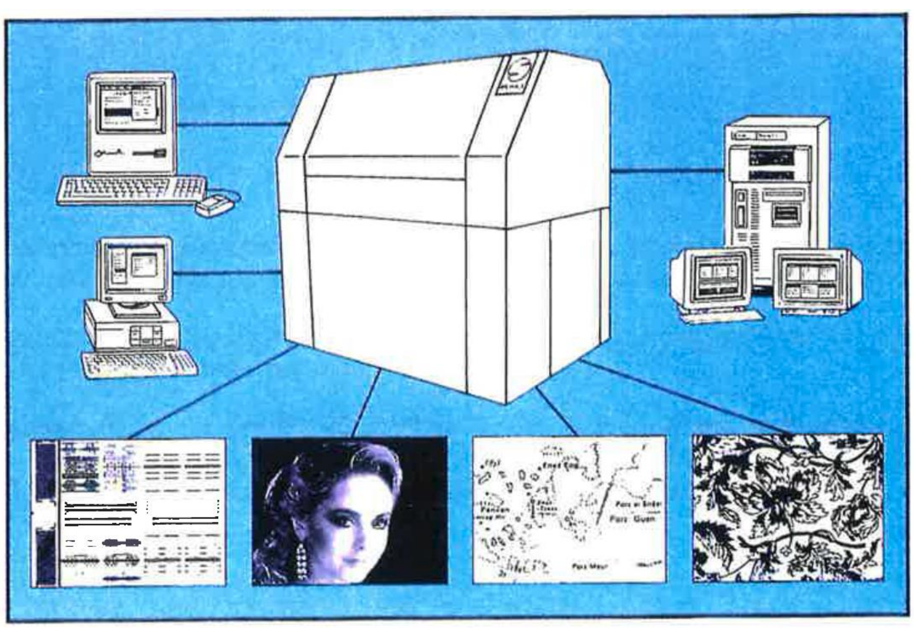


Fig. 33

The solution used on the reference site is illustrated in chapter 3. We will see that it takes over the principle of delocalization of the output device in order to keep the flexibility and functionality of the production chain.

II.4.3.2. : The problem of the laminated final press proof

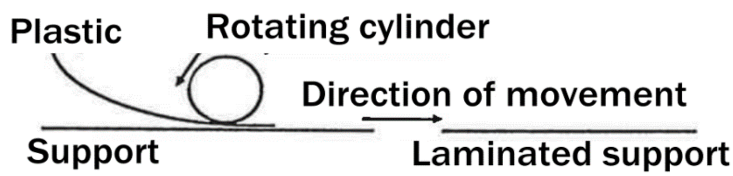
Today, the laminated proofs technology is for around 95% of the production one of the only solutions to the problem of making a paper proof as close as possible to the print that will be produced by the final print.

This technique uses:

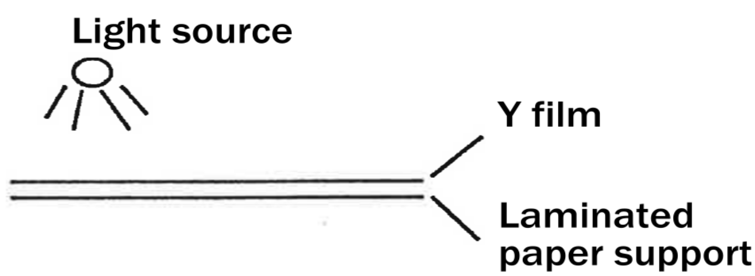
- a paper support
- a photosensitive plastic laminating film
- 4 basic CMYK pigments in powder

Procedure:

1) Lamination of the paper support with a plastic sheet:



2) The laminated paper support is then insulated through the film bearing the Y separation according to the following figure:



After removal of the film and then of the plastic film, the support remains adhesive in the places having been masked by the dark parts of the film used during the insolation.

3) Dusting with the yellow powder therefore deposits the yellow pigments in the required places, still adhesive.

By repeating these phases with the films carrying respectively the separations M, C, K using the powders M, C, K, we obtain a facsimile of the prints that will come out (after the customer's approval) of the printing presses.

This long and expensive technique, since it requires the production of films that will be used for the realization of offset plates, also has the disadvantage of offering a rather unrepresentative result because too far removed from the final print (exaggerated rigidity and brilliance).

If the color printers mentioned in 2.4.1. give a solution to the problem of the "first throw" of the page to realize, their fidelity in color and especially their resolution limited to 120 l / cm prevent a use for the production of the "final page proof" (OTSCHIK / FOGRA).[13]

This is why the main manufacturers of photo plotters tend today to propose purely digital solutions to the problem of the final page proof.

The solution chosen on the reference site is developed in chapter 3.2.2.3. of this study.

III.

The implemented solution

III. The implemented solution

III.1. : The production line

III.1.1. : Chronological evolution

The configuration most commonly used today is the result of a gradual evolution from a system of vector images creation.

While all digital reprographic systems prefer a "pixel" approach to the problem of digital layout, the system we propose is born from a vector approach to the problem.

The configuration shown in Figure 34 is the first draft of the final system presented below.

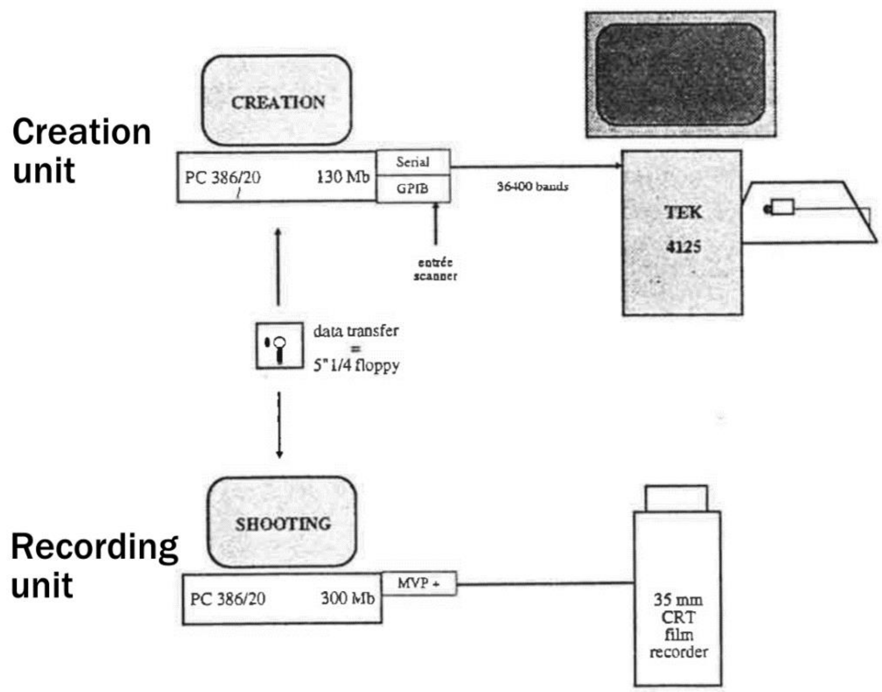


Fig. 34

The vector image creation is ensured by a graphical software running on a personal computer of type PC / AT 386/20 MHz. The high-resolution graphics console controlled by this PC is a Tektronix 256-color graphic display terminal.

The vector files thus generated hold only a few kilobytes of memory space and thus lend themselves to transfer via 5" 1/4 diskette to the output unit on a cathode ray tube camera such as that presented in 2.4.2.1.

Such a configuration, however, has the disadvantage of being poorly adapted to the import and processing of real images (pixel type). The reasons detrimental for such use are as follows:

- 256-color limitation of the TEK 4125 graphic display terminal requiring adaptive processing of actual images (pixel)
- transfer of pixel files (often several megabytes) inefficient by diskettes between creation and registration units
- flat scanner input via PC / GPIB poorly adapted (insufficient resolution) to ektachrome films constituting most of the documents to digitize
- output on ektachrome slide insufficient as to the resolution of some elements, especially texts.

These various reasons are at the origin of the evolution of this configuration towards the system presented in figure 35.

We see in Figure 35 a delocalization of the pixel processing (IKON pixel engine). This solution presents an evolution of the configuration previously proposed to the extent that the entry of pixel images can also be provided by means of a video camera. A tape drive connected to the output PC also allows high-resolution input / output via conventional digital imaging systems.

This solution, in comparison with that presented in Figure 34, has the following advantages:

- passage "on UNIX" on TEK 4337 24-bit graphic station of the basic software used (Dalim) in order to overcome the limitations of the PC systems which remain here simple input / output units
- ETHERNET networking of all the units of the configuration.

It is in fact Figure 36 which constitutes a first productive configuration of integrated reprography. In fact, the input unit (Scanner Howtek) and the unit of production of separations (Linotronic) are united on the same system.

The output PC allows transfer via ETHERNET then APPLETALK (TOPS card) of the PostScript files calculated on the graphics station to the RIP (Raster Image Processor) serving the Linotronic photo plotter.

There is also a disappearance of the delocalized pixel processing for a redesign of the software integrating both the pixel and vector functionalities within the graphic station TEK 4337 (see attached descriptive sheet).

High-resolution data input / output, however, has been abandoned for productivity reasons and has been replaced by a specific development described later.

The ETHERNET / APPLETALK MacIntosh (DTP) graphical station connection also opens up a perspective of use for importing PostScript data. This development will be implemented later.

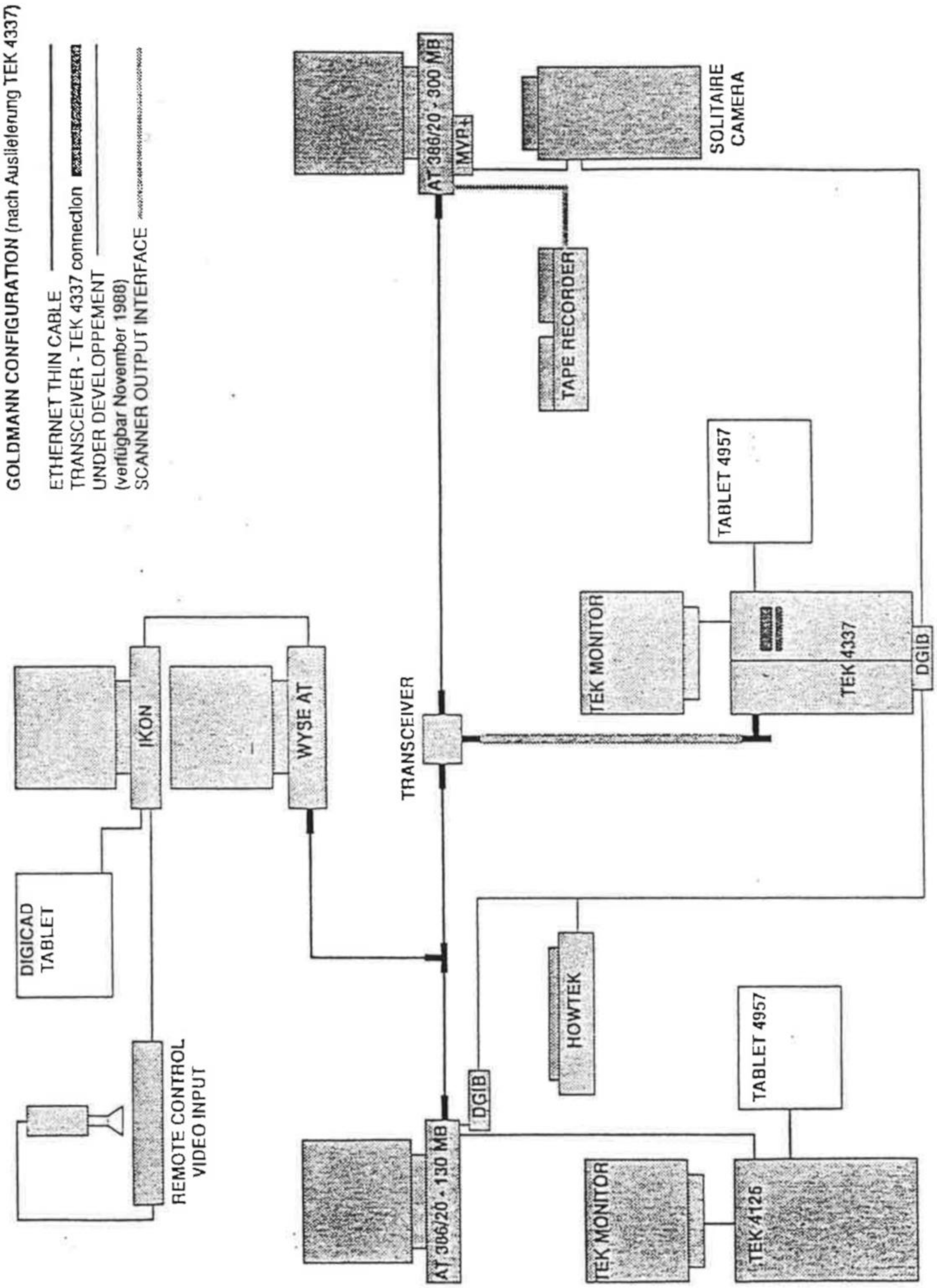

GOLDMANN CONFIGURATION (nach Auslieferung TEK 4337)
ETHERNET THIN CABLE
TRANSCEIVER - TEK 4337 connection
UNDER DEVELOPPEMENT
(verfügbar November 1988)
SCANNER OUTPUT INTERFACE
AT 386/20 - 300 MB
MVP+
SOLITAIRE CAMERA
TAPE RECORDER
TABLET 4957
TEK MONITOR
TEK 4337
DGIB
IKON
WYSE AT
TRANSCEIVER
DIGICAD TABLET
HOWTEK
REMOTE CONTROL VIDEO INPUT
DGIB
TABLET 4957
AT 386/20 - 130 MB
TEK MONITOR
TEK 4125

