### ELECTRONIC TOOLS FOR DESIGNING CHARTS AND GRAPHS

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B.F.A., Massachusetts College of Art Boston, Massachusetts June, 1966

Submitted to the Department of Architecture in partial fulfillment of the requirements of the Degree of Master of Science in Visual Studies at the Massachusetts Institute of Technology

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ABSTRACT

This thesis explores the issues involved in designing an interactive chart and graph making system, especially tailored to the needs of the graphic designer. It defines a set of user interface requirements and describe the implementation of the prototype software system.

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### INTRODUCTION

As the result of a need to digest and disseminate enormous quantities of corporate and financial information, business graphics has grown considerably and further substantial growth is predicted.

"U.S. suppliers of commercial grade (non-military, non-consumer) computer graphics equipment and services can anticipate total annual worldwide sales of \$14.5 billion by the end of the decade - a figure more than 1,000% increase over the estimated \$1.3 billion worth of equipment sold during 1980. But business applications are expected to grow at nearly twice that rate, increasing their percentage of the total market from 21% (\$273 million) in 1980 to 40% (\$5.8 billion) by 1989."

"Business graphics usage, both present and future, tends to increase with the size of the organization - reflecting in part, the increased complexity of the information which must be

assimilated by upper-level management. See Table 1 for a list of financial and management reports that can be improved by the application of business graphics.

Both of the quotations above are from a recent report entitled "Computer Graphics for Business Applications. 1980-1989" by the consulting firm Frost & Sullivan. That same report predicts that the generation of charts and graphs for business will soon rival CAD/CAM as the dominant computer graphics application. See Table 2 for a list of industry and other classifications that were analyzed by the same Frost & Sullivan report.

This clearly indicates that there is a growing need for large quantities of numerically stored data to be converted into diagrammatic images. As this field grows, it becomes increasingly apparent that technical achievements are surpassing the quality of graphic images. A better balance between graphics and technical expertise is needed. Such a balance will be achieved as the quality and effectiveness of visual presentations improve, and this will come to pass as more graphic designers become involved with computer graphics and share their expertise. But how will the future chart designer go about creating diagrams? What tools will be available? How will these tools work, and will they hinder or will they help the creation of sophisticated graphics?

Financial and Management Information Susceptible to Graphic

Table 1

Presentation

Balance Sheets	Measures of Operating Efficiencies
Cash Flow	Operations Statistics
Financial Modeling	Planning Data
Financial Results of Operations	Production Statistics
Forecasts	Status of Programs
Investment Planning	Sales Statistics
Key Financial Ratios	Status of Capital

Table 2

Business Graphics Industry and Other Classifications

COMMUNICATION	&	UTILITIES
---------------	---	-----------

GOVERNMENT

Energy Broadcasting Other Federal State Municipal

EDUCATION
Secondary Schools
Colleges/Universities

MANUFACTURING Electrical Mechanical Aerospace Automotive

Other

Other

FINANCIAL Banking Insurance Brokerage Other PROCESS Chemical Petroleum Other

GENERAL SERVICES Time-sharing Service Bureaus

TRANSPORTATION Air

Service Burea Other Marine Rail Other Present methods for designing charts and graphs range are either totally non-interactive or, at best, semi-interactive.

Most designer's are forced to change their natural thinking and working habits and make unnecessary compromises in the way they normally communicate visually and otherwise.

My thesis topic, "Electronic Tools for Designing Charts and Graphs, deals with interactive electronic layout and the creation of a designer friendly chartmaking environment. This thesis is addressed to graphic designer's working at the creation of charts and graphs, particularly the type of chart-making found in that area of business graphics known as presentation graphics. This category within business graphics, according to Frost & Sullivan, will show the most growth in the Therefore, it is essential that chart next ten years. designers be given the tools they need. The output for a presentation graphics system usually consists of high quality color charts and graphs used to accompany the presentation of specific information. The output is displayed either by system generated video or by slide/overhead projectors.

Today many large companies have a tremendous need for graphics of presentation quality. This tool serves a wide variety of corporate purposes, including visual support for speakers at meetings of stockholders, board members, and sales

representatives. In addition, there is a substantial need for graphics as aids to instruction for in-house seminars, as sales tools in customer promotion and packaging, and as hard copy reproduced in corporate publications.