Fig. 35

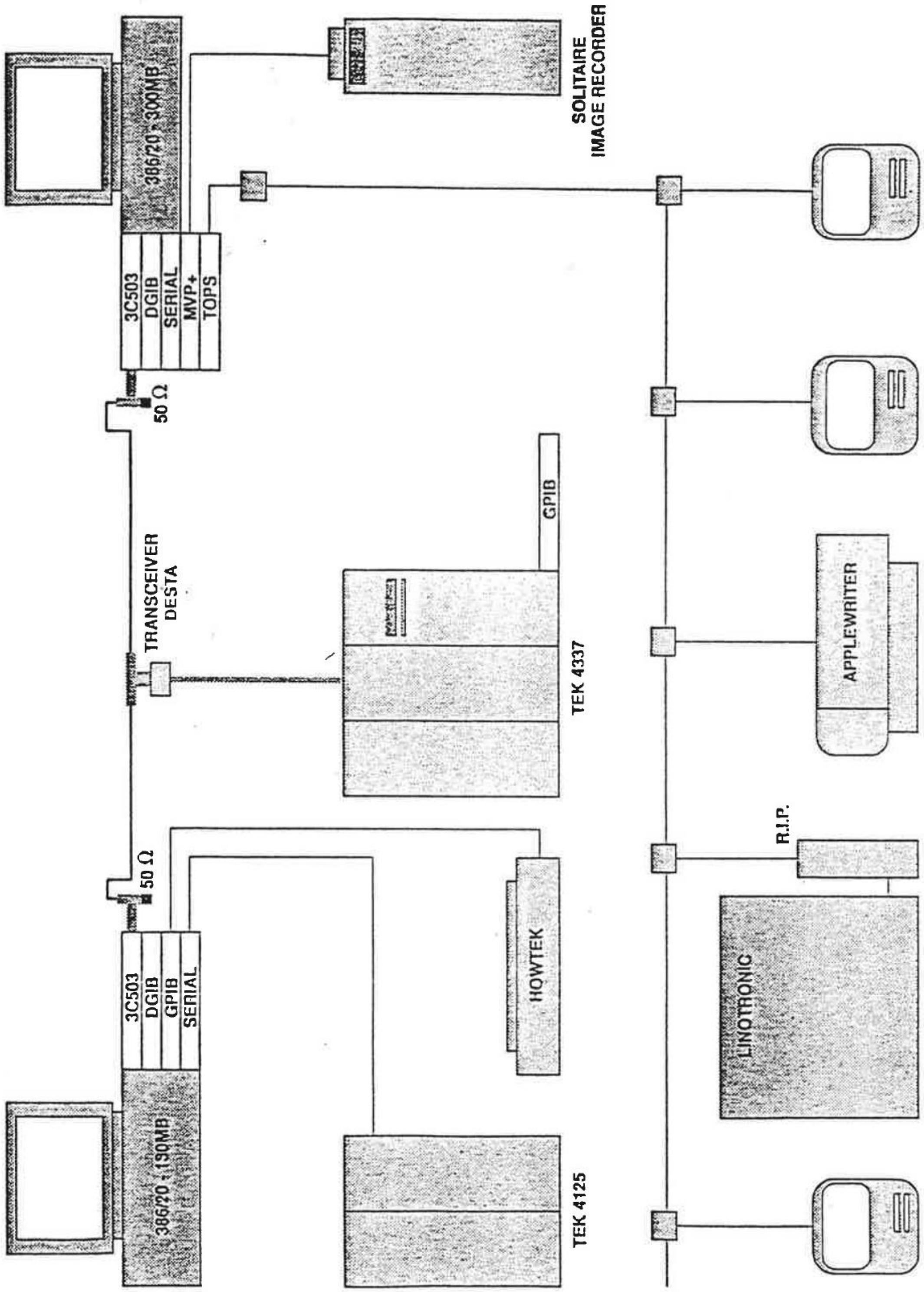

386/20 - 300MB
3C503
DGIB
SERIAL
MVP+
TOPS
SOLITAIRE
IMAGE RECORDER
50 Ω
TRANSCEIVER
DESTA
GPIB
TEK 4337
APPLEWRITER
R.I.P.
LINOTRONIC
HOWTEK
50 Ω
3C503
DGIB
GPIB
SERIAL
386/20 - 190MB
TEK 4125

Fig. 36

Figure 37 shows an expanded version of the configuration shown in Figure 36.

This configuration adds to the one previously proposed an additional TEK 4337 graphics station. The overall disk space, due to the pixel images, now exceeds the gigabyte.

A Mitsubishi G650 color thermal printer provides an effective solution to the final page proof problem.

The video camera in figure 35 has also been replaced by a high-resolution CCD camera (6000 x 4000 pixels) to digitize ektachromes.

Figure 38 introduces the notions of server (GOLD 3) and digital input for high resolution scanner (SCREEN).

The Mitsubishi printer is also equipped with a multiplexer videoprocessor allowing a simple and fast screen copy (low resolution) offering an alternative to rasterised proofs (longer production time).

The ultimate evolution of the configuration resulting from our development and the basis of our later research is shown in Figure 39.

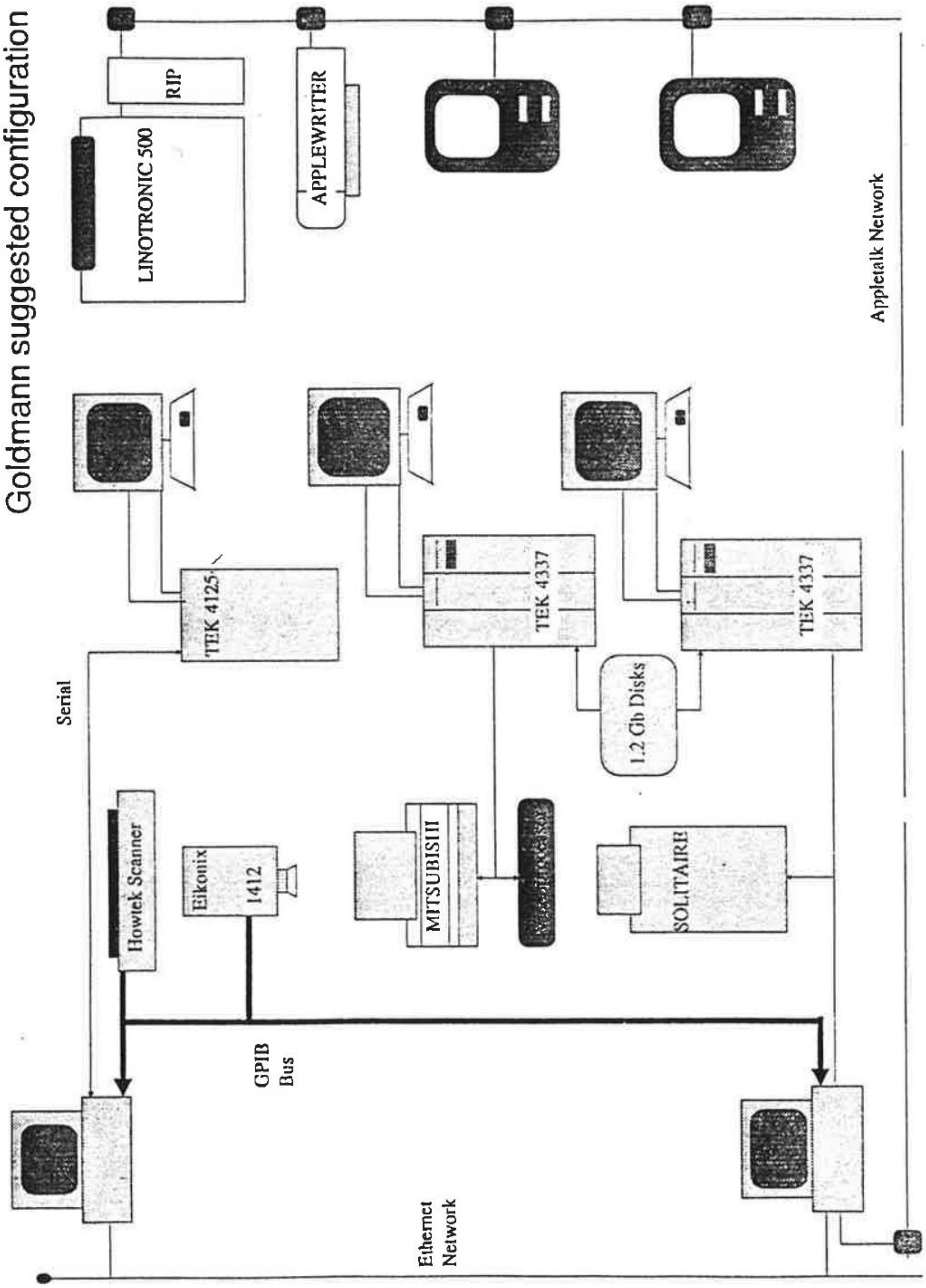

Goldmann suggested configuration
LINOTRONIC 500
RIP
APPLEWRITER
TEK 4125
TEK 4337
TEK 4337
1.2 Gb Disks
Serial
Howtek Scanner
Eikonix
1412
MITSUBISHI
SOLITAIRE
GPIB
Bus
Ethernet
Network
Appletalk Network

Fig. 37

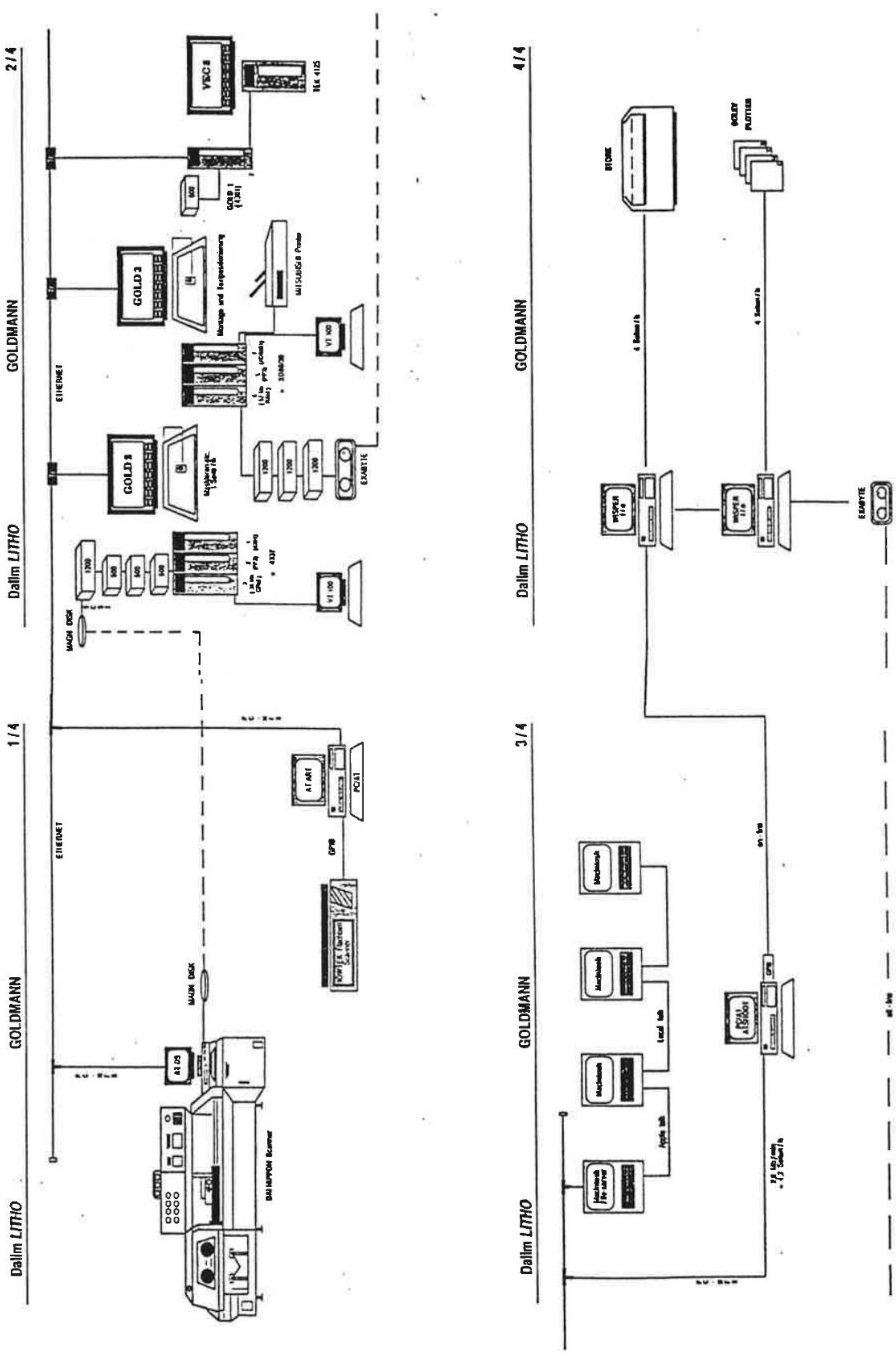

Dalim LITHO
GOLDMANN
1/4
2/4
3/4
4/4
ETHERNET
MAGN DISK
DAI NIPPON Scanner
AT AT
PC/AT
GPIB
VEC 8
GOLD 2
GOLD 3
MITSUBISHI Printer
VT 100
EXABYTE
STORE
Macintosh
Local talk
Apple talk

Fig. 38

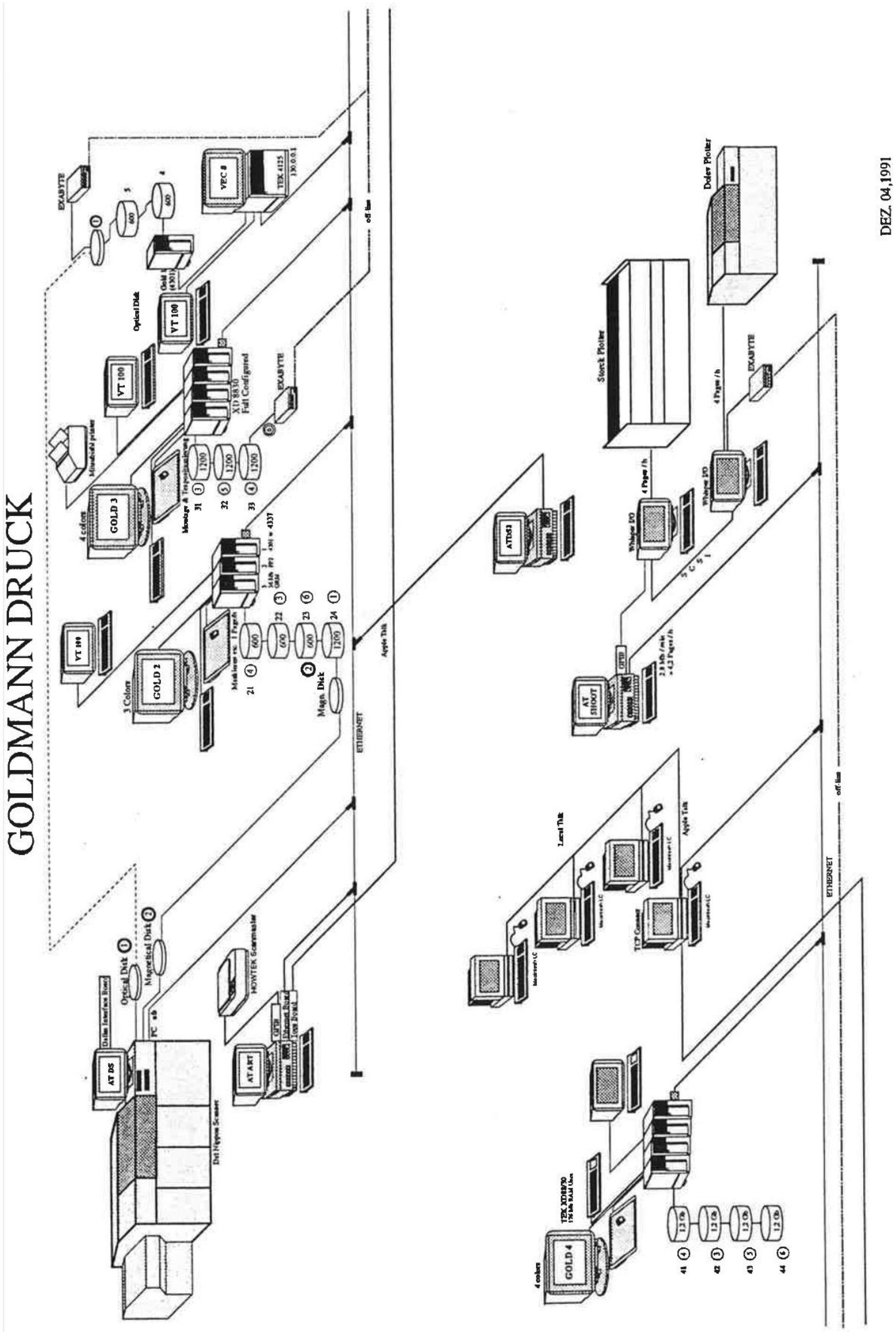


Fig. 39

III.1.2. : The DALIM creation / production software

III.1.2.1. : The object oriented concept

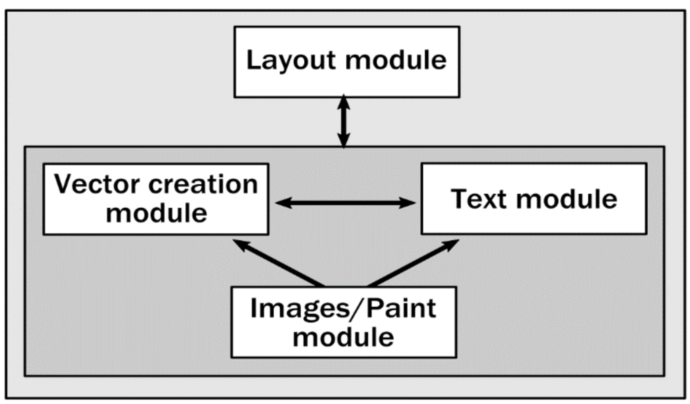
DALIM's Litho is a system of creation, edition and layout offering four main functions (DALIM 1990).[14]