Presentation graphics can be created in-house in a media service department or art department, or can be sent out of house to a slide service center. In both environments, graphic designers work at CRT work stations to create the final visual.

## Graphics and Information Science

Traditionally, information science has been concerned with the organization and dissemination of information. In the past ten years computer graphics have been increasingly used to create, store, and transmit images that communicate facts and concepts about data. As computer graphics grows as the typical means of communicating information, information science must consider the methods of analyzing, disseminating, and improving the images. Graphic design is a discipline concerned with the visual aspects of how information is presented and the effectiveness of its communication. Collaboration between the two disciplines is germaine to the future development of computer graphics, if computer graphics is to go beyond the need for information and expand into the realm of the effective visual communication of concepts.

What role will graphic design have in this collaboration? And how will designers help integrate the two disciplines and ultimately contribute to the growth and development of this field?

Graphic design is becoming increasingly important to computer graphics because of the need to make use of the increasing capabilities of the machine, and because computers are expanding out of research institutions and into offices, homes, and design studios. Therefore, the needs of large numbers of noncomputer science people are increasing as is the demand for more effective visual communication of complex ideas and processes.

According to Aaron Marcus (in a speech given at Siggraph 82), "Graphic design can have a distinct impact upon the three 'faces' of computer systems: outer faces, inter faces, and inner faces. Outer faces are the images of information (texts, charts, maps, and diagrams) which a computer system produces to communicate the results of data processing. Inter faces are the frames of information (including on-line and off-line documentation) in the human computer interface through which final images are achieved. Inner faces are the internal representations of program function, structure, and process by which computer systems are built and maintained. In all three

areas graphic design has a role to play in achieving significant functionality and providing aesthetic and humane information environments.<sup>2</sup>

Graphic designers can make valuable contributions by transfering their expertise directly into the development of software and software systems and designing systems that enable other designers to work in more comfortable and natural ways. As Karl Gerstner said, "graphic designers will design processes, not just products." By developing programmatic approaches to software design, the designer can create the process in which design takes place. This means creating a design environment that is always changing and ever more dynamic. This also means creating an environment wherein the designer, not the computer software, is the primary decision-maker.

It is important to make sure that the needs of graphic designers, the way they think, and their approach to problem-solving become integral parts of software design. This is the key to creating the most useful kind of tool.

# The Thesis

As a graphic designer, I have made my primary objective in undertaking this thesis, the creation of a software environment

that would help the graphic designer to make design decisions, and would emulate and augment the natural design process.

The thesis is divided into four parts, the Introduction, The Chart, the Chart Module and a Review of Presentation Graphics.

#### THE CHART

## Tools of Explanation

Charts are a means of presenting quantitative as well as qualitative information in an effective and efficient visual form. They are images that use lines and shapes to represent numbers and concepts. Visual hierarchies are simple and clear. One bar, for example, is larger than another. Comparisons are clear, thus enabling the reader to grasp and return the information easily.

As symbolic drawings, charts represent a synthesis of ancient and modern methods. Lines and shapes such as circles, rectangles, triangles, and curves have always been used to help explain our environment. The circle represents unity; the arrow represents attraction, flow, and direction; and the rectangle represents area or mass. These shapes are combined into forms that are known as bar charts, pie charts, orgnizational charts, flow charts, line charts, etc.

Charts help us to gather and process information. They increase the effectiveness and efficiency of transmitting information in a way that helps the reader to process what is portrayed. They give meaning to information because they go beyond the information itself and show relationships, trends, and comparisons. They help to tell the reader which numbers and which ideas are more important than others. "Diagrams are useful for finding critical issues in complex situations even when the reader has no knowledge of the structure being mapped" In addition, in order to be understood, a chart must be not only simple and clear, but appropriate to the subject.

### Tools of Influence

In his book, <u>Visual Thinking</u>, Rudolf Arnheim shows that all thinking is basically perceptual and the dichotomies between thinking and seeing and between reason and perception are false and misleading. Therefore, to see is to reason. As visual forms of communication, charts have great potential for influencing what a person thinks. They are more than just a way of presenting facts or information. Because they influence thought, they are strategic tools of persuasion.