- edition and retouch of real images,
- graphic creation (illustration),
- composition and manipulation of texts,
- layout of all the elements.

These four modules are organized around an original and powerful user interface that combines the advantages of menu driven control with those of windows that can be activated any time.

Software architecture

The Litho system consists of four modules:



We will explain the principles of exchange between the different modules.

Let's start by describing the characteristics of the modules previously described.

First, we need to clarify what we mean by layout. For Litho, the layout module works on three different types of data:

- vector illustrations and logos
- the text
- the real images - pixels (photo)

These three types of data each have particular requirements regarding their output resolution; the text being by far the most demanding (at least 1000 dots per inch for quality output).

The page has a resolution of 64K x 64K; each image has a maximum of 12 or 24 million pixels (depending on the chosen configuration).

The layout module is able to output a page on different devices by distinguishing the heterogeneous elements of the component and respecting the output resolutions specific to each of them: traits, texts and your continuous tone, by managing also the frame orientation.

This module uses the concept of "virtual image buffer". That is, an image is considered an "object", which makes it possible to manage the priority of the actual images. The number of photographs contained in a single page is limited only by the disk space available to the user.

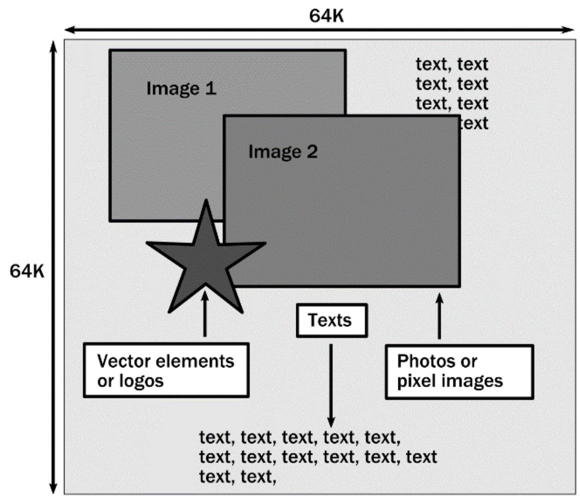


Fig. 40

With the layout module, you can:

- rotate, scale, translate or distort on flat or uneven surfaces, on all elements of any type (graphic illustration, text, actual images),
- align elements,
- control the size and dimensions of documents for output with micron precision on an A0 document,
- copy or delete elements.

The vector creation module allows to create "segments" or polygons defining masks for images used in the image / paint module.

The masks thus created define zones (visualized in red and superimposed) in which any subsequent treatment is either allowed or inhibited. In the latter case, when using an airbrush, the areas appearing in red are not retouched.

When a mask is defined for a "continuous tone" image, it is also used to identify that part of the image in the layout module.

Thus, it is quite possible to use this mask as a segment. There is no difference in treatment between this mask and the others (vectors). They can likewise be pointed for identification, diminished, enlarged, turned, displaced, deformed, without limitations due to priorities (any continuous tone image can hide any line created previously and vice versa).

When going from the vector creation module to the image / paint module, the vector elements are transformed into pixel data which can be retouched or colored like any real image.

This digitizing operation can be done with the smoothing function. All these features apply in the same way to the text module.

II.1.2.2. : Vector creation module

The DALIM vector creation system has already proven itself at more than 150 sites in Europe and around the world.

Many improvements have been made to this new system. Among them, the possibility for the user to work in true colors (16.7 million colors) with a very high addressing precision (64K x 64K).

This creation module consists of three sub-modules:

- help with the construction of geometric primitives,
- basic geometric editor,
- Logo Creator,

and an optional module, the:

- vectorizer.

This vector creation module represents the heart of the Litho system. The unique and original design in the software architecture explains this power and this great flexibility of use.

Geomod - Help with the construction of geometric primitives

This geometric primitive creation aid module is used for high resolution work allowing micron precision for A0 format.

This precision is explained by the possibility to define "magnetized" points surrounded by a magnetic zone which considerably increases the precision of the graphics. Naturally, these "magnet zones" are constantly updated for each zoom value.

Precision increases in proportion to the power of the zoom, in a ratio of 1 to 10,000 (1/100 x 1/100).

This creation help module allows the creation of all the 2D primitives:

- lines
- circles
- bows
- grids (circular or rectangular)
- divisions (on all entities).

One can visualize at any time the points of intersection of these primitives. The calculations are automatic.

A variety of geometric transformations such as extrusions, translations, scale changes, and automatic rounding calculations greatly facilitate the creation of any 2D construction or even real-time 3D perspective simulation.

On the Litho workstation, it is possible to use concurrently up to:

- 15000 "glue" points (loving points)
- 5000 lines
- 500 arcs
- 500 circles.

The figures built with this module are not part of the created images but serve as guides or sketches for their creation; they can be stored and reutilized later.

Basic geometric editor and "Logo Creator" module

There are two construction editors interfaced directly with the Geomod module. Each geometric entity can be created by the identification of previously defined elements using Geomod.

Geometric data constructed from high-level primitives are as follows:

- lines
- circles
- arcs
- parabolas
- rectangles
- splines, curves and free paths.

For free lines, the software automatically converts drawing figures into sets of parabolic lines and arcs, reducing to a minimum the number of points required for their construction.

In the Logo Creator module, the user can directly work with predefined forms, such as a character font and modify all the points composing a letter or a word. It is therefore easy to create a logo from already existing fonts.

It is also possible to edit with Logo Creator the created figures by taking advantage of 3D functions. The perspective and the angle of vision of objects in space can be modified in real time. The user chooses the perspective and viewing angle (X axis, Y axis, Z axis and focal length). The data is then converted to 2D and "glue" points are automatically generated, which allows precise, fast and easy work.

Vector entities can be displayed in four different modes:

- filled
- outline
- filled + outline
- neon effect

Each outline can be delimited either by a circular edge or by a straight edge.

Gradients

There are thus far four types of gradients:

- vertical
- horizontal
- circular
- elliptical

These gradients use 16.7 million colors and are so subtle that no "benday" effect is visible.

Vectorizer

In addition to the vector creation module, an optional and complementary software facilitates the vectorization of any "line" document.

This module allows the automatic digitization of B & W documents (logos, character fonts) via a flatbed scanner.

The figures or logos are instantly vectorized and the distinction between lines and curves is done automatically.

Other operations such as real-time curve fitting, adding or removing of points are also possible.

It is the ideal tool to work on character fonts and the saving of time is considerable because each digitized logo is transformed into vectors.

The vectorization operations take a few minutes and are broken down into six steps:

- low-resolution digitization of the document
- contrast selection
- selection of the final digitizing window (Preview)
- high resolution digitization
- extraction of contours
- reduction of the noise present on the image
- vectorization in the logo format.

In less than three minutes, the user has a figure with lines and parabolic arcs containing control points that can be edited in real time.

Real time edition of vector logos

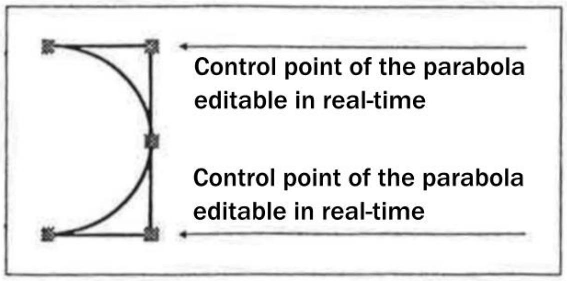


Fig. 41

Configuration of equipments:

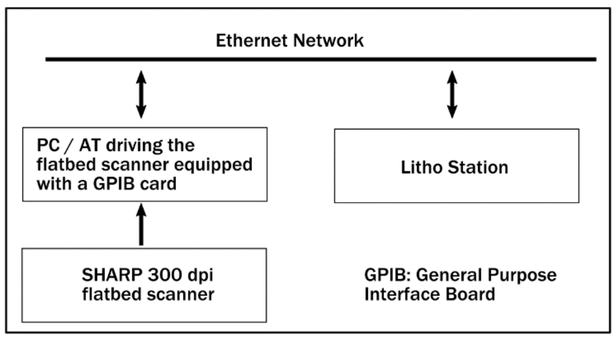


Fig. 42

III.1.2.3. : Input and integration of external/third party data

This module allows the input of third party data files.

The integration module accepts three types of standard formats:

- IGES
- CGM
- HPGL

IGES format

To input 3D files created by CAD or CAD / CAM software - Euclid, ComputerVision, Catia, etc ... - Litho accepts all files formatted according to the IGES version 3.0 standard in wireframe mode.

The integrated 3D objects are then directly editable, the IGES data being converted into "Logos DALTh1". One can modify the perspective and the angle of vision of objects in space and in real time. The user chooses the perspective and the viewing angle (X axis, Y axis, Z axis and focal length). The data is then converted to 2D and the "glue" points are automatically generated.

For conversions and manipulation of very large IGES files, DALIM recommands the conversion module of the Litho station.

The configurations are as follows:

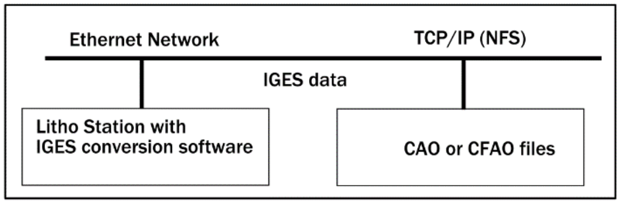


Fig. 43

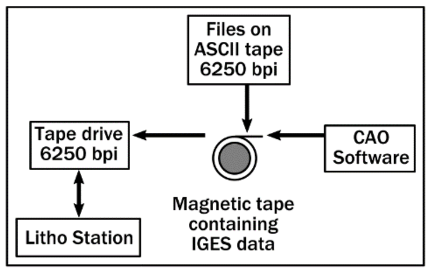


Fig. 44

The physical link is through a magnetic tape or a network link (NFS + TCP / IP). In the same way, DALIM vector images can be output in IGES 3.0 format.

CGM format

In the world of computer graphics, CGM (Computer Graphics Metafile) is one of the best-known formats.

Thanks to a specific interface, data in CGM format is automatically converted to Litho format.

Thus, there is no difference in treatment between the data generated by DALIM and those generated by software working in CGM format. Software that formats CGM data includes Lotus Freelance and Harvard Graphics for business graphics.

These software running on PC compatible, the CGM integration interface is also available on PC and is already integrated in the vector software DALIM / PC.

Equipment configuration:

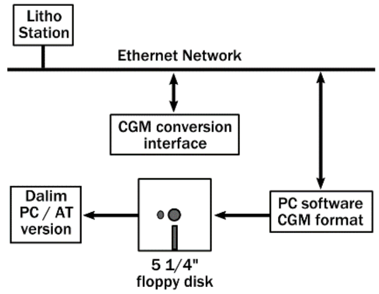


Fig. 45

The DALIM / CGM interface reads the data and translates the CGM format files into DALIM format and not the other way around.

HPGL

This module has the same functionality as the IGES interface and requires the same configuration. HPGL is one of the most recognized standards in the industry.

Input and output accepted.

III.1.2.4. : Texts module

Litho gives access to more than 1300 character fonts (10 of them are delivered as standard with the system). These fonts based on the IKARUS standard comply with the quality standards of photocomposition systems.

Each font can be projected on any surface, flat or not, and can appear in four different ways (filled, outline, filled and outline, or as mask).

The spacings are automatically done at the characters, words or text blocks level. Of course, all layout functions are possible (deletion, insertion, tabulation, line break, replacement, hyphenation ...). A single block of text can include different fonts.

You can also align the texts either on a circle or on an arc.

In addition, a set of commands called DALIM Macro Language (DML) allows the user to save valuable time when translating into different languages or when manipulating important texts.

The DML command language works on any PC / AT compatible. It extracts text files from vector images keeping the used color palette, font and spacing and automatically generates images from text files.

Text blocks can be horizontally aligned, vertically spaced, or centered.

III.1.2.5. : Image / Paint module

Generalities

Depending on the configuration of the equipment used, this module can manage up to 24 million pixels in real time (resolution up to 4K x 6K) and retouch each of these pixels individually.

Pixel editing can be done in 4 different modes:

- RGB (red, green, blue)
- HLS (hue, luminosity, saturation)
- CMYK (cyan, magenta, yellow, black)
- CIEL uv.
-

The features of this module apply regardless of the type of operation:

- color control
- editing
- clipping
- composition of a page

Color control

Color control procedures apply either to the entire image or to certain areas only. These can be defined by masks or simply by rectangles.

It is known that color outputs do not all have the same characteristics. These color features can be represented by a response curve.

This module offers the possibility of controlling this response curve for each color component (CMYK) and keeping it in memory.

A GAMMA correction can be done in real time and concurrently with the other components (same possibility for the control of the black). Contrast is treated as a separate color channel.

It is also possible to change the color balance over the entire image. The user can rely on the lightest and darkest areas and set these new values.

The entire image is then modified based on linear or logarithmic graduations.

Brushes, airbrushes and Litho specificities

Litho brushes can be set in real time on:

- their size (from 1 x 1 to 80 x 80 pixels)
- their profile (from to)
- their intensity

They are operational regardless of the working window as well as its size (ratio: 1, zoom-magnification or reduction view); the brushes allow for predefined masks to be active or inactive.

Different aerographs are available in Litho and offer a very soft color distribution perfectly simulating the work of a traditional airbrush.

The brushes used are always in "high resolution" and avoid any crenellation. The color mixing makes it possible to simulate all the effects of painting with water or oil.

This module also provides brushes simulating watercolor, smudge or chalk and allows you to modify only the shade or saturation of a given area to create glare effects or subtle chromatic changes.

For retouching, two brushes are extremely useful: the delta brush and the transparency brush.

Delta Brush

This brush has the originality of being composed of two zones; a first zone serves as a "source" brush while simultaneously a second "destination" zone copies the pixels corresponding to the "source" zone. The distance between the two brushes as well as the transactional axis of the transfer can be freely chosen.

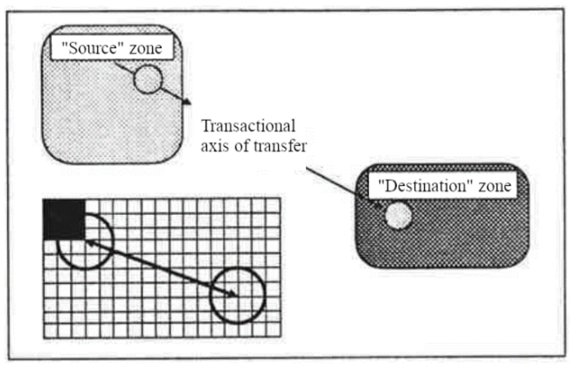


Fig. 46

Transparency brush

This second brush allows the mixing of two zones (source and destination) by respecting a constantly adjustable transparency factor.

Sharpness or blur rendering functions

An algorithm specially developed by DALIM makes it possible to increase the sharpness of the photos according to three levels of intensity and fineness. Conversely, we can blur some parts of images.

Editing and positioning images (or photos)

There are currently two editing methods depending on the module used: that of the layout module and the specific editing of the image / paint module.

We will describe here only the use of the direct editing of the image / paint module, the other being detailed later in the section titled "Software Architecture".

Although independent, these two modes have the same functionality.

The composition and the photo assembly in the image / paint module are used when it is decided to copy a previously defined mask from one image to another (or to the same one).

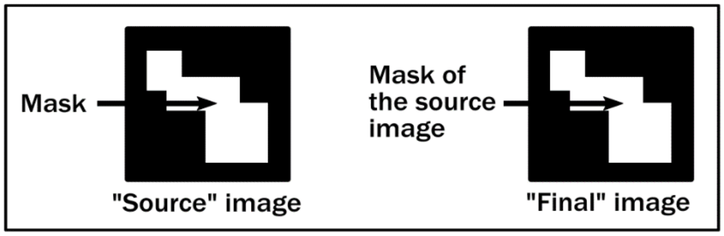


Fig. 47

The user has of course the opportunity to change the size, position and orientation of the mask in the final image, and this in real time.

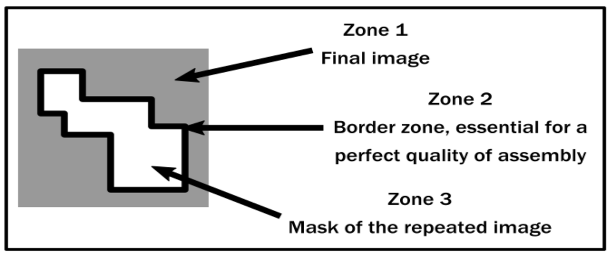


Fig. 48

Zone 1 :	This area is not impacted by the composition
Zone 2 :	This area is essential because it represents the border between the repeated image and the image serving as a support. In this zone, which thickness can vary from 3 to 80 pixels, the two images are mixed according to the alpha channel that describes the current occupation of a pixel relative to the rest of the image. This area is filled by an algorithmic calculation based on the borders of the two images. Naturally, editing can always be refined with the airbrush.
Zone 3 :	This area contains the original image.

Creation of masks

Making masks is one of the most important functions of a retouching system.

It is about defining and creating masks that are part of a continuous image and can be processed separately or concurrently with the rest of the image.

The creation of masks proves very useful in the following cases:

1. We want to define an area of the continuous tone image in which we can work without the brush being active beyond this area.

2. We want to work a part of the continuous tone image indifferently in vector mode or in pixel mode.

3. We want to edit and compose a continuous tone image inside another.

4. We want the color changes or other transformations to be valid only in the masked areas (or outside).

5. We want to perform geometric transformations on masks only (scale change, rotation, translation ...).

Four methods allow for the creation of masks. They can combine with each other to obtain the best possible result:

1. manual generation,

2. automatic generation by color extraction,

3. automatic generation by luminosity extraction,

4. Automatic generation by uniformity of hue.

Let's see in more detail these different functions:

Manual generation

This tool is often used in zoom. The user defines the ends of the mask; a scroll function is automatically activated when a point passes the "zoomed" zone.

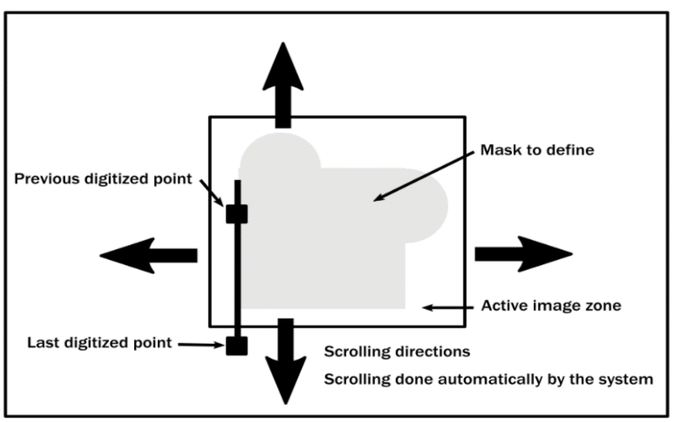


Fig. 49

An UNDO function - going back one step - allows the erasure of mask points previously entered.

Once the limits of the mask are defined, the form is filled thanks to a filling algorithm. Thus, the user only has to define the contours of the mask, the system fills it automatically.

Automatic generation by extraction of colorimetric values

Generally, a mask has global color features, which define an object or group of objects as opposed to a given background.

Thus, it is interesting to use the colorimetric characteristics of an object to extract it from a given background.

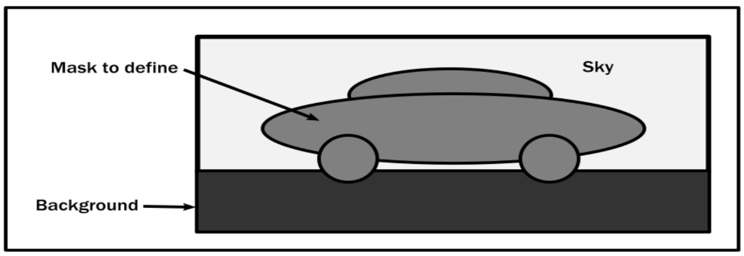


Fig. 50

In some cases, this operation is very simple (red car on a uniform background for example), in others it is much more complicated. This is why we have the possibility to extract colors in real time but also to choose primary colors (cyan, magenta, yellow, black, red, green, blue) and to vary the contrast in order to correctly define the object in relation to the background.

Automatic generation by extraction of brightness values

With this method, we define the lightest point of the darkest zone and the darkest point of the lightest zone in order to separate them well. Since the limit values are acquired, the system can then draw the mask (pixel by pixel).

This function is most often combined with the previous (generation by extracted color) to obtain a perfect mask that does not require any retouching.

Automatic generation by uniformity of hues

In this function, the mask is constructed taking into account the percentage of variation of the chosen hue.

Interactive control tools, resident and specific to all modules

Pixel zoom

Can be active at any time - magnification factor from 2 to 16 in arithmetic progression.

Scrolling - Real Time Displacement

Since the frame buffer is only 1,024 x 1,280 points, it is possible to move in a complete image of 4,000 x 6,000 points in real time.

Choice of the visualization ratio of the image

This function can be activated at any time. It makes it possible to reduce the image (4K x 6K) to the size of the screen in smoothed mode, or to enlarge it up to 16 times for a very precise pixel by pixel editing work.

Mix of colors

This function similar to the palette of a painter. Thanks to this palette, it is easy to mix colors, to retrieve any color existing in an image or photo and to obtain all the effects of oil painting or watercolor.

You can also create and control your own colors in cyan, magenta, yellow and black.

III.2. : Interfaces

The solutions described and discussed in this chapter are refer fully to the Figure 39. This diagram represents the latest stage in the evolution of the configuration of the experimental site.

Furthermore, the techniques described below do not claim to be an exhaustive illustration of the possibilities of interfacing. It is more a matter of making a constructive contribution to the fundamental problems that pose the interfaces in the field of digital reprography.

III.2.1. : Input devices

III.2.1.1. : CCD scanner

While most so-called "desktop" CCD scanners are equipped with "standard" GPIB-PC interfaces, the direct connection to a UNIX-based workstation often poses serious practical problems (BRUNE / OTSCHIK / FOGRA).[15] In our case, we will highlight the absence of GPIB implementation for TEKTRONIX stations.

This is why the "mailbox" solution has been selected to have the advantages of CCD scanners on a workstation. Illustrated in Figure 51, the solution takes up the flexibility of the "standard" GPIB-PC interfacing by supplanting the development of a specific hardware - a GPIB card dedicated to the workstation - by using the Ethernet network for data transfers.

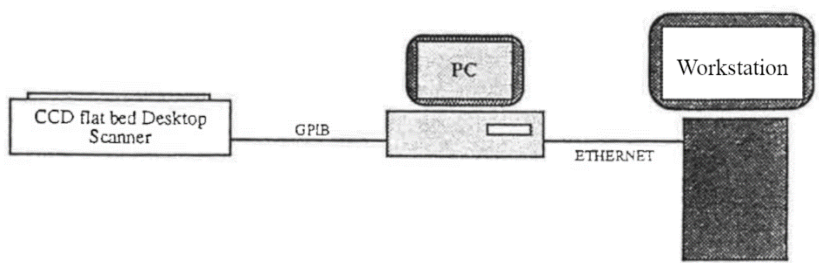


Fig. 51

The principle of the "Mailbox" is as follows: a "waiting" software integrated into the scanner control program allows the PC to check the contents of a "mailbox" directory on each workstation of the configuration (Gold 2, Gold 3, Gold 4). If one of these stations requires a CCD input, its imaging software then generates a boot file in the mailbox directory. This startup file contains or not specifications regarding the scan to execute (precision, dimension, color, etc ...). Read by the scanner control program, this file triggers the scan operation through the Ethernet network, to the workstation concerned. At the end of this operation, the scanner control program generates an end signal which, read by the station's creation software, completes the CCD input.

The flowchart in Figure 52 summarizes the process described above.

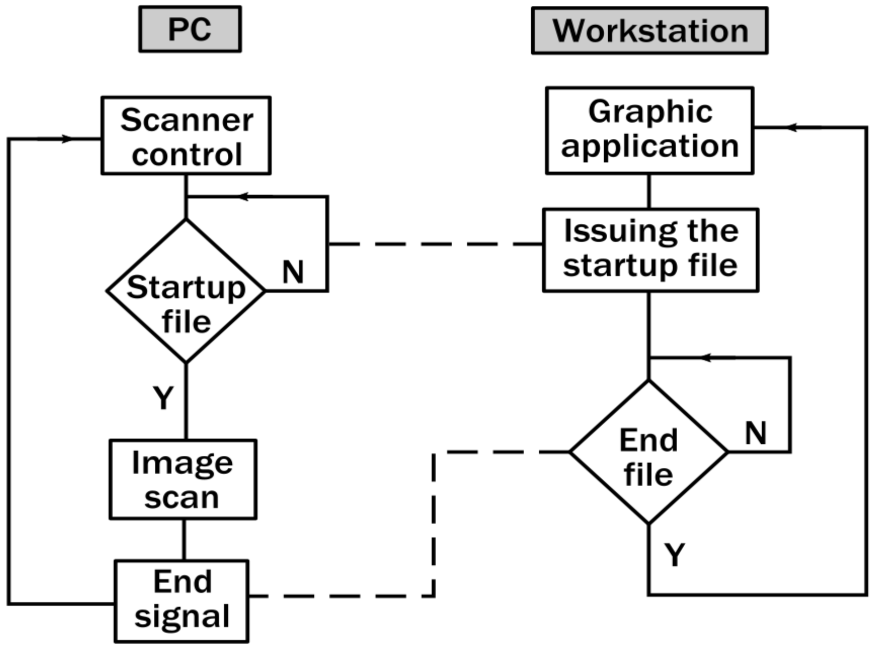


Fig. 52

Note that the use of the Ethernet network limits the productivity of this interface.

III.2.1.2. : Drum scanner, the SG 60811 solution

III.2.1.2.1. : Principle of the interface

The solution takes up the diagram illustrated by the flowchart completing paragraph 3.3.2.2. With regard to practical realization, reference is made to Figure 53.

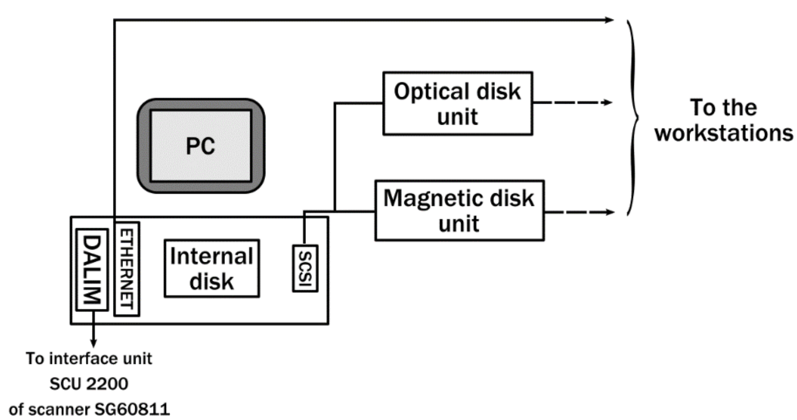


Fig. 53

The problem with the realization of this type of interface is to capture, store and process the CMYK signals from the scanner. Since the rotation of the cylinder carrying the images to be digitized is at 1200 revolutions / minute, the data flow to be processed is considerable. The data from the scanner is in a first time stored. They are then processed to give them the required pixel format.

With regard to the platform used to base the development of the interface card, our choice fell on a PC compatible with the advantage of being adapted to the coexistence of several technologies.