Charts convey information that is both understandable and convincing. The reader understands what he is being shown and believes in the correctness of the points being made because

charts give the appearance of preciseness and surety. These attributes create an impression of accuracy, thus serving the specific needs or opinions of a chart's author.

## Tools for Analysis

When charts are used as tools for thinking, and for defining and solving problems, the process of creating them is as important as the product.

Charts and diagrams can be analytical tools used not only to solve a wide variety of problems, but to monitor and define trends and conditions. Corporations make important decisions on the basis of what charts show. As conditions change, follow up graphics and/or new charts are necessary.

Because they have to be updated and changed, charts are ideal material for electronic interactive design and layout. Electronic layout systems, because of their capacity for speed, immediate response, and accuracy are the best means of serving the dynamic nature of charts. Computer animation, in particular real-time movement of individual graphic elements and color cycling through multi-projector emulation, serve a growing need to create images and animation sequences that can be stored easily and reworked quickly. In addition, electronic filing systems, associated with electronic graphics networks, provide the most efficient way of storing, copying, updating, and reproducing charts.

### DESIGN REQUIREMENTS

This section deals with the generic user needs not the specific designer needs. For a more detailed explanation of the specific designer needs, see the Layout section in Chapter 4, The Chart Module.

Analysis and Synthesis

Analysis

The design of an interactive layout system begins with "task analysis." This process consists of understanding what its application is to be, and defining its users. "Task analysis" involves establishing what are the goals of its users, what information they will use in performing their task, what information they will generate, and what methods they will use. "The idea behind this phase of design is to build up a new task environment for the user, in which he can work to accomplish the same goals as before, surrounded now by a different set of objects, and employing new methods." 1

## Synthesis

Prototyping is another critical aspect of system design.

Concepts should be implemented with the knowledge that they are interim measures in the development of the final system. The prototype is instructional, its role being that of a step in time, a contributor to the design of the final economically satisfying system.

# The Design Principles

A good way to start a task analysis is by defining typical user problems, and breaking down their meaning. After the basic problems have been defined, several general design principles should be applied to the task. These are human-factor principles that can apply to the design of any computer system and are used as guidelines in keeping the system "friendly."\*

I used seven principles:

- 1. Provisions of feedback
- Consistency
- 3. Minimization of human memory demands
- 4. Structure the display to aid understanding

<sup>\*</sup>For a similar list of design principles, <u>see</u> Foley & Van Dam, Fundamentals of Interactive Computer Graphics.

- 5. Matching the program to the user's computer skills
- 6. Maintenance of operator orientation
- 7. Accommodation of human error
- Feedback: People need to know that their action has had an 1. effect. If the user makes a keyboard entry and nothing happens, he has no way of knowing what effect his action has had. When there is no feedback, the user may repeat his action several times or try another action, thereby possibly causing something unintended to happen. Foley & Van Dam list three possible levels of feedback corresponding to the levels of the language. lexical, syntactic, and semantic. "The designer must consciously consider each level and explicity decide whether feedback should be present and if so, what form it should take. The lowest level of feedback is lexical. Each lexical action in the input language can be provided with a lexical response in the output language: instance, echoing characters typed on a keyboard and moving a screen cursor as the user changes the position of a locator.

Feedback to a syntactic input occurs as each unit (word) of the input language (command, position, picked object, etc.) is accepted by the system. A command picked from a menu or an object picked to be moved is highlighted, so the user can know that the actions have been accepted (that is, the "words" have been understood). Similar forms of feedback to syntactic inputs are prompting for the next input, lighting the PFK button which has just been depressed, and echoing verbal (speech) input with verbal output. The furniture layout program in Chapter 2 uses several such feedback mechanisms.

Another form of feedback on the syntactic level occurs not as each syntactic token is input, but rather when a complete syntactic sequence (a sentence in the command language) has been input and been found to be well-formed. This is acknowledgement of receipt of a proper sentence, and is generally needed only if performing the semantics of the sentence (the actions specified by the command) will take more than a second or two. The layout program does not use this form of feedback.