The operation of the implemented interfacing system is illustrated by the two following figures:

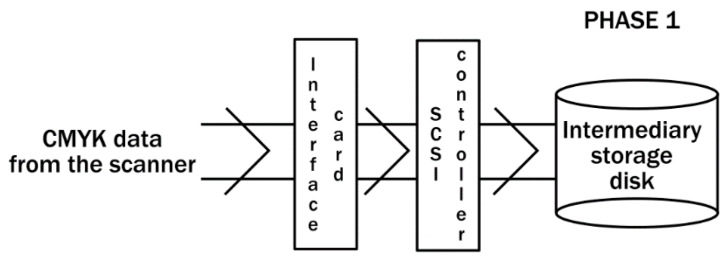


Fig. 54

Operation via SCSI ensures sufficient speed to follow the rotation of the scanner drum.

As illustrated in Figure 53, the peripheral disk drives of the PC allow a transfer adapted to both the performance of the scanner and the requirements of the user.

Figure 55 summarizes in a table the maximum frequencies of the signals from the scanner. These frequencies are achieved by combining the rotational speed of the scanner drum with the scan resolution (350 to 400 lines (inch).

Scan resolution	Signals frequency
350 lines / inch	158.4 KHz
400 lines / inch	181.0 KHz

Fig. 55

It is therefore necessary to collect a maximum of 181000 times per second four times (C, M, Y, K) 8 bits per color or

181 x 4 = 0.724 Mb / s

Only the raw disk transfer via SCSI, freed from the contingencies linked to an operating system, makes it possible to "follow" this data flow (cf chapter 2.2.1.).

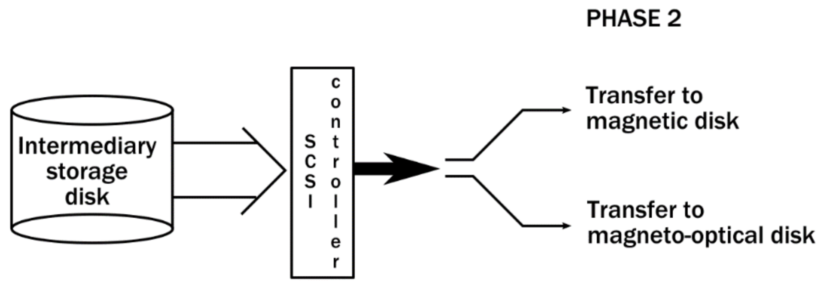


Fig. 56

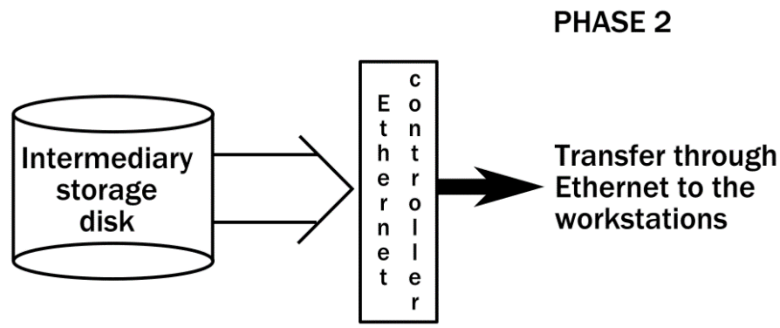


Fig. 57

Note that if the options shown in Figure 56 relegate the conversion to the required pixel format to a simple playback of the removable media on the workstations, the option shown in Figure 57 performs a transfer combined with a conversion of the data stored on the intermediate disk.

III.2.1.2.2. : The interface card

Most of the previously mentioned components are available in the computer technology market in the form of semi-finished products (disks, SCSI controllers, etc.). However, from the manufacturer's data for the SG 608 II scanner and its SCU 2200 interface box, it was necessary to create from scratch the "collector" card for the color data.

This map whose diagram is illustrated in Figure 58, if it remains specific in its realization to a type of scanner, is nevertheless a model of applicable technology - with some modifications - to almost all scanners in the market.

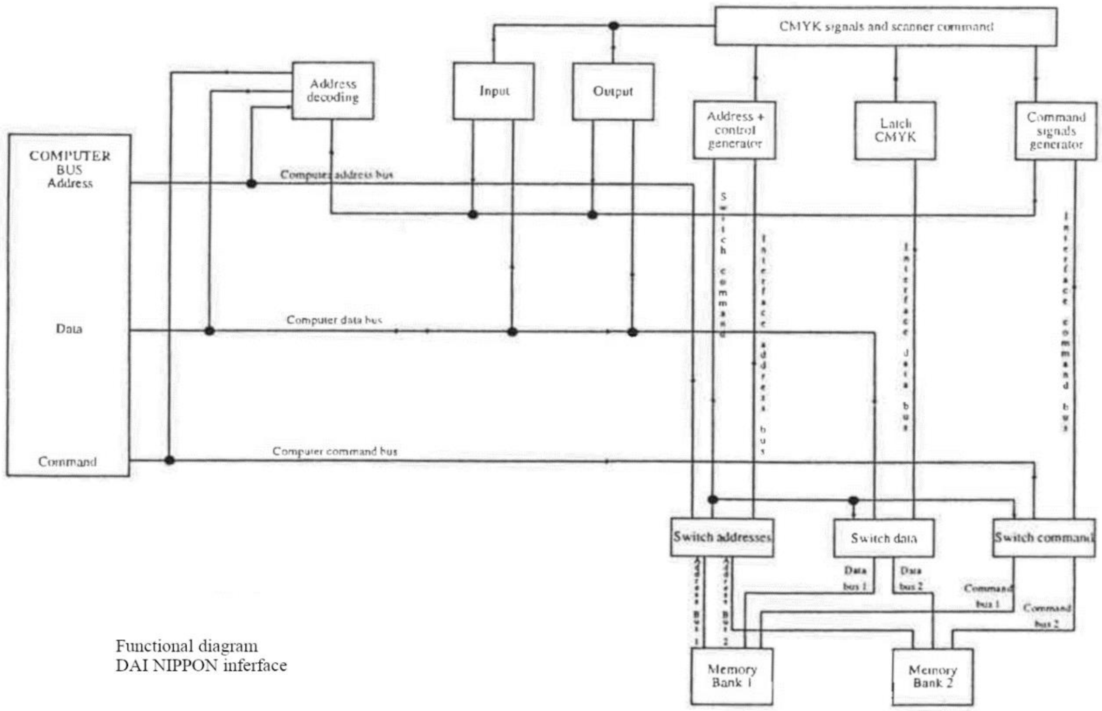


Fig. 58

III.2.1.2.3. : Data transfer by removable media

Pixel information lines, once on the raw internal disk of the PC (Figure 53), must be transferred to the workstations. The network, although it has the advantage of allowing transfer and conversion in a single operation (see Figure 57) is however too slow (see ill.3.) to ensure a sufficient productivity with the scanner. This is why we used the removable data carriers which qualities are briefly recalled in Figure 59 (SCHMIDT 87).[16]

	Diskette	Magnetic tape	Magnetic disk	Magneto-optical disk
Capacity	0	++	++	++
Access time	+	0	++	+
Storage speed	+	++	++	++
Security	+	+	+	++
Cost	++	++	+	+

0 Unattractive

\+ Intermediate

++ Appropriate

Fig. 59

The above table was made in the light of the following figure.

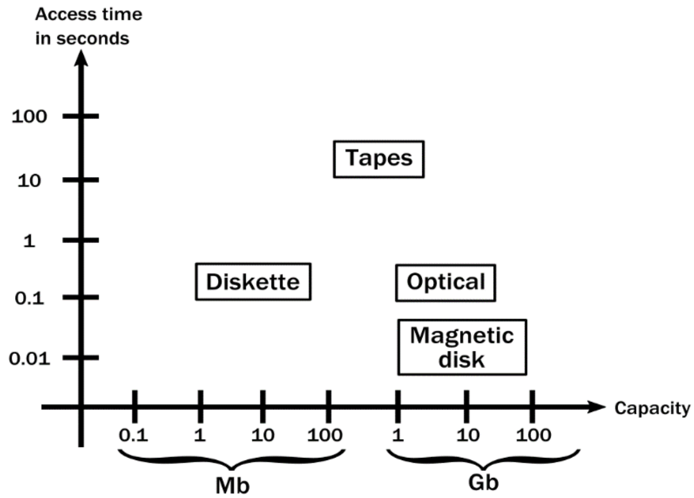


Fig. 60

The imperatives of production on our experimental site thus naturally induced the choice described in figure 53 combining the magnetic and magneto-optical technologies.

In practice, magnetic or magneto-optical units equip the workstations as well as the interface PC (Figure 53). It is therefore the rate of transfer of disks from the PC to the workstations which ensures the production rate of the digital chain.

The choice of these two complementary technologies made it possible to confer to the system described in figure 53 the qualities required for a use in production. The performance of this interface is detailed in chapter 3.3.

III.2.1.3. : DTP reserved entries

In this chapter, we present the solution adopted for importing into PostScript workstations the PostScript data from the DTP programs presented in Chapter II.3.3.

Figure 61 isolates the technique used within the overall configuration of Figure 39.

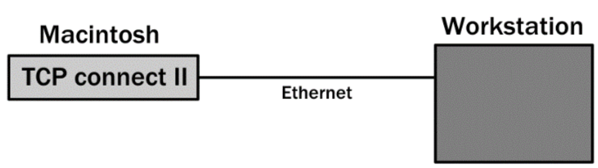


Fig. 61

The need for such an interface is dictated by the fact that a printed page is made of pixel information on the one hand, data line (or text) on the other hand. If the processing of pixel information - especially because of file sizes of several megabytes - requires the use of high-performance and costly workstations, the generation of line and text components can be done optimally on basic computers (type MacIntosh). PostScript (EPS) encapsulated data requires little memory space and therefore allows the Ethernet network to be used for efficient transfer.

As far as the convenience of this interfacing is concerned, an Ethernet card installed in the MacIntosh decouples or, where applicable, replaces the standard AppleTalk network. MacIntosh software - TCP connect II - allows you to establish TCP / IP type communication with either workstation. This software allows, through the use of File Transfer Protocol (FTP), a two-way file transfer as well as the use of MacIntosh as a workstation terminal suitable for pre-processing * PostScript files.

III.2.2. : Output devices

III.2.2.1 : Thermal printers

As shown in chapter II.4.1, the interface available as standard on the Mitsubishi G650 printer used on the reference site is a Centronics type interface.

The four files relating to the page to be produced (CMYK) calculated by the workstation are transmitted by this conventional interface to the printer which produces at 300 dpi resolution proofs of the created page.

If the resolution of 120 l / cm does not allow a correct reproduction of data lines for which a minimum resolution of 700 l / cm is absolutely necessary, this printer nevertheless allows a qualitative appreciation of the pages generated. The quality of this reproduction lies mainly in the screening possibility ooffered by this printer.

This screening, similar to that of printing films, allows a relatively satisfactory approach to rendering a print.

It will be useful to refer to Appendix VIII, which gathers several varieties of proofs made using various techniques.

III.2.2.2. : DTP outputs

In this case, the interfacing technique is strictly identical to the method described in 3.2.1.3.

On the experimental site, the output DTP recourse notably presents two interests (EDV / DRUCK).[17]

- The transfer of reduced pixel files: these files, once loaded into the DTP software, allow the positioning on this low-resolution "background" of the text elements of a page.
- The transfer of PostScript files calculated for the production of color separations on PostScript photoplotter: this last use does not answer to a productive reality given the large size of the files to be transmitted. Indeed, during such use, the RIP (Raster Image Processor) coupled to the photoplotter, must process a very large amount of information, especially because of the presence of pixel data within the file. That is why this process, a big consumer of processing time, cannot yet constitute a real means of production.

** Because of the use of two separate operating systems on Macs and workstations, PostScript data ASCII files must be pre-processed, including a LF (Line-Feed) exchange. for CR (Carriage-Return).*

III.2.2.3. : Quadrichromic separations

This stage of the experimental realization concerns the last link in the studied production chain. We have seen, in previous chapters, how the issues of entry / processing could be addressed and resolved. The paragraphs III.2.2.1. and III.2.2.2. have furthermore explained the solutions adopted with regard to the thermal proof on the one hand and the DTP outputs on the other hand.

Since the production of quadrichromic separations is the very vocation of a reprographic production line, we are here dealing with the printing stage of these photographic films used for the production of offset plates.

At this stage of production, the digital page is completed on one of the graphics stations (Figure 39) and this page, approved from the thermal print, can lead to the 4 films (CMYK) of the separation.

Let us recall here that the mode of operation of the photoplotters calls for a preliminary division of any image in a LW * line part with high resolution (800 1 / cm approximately are necessary to a clear print of the stroke outlines) and a continuous tones CT part grouping the purely "pixels" elements of the image for which a reproduction resolution of 120 l / cm is usually sufficient. Thus, the file calculation software performs, from the two CT and LW sub-pages coming from the division of the original page, a double rasterization to produce two files. These CT and LW files, both in "handshake" format supported by the photoplotter each contain 4 separations. Once assembled on the "whisper" station (see Figure 39), these 2 files will produce the set of 4 separations relative to the realized digital page.

We then discuss the problem of transferring the handshake files of the graphics stations that produced them to one of the "whisper" stations which ensures the combination then the exposure.

As shown in Figure 39, two transfer possibilities are possible. One, "on-line", successively uses NFS for a network transfer on PC via Ethernet then a specific GPIB transfer on whisper. The other solution, "off-line", favors the use of 8 mm video cartridges for the transfer between graphic station and whisper station. These two solutions as well as an alternative that prefers the magneto-optical disk at the exabyte (video 8 mm) are equal as shown in Figure 67.

The main photoplotter of the experimental site is a Scitex DOLEV photoplotter. The principle of its operation is very similar to that described in II.4.2.2. : a laser light beam, channeled by an optical fiber, reflected by a prism, comes to impress the photosensitive film maintained inside a fixed drum. The film roll used, of 38 cm width, allows, from files residing on the whisper's disc, the production of a set of A4 separations in just under 6 minutes. A removable receptacle cassette is used to transfer exposed films to the photographic development unit.

A second photoplotter of RAYSTAR type also from Scitex is integrated in the production unit of the digital proof described in III.2.2.4. This "flat" photoplotter is fully compatible with the DOLEV and does not require any specific interfacing.

** This line work (LW) part called line usually limits, because of the run length encoding used, the number of colors contained in the file to 256.*

III.2.2.4. : The "all digital" press-ready

As explained in II.4.3.2, at the beginning of the work described in this study, the problem of the press-ready had only two alternative solutions:

- the conventional solution described in II.4.3.2.,
- the thermal printer solution described in III.2.2.1.

None of these two alternatives fully satisfy the conditions dictated by the needs of a printing press, namely:

1) geometric identity with the print

2) color identity with the print

3) respect of printing characteristics (resolution, angle and raster)

4) use of a paper identical to that of the printed matter

5) production that does not require the specific production of a set of films

If a thermal type press-ready can be used to fulfill the criteria **1)**, **2)** and **5)**, its traditional counterpart (CROMALIN, MATCHPRINT, ...), because of the essential character of criterion **3)** associated with identities **1)** and **2)**, will be preferred for an qualitative assessment of the page.

However, the respect of this criterion **3)** costs each time a set of films which, in case of non-approval of the press-ready, are invariably destroyed. This long and costly process is at the origin of the development of the technology described below and which manages to meet the 5 basic criteria previously stated.

The principle of the digital press-ready is based on a technique that is concurrent with that described in II.4.3.2. : analog electrostatic reprography.

Illustrated in Figure 62, this principle uses the semiconductor properties of a specific plate. The 9 phases described below indicate the method of printing a separation on a paper that can be chosen identical to that of the final print.

The repetition of this procedure with the other three separations leads after drying and final rolling to the production of an analogical good print (since produced using films).

(1) Loading the transfer plate.

(2) Installation of a separation (film) on the plate.

(3) Halogen insolation of the plate, the areas masked by the film screen points remain charged while the areas exposed to light fall back to zero potential.

(4) Turn over the plate after removing the film.

(5) Passage on the color tray containing the pigment corresponding to the separation used. The pigments are attracted to the places still loaded with the plate.

(6) Loading of the print paper on a media roll.

(7) The plate loaded with pigments comes to print the paper carried by the roll.

(8) Printing is completed by a second transfer.

(9) End of the process consisting in a cleaning of the transfer plate.

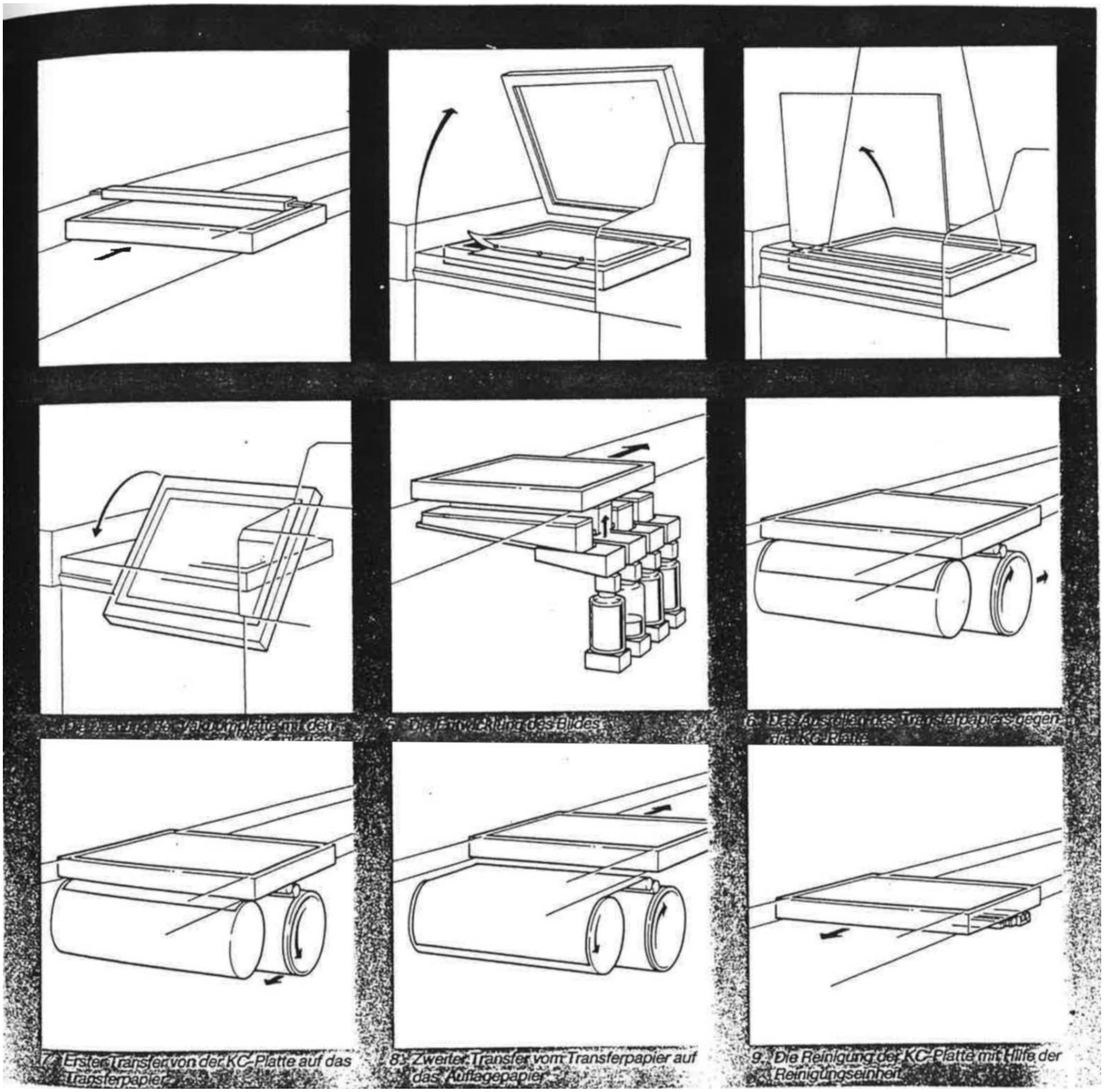


Fig. 62

This analog technique of production of press-ready has the advantage of satisfying the first four criteria mentioned above. The production of the separations (criterion 5) which are necessary for the manufacture of the proof, however, taints this process whose nine phases are combined in Figure 63.

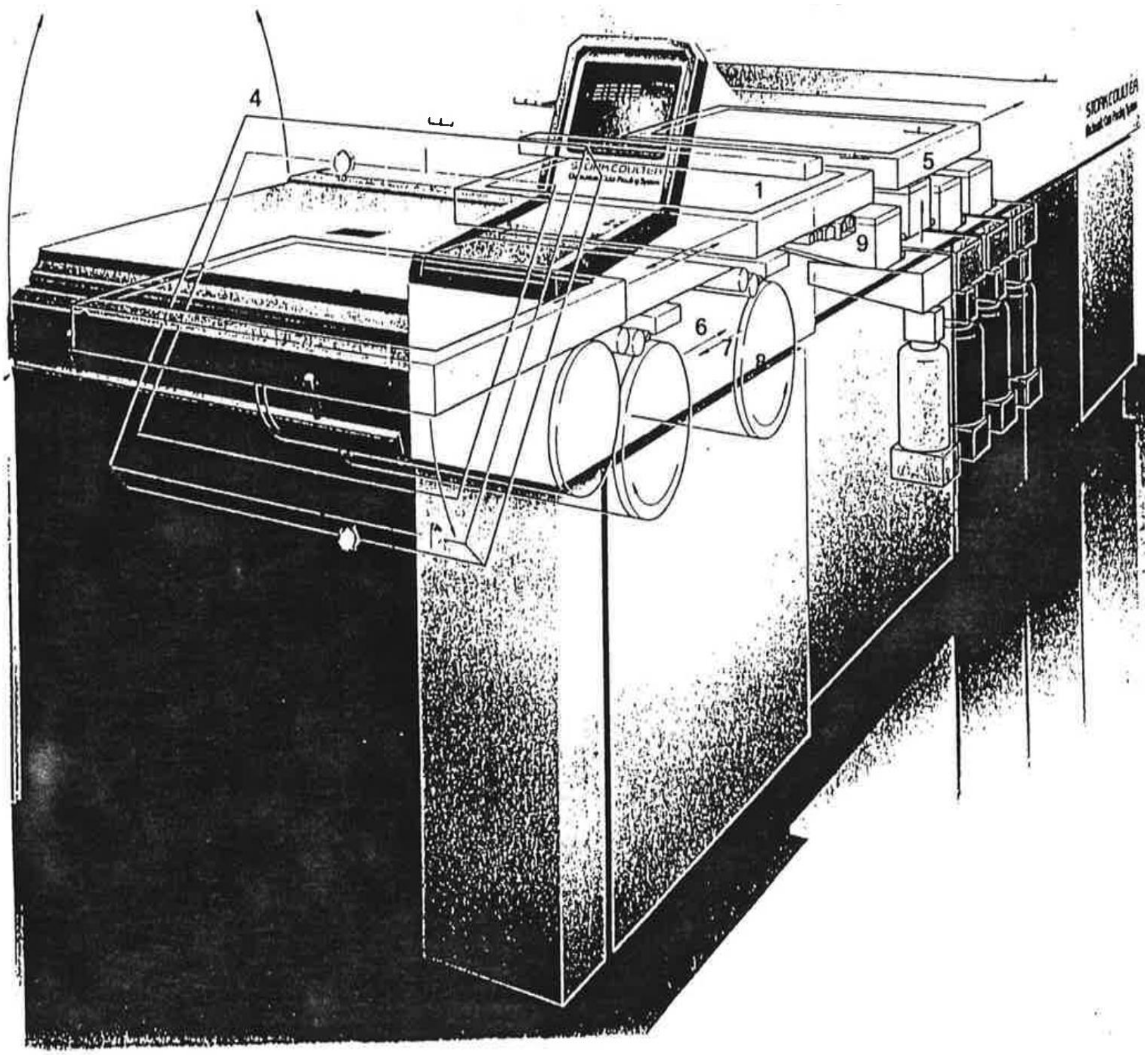


Fig. 63

This observation is at the origin of the process that we implemented on the reference site in collaboration with STORK Digital Color Proofing. This technique uses, on the one hand, a test production unit identical to that of figure 63, the Scitex RAYSTAR photoplotter (see III.2.2.3.) on the other hand.

The idea is in fact to replace phases 2 and 3 of Figure 62 by a laser printing of the transfer plate. This impression is actually done inside the RAYSTAR flat photoplotter. A mechanical device allows the four successive transfers of the plate between the printing unit described in Figure 63 and the phototplotter.

This system achieves, by the "replacement" of the photosensitive film by the semiconductor plate, one of the first "all-digital" proof production systems. In fact, in the light of figure 39, it can be seen that the production of a press-ready now no longer requires the production of separation films. So, the press-ready is finally identical in all respects to the traditional print. Due to the use of a last generation photoplotter, the RAYSTAR, all the parameters of the printing press can be simulated.

Figure 64 describes some of the configurable screen points on the STORK Digital Color Proofer. These impressions all come from the reprographic curves illustrated in figure 65. It is the simulation of these curves within the RAYSTAR which allows the exhaustive modeling of any traditional printing process.