The most useful and welcome form of semantic feedback tells the user that the requested operation has been completed. This is usually done with a new or modified display which explicitly shows the results. The furniture program uses only this type of semantic feedback, because each command can be carried out quite quickly. In some cases, as when

the user asks that a drawing be filed for later use, such explicit graphical feedback is not appropriate, and prompts or completion messages (either text or icons) are used instead."

Whatever form feedback takes, it should be immediate and obvious. Its position and orientation on the screen should be consistent so that the user will know what to expect.

- 2. <u>Consistency:</u> A system designed for consistency is one in which the conceptual model, the command language, and the display formats are integral. The user expects certain things to happen, thereby creating trust and user comfort. Some examples of consistency may be:
  - a. System status messages are shown at a consistent position
  - b. Menu items are displayed in the same relative position within the menu
  - c. Keyboard characters have the same function throughout the system.
  - d. Global commands like "help" can be invoked at any time.
- 3. Minimization of Human Memory Demands: Learning how to use a system involves remembering a lot of new information.

  It's important to minimize the quantity of information that

must be remembered by replacing as much of it as possible with user recognition abilities. "When everything being dealt with in a computer system is visible, the display screen relieves the load on short-term memory by acting as a sort of 'visual cache.' Thinking becomes easier and more productive. \*4 In developing the Xerox star a predominantly visual display approach was taken. results showed that, "a subtle thing happens when everything is visible: the display becomes reality. user model becomes identical with what is on the screen. Objects can be understood purely in terms of their visible characteristics. Actions can be understood in terms of their effects on the screen. This lets users conduct experiments to type, verify, and expand their understanding the essence of experimental science. \* 5 Some examples of ways to minimize human memory demands are:

- a. User points to screen visual
- b. Objects referred to by alphanumeric names
- c. Use of multiple screen windows
- 4. Structuring the Display: In any large system a lot of information must be displayed. The user will find it confusing and difficult to understand unless the display is organized in a structured form. To give structure to the information, the display screen should be divided into areas where specific types of information are consistently

presented. Prompts, error messages, graphical representations, etc., each have their own area. This will help the user to find relevant information quickly and surely.

- 5. Matching the Program to the User's Computer Skill: This design principle can be described by first answering the following four questions:
  - a. What will the users be expected to do?
  - b. What decisions must they make?
  - c. What must they know to make the decisions?
  - d. What levels of skill will be required?

Most graphic systems are designed to accommodate a wide variety of users, from the new and inexperienced to those with many years of computer experience. User experience is fluid: one person might be a novice, an intermediate, and an experienced user while working on the same system.

The novice user needs to be shown what the system does and given examples, while the intermediate may need only prompting and a help button. The more experienced the user, the less prompting is necessary, especially if it slows down the pace of the interaction. Some systems allow the user to control the prompting.

6. Maintenance of Operator Orientation: Some systems are alien to the backgrounds of new users. Instruction manuals explaining the environment are most likely to be written in obtuse jargon, which adds to the reader's confusion. The user needs signposts written in a language with which he is familiar to tell him where he is and how to get back to where he came from.

Menu driven programs accomplish this by providing a main menu to serve as a home base. The program begins with this menu from which the operator can select various subprograms, perform what he has to, and then return to the main program.

7. Accommodation of Human Error: It's easy for all of us to make mistakes. In fact, mistakes can be excellent ways of learning. Making a decision and then changing our minds is part of being human. In designing a system, provisions

should be made to allow the users to conveniently change their minds resulting in a discovery of new and unexpected results not in creating frustration and lessening productivity.

Most techniques for dynamic interaction, such as moving or picking an object, provide error backup by allowing the user to pick and drag the object around the screen. Once the user presses the position button a final decision is made. These procedures don't allow the user to undo or cancel the previous decision and return the object to its starting position. An alternative to cancellation is to ask the user to confirm those commands which, once executed, require a major effort to undo.

These principles describe one major idea: to know the ergonomic needs of the system user. Users need feedback to avoid confusion, consistency to ease learning, minimal strain on memory, visual structure, and simplicity, demands gauged to their level of system expertise, and constant clear orientation.