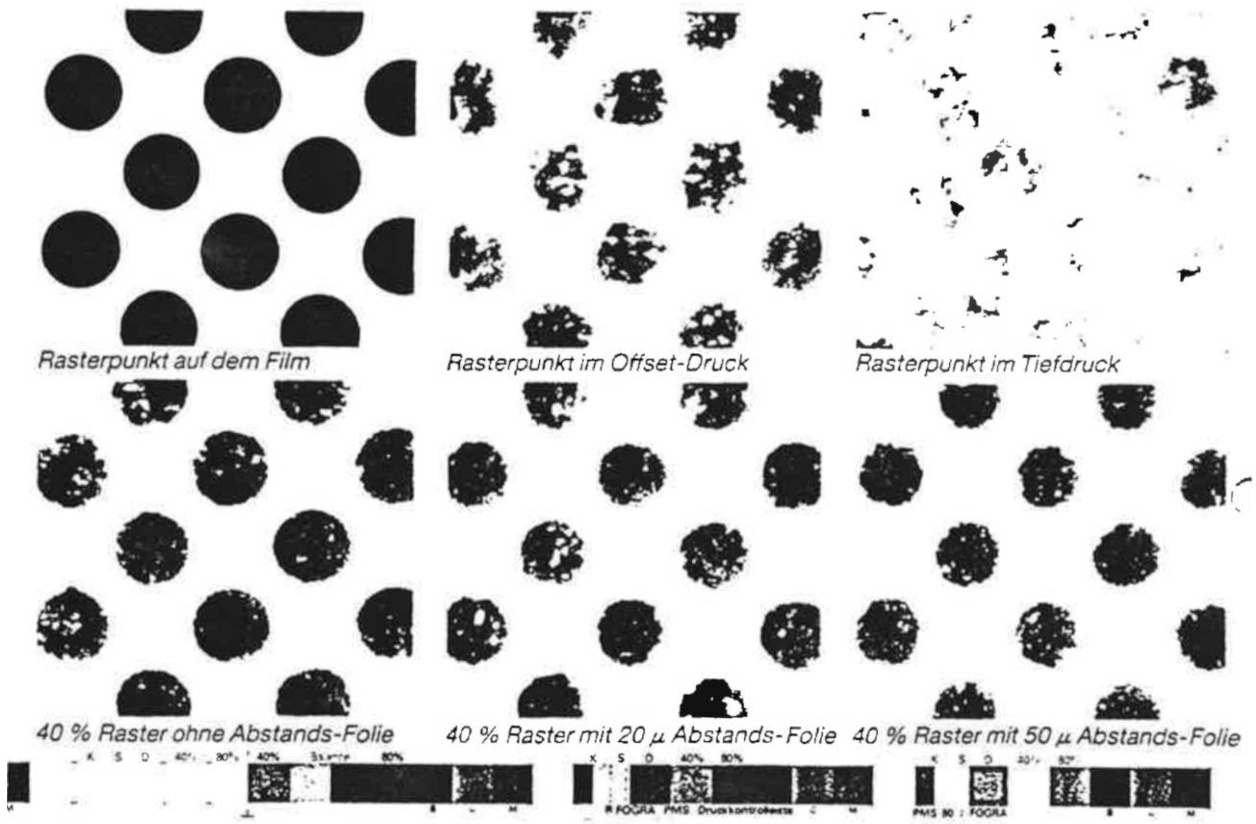


Fig. 64

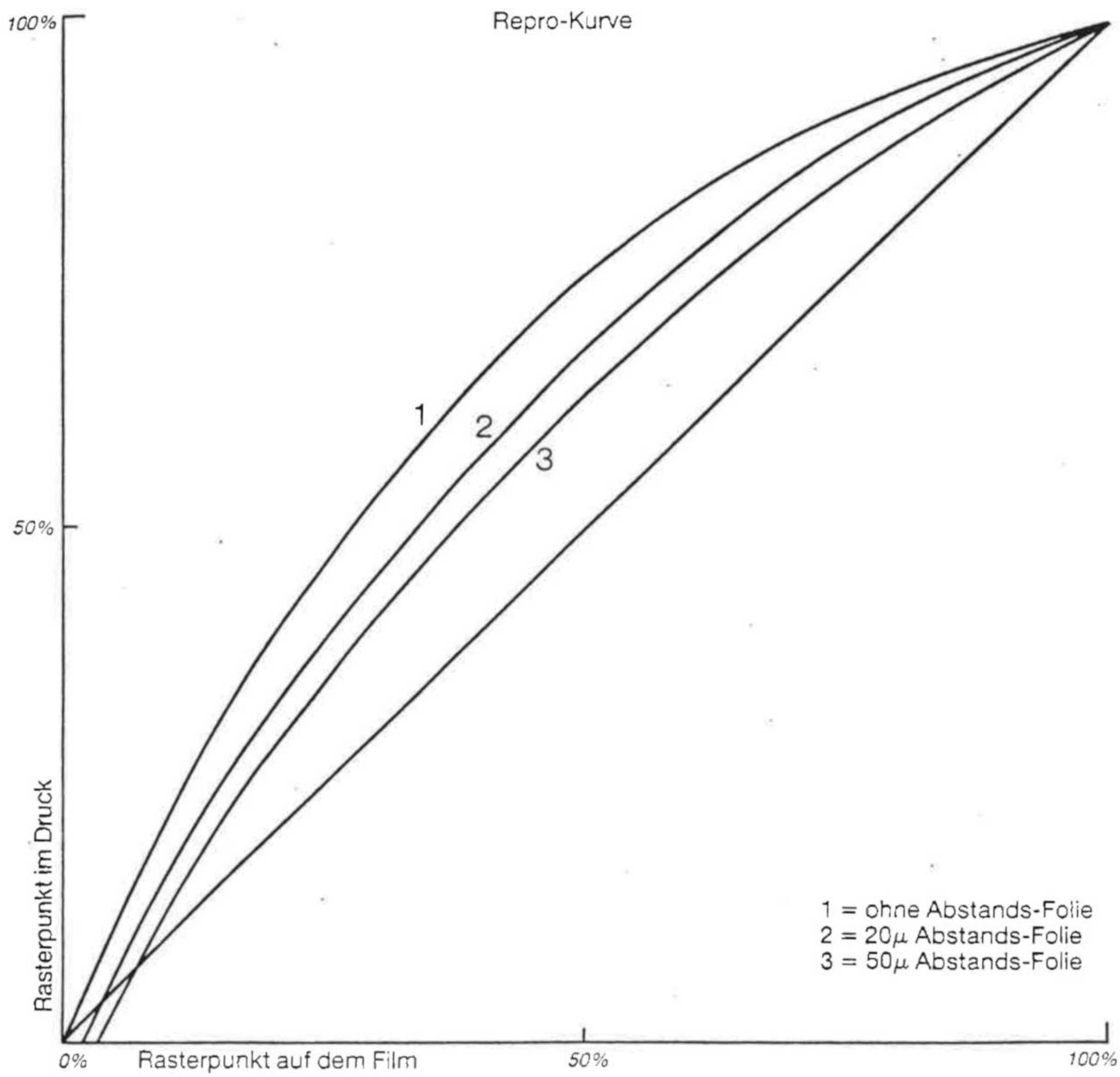


Fig. 65

To close this chapter, note that on the reference site, the handshake files whose generation is explained in III .2.2.3. can thus give place to a digital test and a set of separations after approval of the press-ready.

III.3. : Measurement of productivity and performance

The purpose of this study is not a systematic timing of the processing time on the graphics consoles since these depend on the platform used, and would thus not be very informative. That's why, during this chapter, we pay more attention to the optimization of the transfer times from one unit to another.

The units we take into account are:

- the SG 608 II DAI NIPPON drum entry scanner presented in III.2.1.2.,
- one of the graphic stations TEKTRONIX XD 88/30 presented in II.1.2.,
- one of the SCITEX output photoplotters presented in III.2.2.3.

In the chain of production constituted by these three units, the speed of transfers is decisive. The speed of production is in fact at most inferior or equal to the slowest of the elements of the chain. It is for this reason that we prefer, for reasons of clarity, to study separately the issues of input and output.

III.3.1. : Transfer in input

Figure 66 details the three interfaces installed on the reference site of Figure 39 and used between the scanner and either of the workstations.

The transfer times are given in megabytes per minute (Mb / min). This unit, given the average size of a page * is quite suitable for a quantitative assessment of interfaces.

The findings that can be drawn from Figure 66 are:

- inefficiency of the "on-line" link that a speed of 2.2 Mb / min (due to the PCNFS software of SUN Microsystems) relegates to the rank of additional interface;
- flexibility and speed of the connection by removable magnetic disk. The use of this interface is, due to a capacity limited to 42 Mb per disk, reserved for urgent work requiring a fast transfer;
- relative slowness compensated by a storage capacity of up to 2 x 600 Mb of the magneto-optical disk link. This speed of 3 Mb / min, recently increased to 5 Mb / min by the adoption of a PC 386 / 20e COMPAQ, makes this connection by magneto-optical disk interface perfectly suitable to the amount of scans that can be performed by SG 608 II (a maximum of 140 scans / day totaling approximately 1.4 Gb).

(*) One page represents an average of 70 Mb of input layout data to which should be added approximately 45 Mb of handshake files per output.

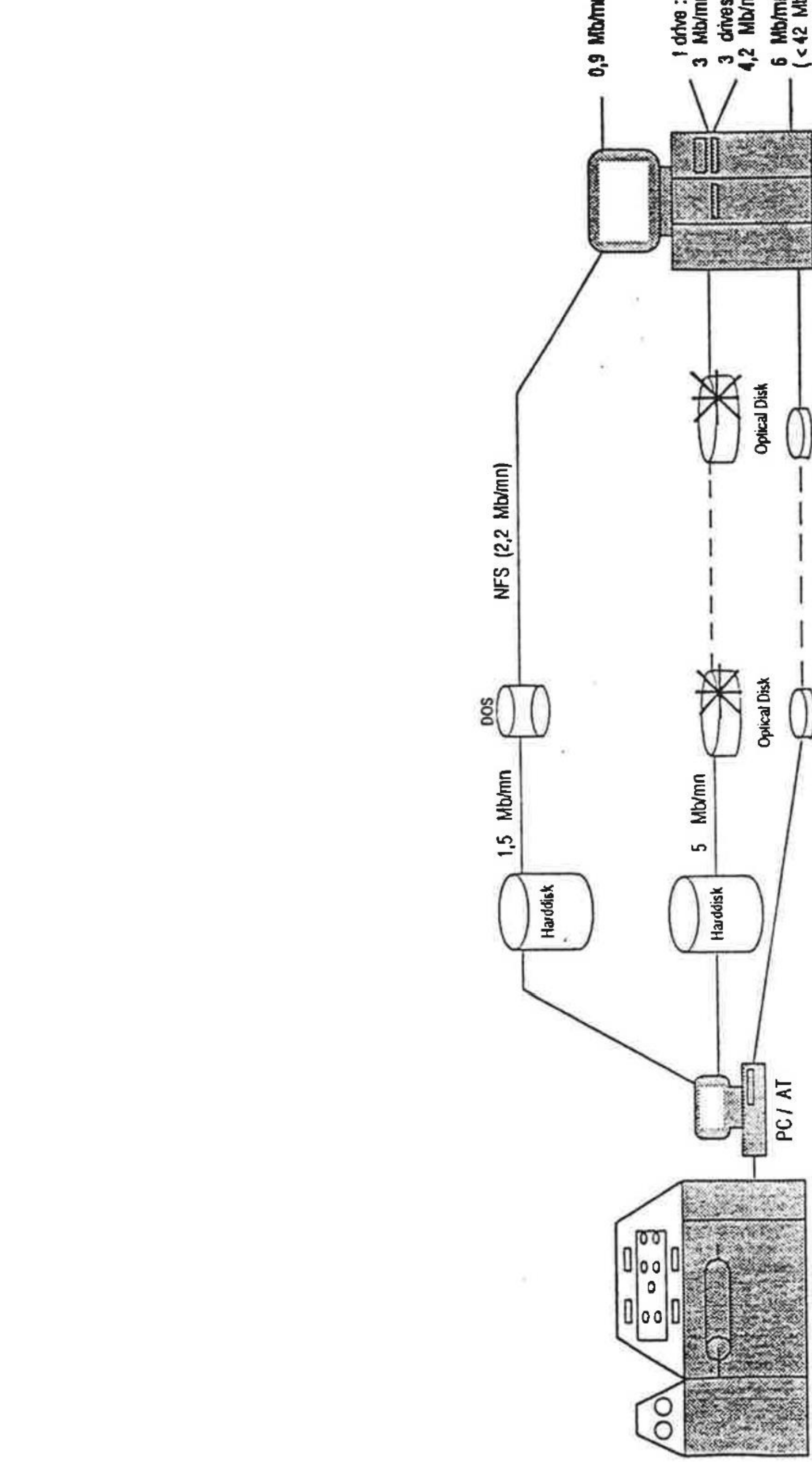

0,9 Mb/mn
1 drive : 3 Mb/mn
3 drives : 4,2 Mb/mn
6 Mb/mn (< 42 Mb)
GOLD X
NFS (2,2 Mb/mn)
Optical Disk
Magnetic Disk
DOS
Optical Disk
Magnetic Disk
1,5 Mb/mn
5 Mb/mn
Harddisk
Harddisk
PC / AT
SG 608 II
Dai Nippon

Fig. 66

III.3.2. : Transfer in output

Figure 67 provides three interface alternatives. The magneto-optical connection, as shown in figure 39 has, for reasons explained later, not been selected on the Austrian reference site.

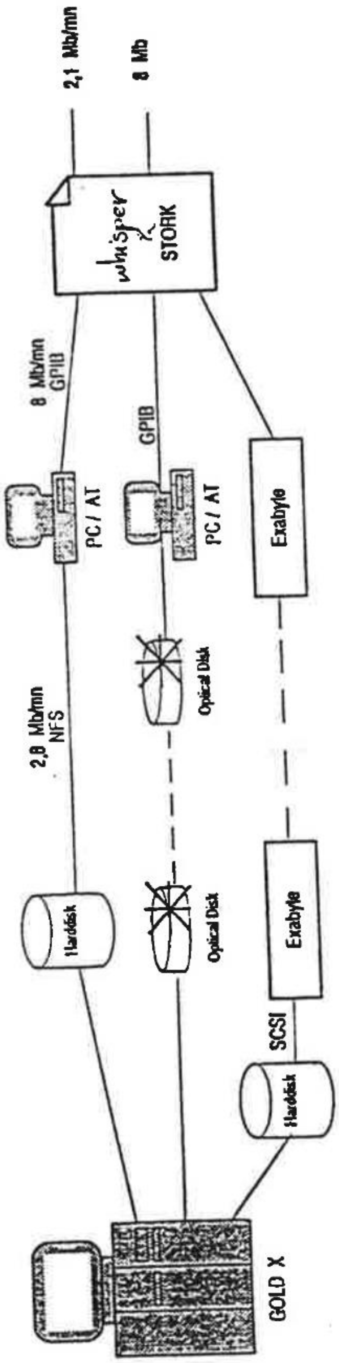


Fig. 67

The transfer times shown here also in Mb / mn are to be compared with those of figure 66. In the light of paragraph III.3.1 above, we can make the following observations:

inefficiency of the "on-line" link. Again, it is the PC-level network (PCNFS of SUN Microsystems) that slows down transfers. This interface serves only as a complement to the adopted exabyte solution,

exabyte interface preferred to the magneto-optical solution because of a similar speed (provided that only one handshake page is stored per cassette) for an exceedingly lower cost.

III.3.3. : Performance and production method

The production line as referenced in figure 39 is suitable for the production on two stations and in a two-week cycle of a copy of the METRO catalog contained in Annex V.

This production has the following steps:

(1) Shooting of the products to be recorded in the catalog.

(2) Digital input of ektachromes on SG 608 II (see Ill.2.1.2).

(3) Transfer of digitized images (111.3.1.) to the disks of the workstations.

(4) Color correction, possible retouching and trimming of catalog elements (see III.1.2.5).

(5) Simultaneous composition on MacIntosh of texts, prices and logos (see III.2.1.3).

(6) Editing of the page on graphic stations (see lll.1.2.1).

(7) Import of PostScript elements (III.2 .1.3) into the page that has been completed.

(8) Realization of a thermal press-ready (Ill.2.2.1)

(9) Division of the page into CT and LW elements (see III.2.2.3).

(10) Exabyte calculation and writing of handshake files as soon as the thermal proof is accepted (see Ill.2.2.3).

(11) Realization of a STORK "all digital" proof (see 2.2.4).

(12) Production of films as of acceptance of the STORK proof (III.2.2.3).

Taking into account the performances measured and shown in III.3.1 and III.3.2, the configuration recorded in figure 39 is able, in 2 x 8 hours per day, to produce a hundred or so "all-digital" pages over a period of 2 weeks.

For this, five workstations (1 input, 3 processing, 1 output) are provided.

This rate of production attests to the validity of the solutions adopted on the reference site (POLYGRAPH 6/91).[18]

IV.

Evolution towards an open system on a standard platform

IV. Evolution towards an open system on a standard platform

IV.1. : The reality of hardware standardization

Due to the specificity of image processing required by reprography and the hitherto limited performance of standard calculators, digital reprographic systems have long been based on dedicated hardware.

At a time when amortization periods often exceeded five years, a specific hardware development could still be profitable. But today, these amortization periods are of the order of two years. That's why, taking advantage of the successive appearances of ever more efficient material, the development tends today to favor the optimization of software that dissociates itself as much as possible of such or such infographic equipment.

It is the emergence of RISC * technology, combined with powerful compilers, which now allows the exploitation of software at speeds of the order of several tens of MIPS. Such performances make possible the software execution of processes long restricted to dedicated cards of expensive hardwares.

It is this state of the art that now positions some graphic stations (SILICON GRAPHICS, IBM, APOLLO, SUN, etc.) as an industrial standard.

(*) A typical case where the computational capacity is fundamental is the RGB / CMYK chromatic transformation described in II.1.3. This transformation that many producers of graphic software have long ignored, begins nevertheless to be integrable within software products such as X / Windows V. X11R5 or PostScript Level 2. It is the RISC MIPS 3000/3010 processors, basis of the CPU (calcu1ation unit == central processing unit) of the Silicon Graphics stations (see appendix VI) that allow our software such a complex real time bi-directional transformation because it takes into account many factors including:

- *color scanner response curves*
- *selective treatment of black*
- *selective color correction*
- *monitor response curves (R, G, B)*

IV.2. : The first signs of software standardization

Ten years after the presentation of the first IBM-PC, graphics stations on the market are generally equipped with several software which, over the years, have gradually adopted an industrial standard value. Such software typically have an infrastructure function, either as UNIX as an operating system, or as a low-level layer between the operating system and the application itself. This is the case of X / Windows (XDMCP)[20] and OSF / Motif (PRENTICE HALL)[19].

IV.2.1. : Operating system: preponderance and future of UNIX

Long reserved for a purely scientific use, UNIX is today unanimously approved by most major computer graphics companies. Two systems running the same operating system can easily exchange information. This is why the adoption of UNIX in the infographic environment not only allows easy interconnections but also the import of data from geographically remote systems.

Constantly improved by successive versions, UNIX is still at the base of the development of the ACE (Advanced Computer Environnent) probably one of the future operating system standards mainly suitable for graphics applications.