#### THE CHART MODULE

The chart module now being developed is a highly interactive, menu driven presentation graphics system. The overall system is designed for maximum flexibility and to accommodate the needs of designers, with computer expertise ranging from the novice to the computer experienced intelligent. It will take into account the dynamic nature of designing and will not impose a rigid set of procedures for the user to follow. Instead it will be friendly enough to encourage the user to experiment and explore different design methods, help him to make multiple design decisions, and encourage him to create his own working environment. It will not make decisions, it will allow them to happen. For flexibility requirements, <u>See</u> Table 1.

The designer evokes the system from command level with the command "CHART." This displays the first level of menues, which consists of the four system functions. The user decides

## Table 1: Flexibility Requirements

A Chart System must be flexible on many levels

Flexible to accommodate different levels of user computer expertise.

Flexible to offer a wide variety of operational functions.

Flexible to allow the user to roam and select at will from the operations offered.

Flexible to offer a wide range of chart types by designing and implementing modular software.

Flexible to enter data, easily manipulate it, copy it and store it.

which system module he/she needs at that time and enters that module, see Diagram 1: System Entry and Diagram 2: Traversing the System Modules.

If there is any doubt in the user's mind as to what function he needs, the system helps him to make his initial decision by giving him a prompt and explaining what each function does.

## The System User

It is assumed that this system will be used by graphic designers and chart artists. Users will probably fall into three catogories of computer expertise: the novice, the intermediate, and the experinced. In fact, the same person in the course of using the system can fall into all three categories. A novice is a person who has had no experience with computers; an intermediate has had some computer experience, maybe with a different system; and an experienced user is one who has had prior computer use and is familiar with this particular system. The needs of the three categories are different (see Table 2, User Needs), and the system must meet them all without leaving the designer intimidated or frustrated.

In addition to the general computer expertise categories, the designer has special needs, such as unlimited creativity and comfortable, familiar ways of producing the created piece.

Diagram 1: System Entry

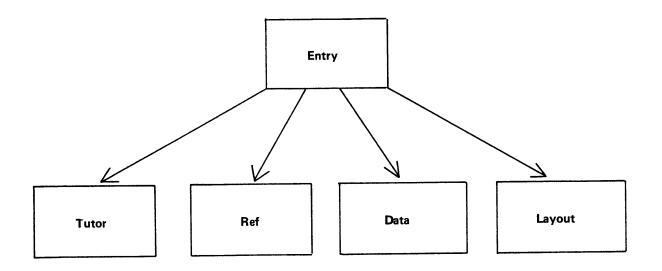
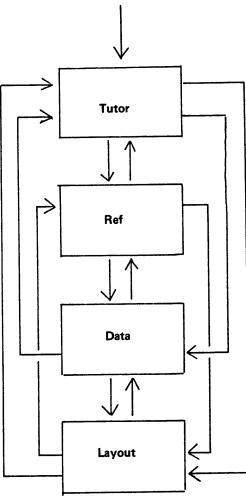


Diagram 2: Traversing The System Functions



## Table 2: Designer Computer Needs

A typical designer will go through three stages of acquiring familiarity and ease in computer chart making.

## New Computer User:

- 1. Needs to learn how to use the system
- 2. Needs many prompts
- Needs carefully explained guidance in exploring the system (especially at his or her own speed)
- 4. Needs encouragement

## Intermediate Computer User:

- Needs flexibility to explore system on their own, discarding steps they no longer require and might slow them down
- 2. Needs prompts
- 3. Needs to travel through system at faster rate

## Experienced Computer User:

- Can go directly and quickly to any system function without guidance or reference
- Operates with utmost ease, and speed and versatility of movement throughout system
- 3. Needs minimum prompts

Designers are visual decision makers. They rely upon good visual memory and the ability to recognize and use visual relationships and hierarchies to effectively communicate. They abstract, explore, and experiment with symbols. They select, point, arrange, and rearrange visual elements such as form, typography, and color to manage the flow of information.

Designing is an ever changing and fluid process, with the designer orchestrating the various visual elements. This System is designed to make use of the designer's abilities and methods of working, take instructions from the user, and perform only the purely mechanical functions.

The skills of a designer can be divided into two general categories: judgmental and mechanical. The judgmental or, as it has been referred to in this thesis, the design process, is the decision-making stage. This stage is characterized by experimentation and change. Decisions made and remade concern not only how something should look, but whether it is effectively communicating. This ability takes extensive thought and visual exploration. The second category, mechanical functions, consist of putting the elements together in the production of the created piece.

Both skills are integrated on computerized systems and can be implemented with speed and ease if the user's is needs are met properly. The designer can experiment with visual elements

such as size, shape, color, and typography, can explore visual relationships, and then see the immediate results of his/her decisions. The designer ends up being in more control of the job than is his non-computer counterpart because he takes on more responsibility for typesetting and color-separating, which were traditionally sent out of the studio for completion.

Every technological advance has made changes to existing tools but there are ways to minimize the differences. "Operating prompts and user's manuals must be written in plain English and designer terminology. Colors can be offered with the same values the graphic artist is used to, so that color combinations that worked in the past work just as well with the computer system, etc." But most important, systems must be designed to allow great flexibility and control of design decisions and methods.

By being in charge of what is the appropriate function for the appropriate time, the user controls his personal methods of working. Thus, he strengthens his position as primary decision maker, and the system is his tool in making decisions.

The Chart System Organization

The chart system is organized into four major divisions or functions. Each function is designed as a separate software

module, increasing the system's flexibility and versatility. The functions serve separate yet related purposes in the total chart making arena. "See Table 3: System Functions. The function modules are tutorial, reference, data, and layout. They serve the user by answering the need for system guidance and explanation; system instruction; chart-making instruction; chart-making reference, data entry, data storage, data retrieval, and reformatting; and how to design and lay out the chart interactivley. Please see below for the first menu level, showing the system functions.

TUTOR	REFERENCE	DATA	LAYOUT
			1

## System Tutorial

The primary purpose of this module is to give the user system instruction and guidance. It serves the user as a private instructor, explaining the location and purpose of other system functions. The user is shown how to go to specific system locations, find out what is accomplished there, how it gets done, how that function relates to other functions as individual units and how it relates to other functions in the making of whole system. The user can select how and when to use the tutorial. The method of interaction is the terminal screen for reading, and the keyboard for entering queries and answering system questions.

Table 3: System Functions

System The primary purpose is to serve as system

Tutorial: instruction. Answers the user question, what do I

want to know about the system?

Chartmaking The primary purpose is to serve as a chart

Reference: reference. Answers the user question, what do I

want to know about charts and how to use them?

Numerical The primary purpose is to provide entry and

Data: storage functions for chart data and existing

files. Answers the user question, where do I

enter chart data, how do I retrieve data, and how

do I do both?

Chart The primary purpose is to provide an interactive

Layout: means for creating charts and graphs. Answers the

user question, how do I layout the chart?

The tutorial is structured to meet the needs of a wide variety of users, from the novice to those with experience. It can be read in detail, or it can be used as a quick check to refresh the memory on some specific point. The user decides what the appropriate need is at what time. The tutorial responds by giving the novice an easy-to-follow, all-inclusive map to the system, and giving the experienced user a short preface to each section, which can be used as a quick check or reminder.

## The Chartmaking Reference

The reference function is primarily a tutorial on charts and how to select chart types. It gives the user information on particular types of charts and corresponding chart data, and helps him to make specific decisions before beginning a chart design.

The designer has access to such information as:

- Description and definitions of different chart types that the system can create
- 2. Applications of particular chart types
- 3. Samples of data-to-chart type relationships
- 4. Samples of data used in a variety of other appropriate chart types
- 5. List (visual) of the components of a chart
- 6. List of system chart terminology

The designer can also use the reference program after chart layout has begun. Because the system doesn't impose a rigid function organization or procedure method, it is easy for the user to save a chart in progress, pop out of layout, and go to reference for a quick check on something specific. The designer can use the chart reference program as an extensive tutorial or as a quick reference, before, during, or after designing a chart.

The chart reference program directly interacts with the other system functions, data, and layout. There are three places in the system where the designer can select chart type and enter chart data: the chart reference program, the data program, and at the beginning of layout. If the user prefers to enter the system with the chart reference program, he or she can decide to input the chart data and select a chart type there, thus skipping data and not doing it at the beginning of layout. user, especially a novice, may feel more comfortable making those decisions immediately after getting the information needed, or he may need to create more than one chart, finding it convenient to enter all data and selections at the end of referencing some chart information. Or the user may just want to enter data and select a chart type in advance of layout and may come back to the system later to design and lay out the chart.