IV.2.2. : Graphic system: adaptation of the X / Windows system

Developed at the Boston MIT (Massachusetts Institute of Technology) - USA to be in graphic applications what UNIX is to computer applications, the X / Windows system is now part of the software equipment of graphic stations.

This interactive system handles the existence of windows within which graphics software operates. Easy to use, transparent to a network use (LAN), this system allows the existence of configurations under a client / server architecture similar in principle to the operation of computing centers (CPU - terminals architecture).

This system offers computer graphics the prospect of an evolution towards CPU type configurations - delocalized graphic consoles which are all inexpensive workstations (X / Windows terminal) coupled to one or more central data processing / storage unit(s).

IV.2.3. User Interface: OSF / Motif

To be truly interactive, graphics software for reprography must have a simple and powerful user interface. OSF / Motif was designed to allow the development of user interfaces for X / Windows based graphics applications.

Thanks to its windows and its icons, OSF / Motif gives the software that uses it characteristics close to those of a MacIntosh. It is for this reason that a user experienced in the use of MacIntosh-type software will easily assimilate the operation of an application adopting this well-known system of drop-down menus and stacked windows.

This system also does not limit the possibilities of improving control sequences. It is thus possible to establish three levels of "adjustment" of a user interface:

a. the basic MacIntosh setting: the user manipulates the software in the same way as the Mac products, which are drop-down menus,

b. the extension of this setting to the interaction with the help of a mouse, a stylus or a digitizing tablet,

c. the combination of functions 1 and 2 with a possibility to memorize series of commands (macros) which allow increased productivity for a knowledgeable user.

IV.3. : Standardization and interfacing

One of the consequences of the repeated use of UNIX is to make communication protocols such as TCP / IP standards to simplify exchanges between units connected to the Ethernet network.

While Ethernet performance seems sometimes modest, the TCP / IP protocol supported by optical filter technologies (FDDI) enables data exchange at a rate at least ten times that of Ethernet.

The proliferation of MacIntosh (AppleTalk) network connection techniques with UNIX systems also makes the integration of DTP products extremely simple and efficient. This undeniable result of the standardization in progress in the area of LANs (Local Area Network) testifies of the current trend towards a unification of techniques.

However, the communication of data between graphic units of different manufacturers does not rely solely on the adoption of "on-line" communication standards such as Ethernet or TCP / IP. Indeed, the data description formats, whether pixels, lines or texts, may adopt, depending on the manufacturers, structures more or less suitable for transfers "on" or "off"-line.

If the text files seem to be able to almost universally adopt PostScript (see III.2.2.2.) as a format, the problem of the exchange of lines or pixels data remains. Among the difficulties encountered when transferring data between processing units we can note the following:

- strategic reasons consisting mainly of protection of internal formats by "trade secrets",
- technical reasons due to the disparity of formats and applications involved,
- financial reasons related or not to strategic marketing reasons,
- the influence of states on the adoption or not of standards,
- uncertainties as to the direction of developments in the graphic industry.

A first step towards standardization was made in 1985. Known as the Digital Data Exchange Standard (DDES), this attempt reveals today the weakness of the development of an intermediate format too far removed from actual practice. This weakness illustrated in Figure 68 demonstrates that the transition through a third format (DDES format) is poorly adapted to an effective transfer from system A to system B and vice versa.

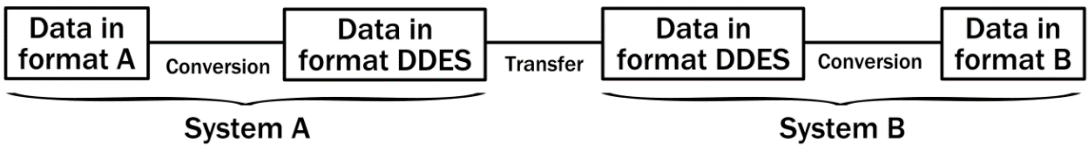


Fig. 68

It is for this reason that in the framework of the IFEN / CPD project (lntercompany File Exchange Network / Constructive Page Description) presented at DRUPA 90, major manufacturers seem to deliberately abandon the idea of bringing DDES to the rank of a communication standard.

Alternatives to DDES have therefore logically been proposed by major manufacturers. These solutions - Handshake for Scitex (see III.2.2.3.), Chromalink. for Linotype-Hell, Freeway for Crosfield, Omega for Daï Nippon Screen to cite the most popular - realize in terms of their inventors two objectives:

- allow the user of a traditional digital system (Scitex, Hell, Crosfield, Daï Nippon) to exchange data with other sites through the more or less expensive (usually more) acquisition of an interfacing unit,
- authorize, by the publication of these formats, other systems to communicate with the traditional systems. This publication allows thus large manufacturers to impose a format relatively close to their internal format as a communication standard.

The unsatisfying state of the art described above justifies the choice of a direct interface (called "on the fly") of the Dalim software with, among other formats, the 4 pseudo-standards mentioned above.

This transfer illustrated in figure 69 thus optimizes the conversion times since the use of an additional intermediate format is avoided.

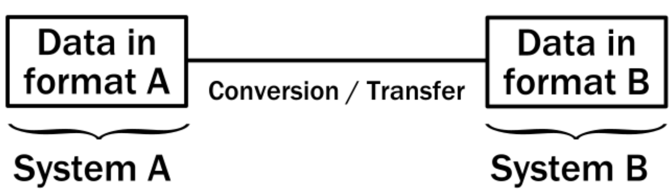


Fig. 69

This interfacing method now fulfills one of the characteristics of the fourth-generation open system currently under development within our research and development unit.

V.

Conclusion

V. Conclusion

V.1. : Research Strategy

In the course of our research, we endeavored to develop new concepts for the mathematical management of digital images and to apply them to reprographic technologies.

The various constituent elements of the chain of production of an image that meets standards, making it possible to print it, are pictured in figure 39.

This modeling has been implemented on a production configuration and allows a production rate of ten pages per day and per machine. These pages, of which Appendix V presents some representative specimens, illustrate the diversity of text / image integration cases encountered and mastered during the experimental development phase.

However, the subjective figure of the number of pages produced per day is too dependent on the operating mode of the production team to be retained as an optimal reference of the efficiency of the system that we developed.

This is why we chose to focus our directions in the fourth and last part a development direction based on a modular approach called "object".

The specifications relating to the evolution of the experimental site in which our work continues from the configuration resulting of our study will therefore be in the logical continuity of the two main development strategies that we have determined.

V.2. : Originality of the physical design

The system has an open aspect that will continue in its evolution to distinguish itself from specific solutions. All components of the creation / processing / production chain must be interchangeable. Similarly, the design of the configuration should allow the possible insertion of subsets, without involving the development of a complex interface.

Our study demonstrated theoretically and then experimentally that the compliance to recent standards (SCSI, GPIB, etc.) made the conception of such a system not only possible, but above all essential to stay competitive in the context of a rapid evolution of technologies. The configuration is thus made scalable and hence its performance follows the evolution of the its elements while ensuring an enrichment of the tasks.

V.3. : Originality of software design

The software architecture makes it possible to keep the application independent of the platform on the one hand and of the disparity of peripherals on the other hand.

Part IV of our study highlights the fundamental importance of software standards such as:

- UNIX as an operating system,
- X-Windows as a user interface and
- C ++ as a programming language.

These application supports allow today the design and production of software free of any concept of manufacturer dependence. It is now possible for an infographic application to be conceptually and practically portable from one platform to another.

This is why the evolution of the system we have developed will most likely benefit from successive generations of MIPS processors used in the latest Silicon Graphics graphics stations. Indeed, once the infographic software is developed with the exclusive use of compatible software tools (part IV) for an application on an IRIS Silicon Graphics station, it is possible to benefit from a binary compatibility imparting to the configuration the improved performance of the future generations of processors. An improvement in these performances by factors 2, 3 or more can then be readily achieved. The binary compatibility of the applications provided by the continuous evolution of the IRIS (Silicon Graphics) operating system allows, among other things, extremely fast portage of the application to a new generation of processors.

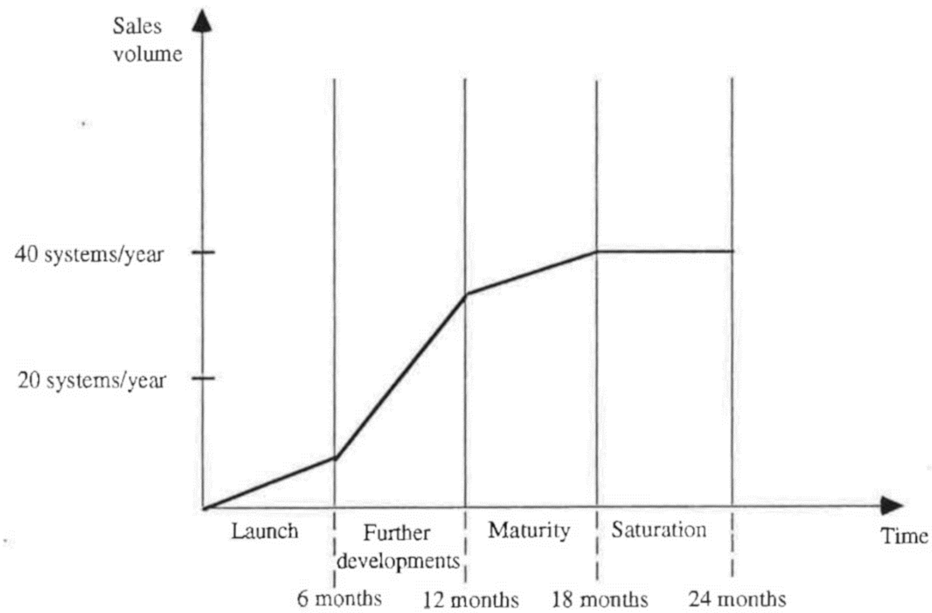
The effective implementation of the applications of the two concepts mentioned above has made it possible to provide the experimental site with an observed evolutionary character.

That's why at the time of the completion of this study, the presented configuration knows a new phase of its evolution with the installation of new Silicon Graphics IRIS CRIMSON workstations. Equipped with the MIPS 4000 processor running at 100 MHz, these stations bring a potential increase in the production rate of around 150%.

The implemented technologies make it also possible to accelerate the inputs / outputs, insofar as a dual SCSI II bus (compatible SCSI bus evolution) allows approximately twice as fast an access to any even number of fast disks connected in parallel with both SCSI connectors of the workstation.

V.4. : Introduction to the market

In order to evaluate the potential expansion of the product on the pre-printing market, it will be useful to refer to the different phases of the evolution of this product, recorded in the adaptation of the graph (DAYAN 10/89) below.



The volume of sales being, beyond the technological considerations, for a product as presented by our study, directly dependant on the importance of the sales team, we voluntarily stand, in the graph above, at an indicative value of the maximum sales volume equal to 40 systems per year.

The overall time span of two years over which the projected growth is carried out is approximately the current refresh rate of the infographic technologies used by our project.

This is why, given the high rate of renewal of infographic technologies, the modular replacement of the "engine" of the digital chain mentioned in V.3. has a strategic advantage in maintaining the experimental site at the highest level of productivity. This operation provides an illustration of the increased competitiveness resulting from the implementation of the concepts that we presented in this study.

The architecture very close to all available graphics stations, correlated to the standardization of peripherals confirms the validity of the original reflection pursued since the beginning of our work. DALIM operates the result of our research and introduces on these bases the foundation of new generations of digital reprographic production units.

GLOSSARY

Glossary

CCD : **C**harge-**C**oupled-**D**evice
Semiconductor layer of metal oxide reacting as a set of capacitors whose discharge is a function of the received light intensity. Such sensors are universally used in audiovisual.

CPU : **C**entral **P**rocessing **U**nit

CT : **C**ontinuous **T**one
Image whose tones vary continuously.

DTP : **D**esk**T**op **P**ublishing
Expression denoting a set of technologies dedicated to computer publishing.

FTP : **F**ile **T**ransfer **P**rotocol

HPGL : Introduced by Hewlett Packard and also intended for CAD / CAM applications, this format achieves an industry standard "printable" file.

IGES : Almost universal format used by CAD / CAM software (Euclid, Computer Vision, Catier Vision, Catia, etc ...) to describe a 3D image.

LAN : **L**ocal **A**rea **N**etwork

LW : **L**ine **W**ork
Image whose content can be described by the unique use of white and a 100% saturated hue.

MFLOPS : **M**illion **FL**oating **O**perations **P**er **S**econd

MIPS : **M**illion **I**nstructions **P**er **S**econd

Off-line : Is said of a data transfer via removable medium (disk, magnetic tape, etc ...)

Pixel (Picture Element) : Elementary point of an image defined by its coordinates in X, in Y and by its color

Portability : Expression used in the IT environment to characterize the compatibility of a software during its transfer (porting) from one operating system to another.

PostScript : Preferred language for most DTP systems.

Rasterize : Calculate a pixel image from a complex image composed of pixel and vector elements.

RIP : **R**aster **I**mage **P**rocessor

RGB : **R**ed, **G**reen, **B**lue
Usual designation of the tri-chromatic space. It is also the mode of operation of many input or output devices (screens, printers, scanners).

RISC : **R**educed **I**nstruction **S**et **C**omputing

Vector :

A graphic object defined by an outline (points, lines, curves) and a fill color.

WYSIWYG :

What **Y**ou **S**ee **I**s **W**hat **Y**ou **G**et
Expression often used in the graphic arts to highlight the complexity of reproduction of all the features of an original document (color, sharpness, geometry, etc. ...) after digital processing.

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Summary

During the two last decades, manufacturers of graphic workstations have been working hard in order to design and market development platforms with reliable and high performing architectures enabling both modelisation and processing of numerical reprography.

Until recently, a few big manufacturers developing specific solutions, more reliable than efficient, shared the prepress market. However, more and more software houses are choosing the conceptual and then technical design of different prepress systems based on standard hardware collecting the last available electronic and programming technologies.

Every passing year, with the replacement of one workstation with one of greater performance, it becomes rather obvious that the future of the prepress industry definitely belongs to this kind of equipment, cheaper than a dedicated hardware but also and above all, more flexible, i.e. upgradable, for adaptation to new technological innovations.

However, until today, none of these new architectures has ever been at the center of an experimental site within a traditional repro house. Such a development seems to be useful, even unavoidable in order to define precisely the possible evolution of those new technologies which offer, as we will see, real productive user-oriented solutions.

The work described in this document has led to the realisation of a system which went from an experimental level to a productive one as soon as September 1991.

A first part locates the problematic of digital page layout and outlines the state of the art in the current technologies involved on the market.

The second part of this work consists in a non-exhaustive analysis of specific tools to be integrated within a digital production line for the prepress industry.

A third part presents the conceptual study as well as the experimental evolution of the production tool resulting from the needs of a "digital" printing industry.

As a conclusion, we present a synthesis of the work accomplished together with a critical analysis proposing an evolution of the created configuration.