If the data and chart type are entered here the system will check to see if they are compatible. If they aren't, the system will prompt another selection. The user may need to make additional chart references before making a final decision.

### Numerical Data

This system function serves as a data entry and storage facility. The designer enters data and selects from three alternatives. The choices are to create a new file and then enter the data; to display only an existing file; or to display, copy, and modify an existing file.

If the user decides to create a new file, the system format file is displayed. The chart data is entered at the keyboard, and the user answers the file queries and fills in the data blanks. For a sample of the format file, please see next page. The format uses designer terminology and plain English for user convenience and comfort. See Diagram 3: Chart Catagories.

If the user asks for a file to be displayed for perusal, the system displays it, then asks whether another selection is desired. If the response is yes, it requests the new file name, and displays it. If the response is no, the system returns the user to the first query level.

If the user wants to copy and modify an existing file, the system gives him a choice between modifying the image and retaining the data, or retaining the image and inserting new data.

### DATA FILE

Please fill out this form to create your chart data file. If some of the signal words don't apply to your chart, leave the category blank. If you have any questions concerning this form and it's terminology, please refer to the system tutorial. You can go there by selecting Tutor on menu level 1.

# Data file name:

Chart title:

Subtitle 1:

Subtitle 2:

Subtitle 3:

Scale title 1:

Scale title 2:

Scale unit of measure:

start:

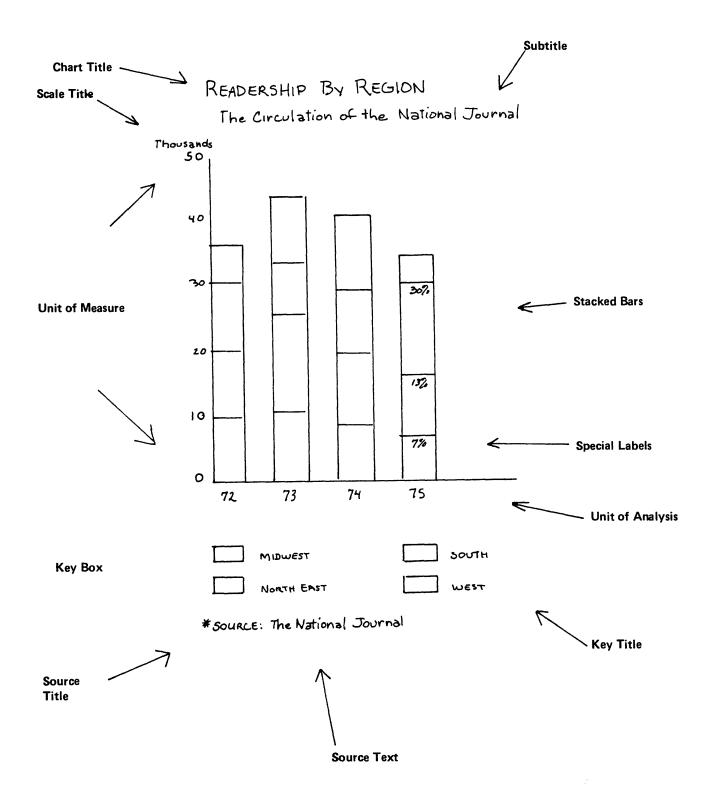
end:

increment:

```
Add'l units:
    Cluster bar values:
    Stacked bar values:
Scale unit of analysis:
                 start:
                   end:
Chart text 1:
Chart text 2:
Chart text 3:
Source title:
Source text:
Key title 1:
Key title 2:
Key title 3:
Key title 4:
Key title 5:
Special labels 1:
Special labels 2:
```

Special labels 3:

Diagram 3: Chart Catagories



For each data selection the system checks for compatibility between chart type and chart data. If the two are compatible, the user is instructed to proceed to layout. Otherwise, the system sends an error message to the user with queries and instructions about proceeding.

### Layout

Layout is designed to dynamically allow the user to create charts and graphs. It is an unobtrusive tool, meant to respond to the user's decisions and changes. It allows the user to immediately see the effects of what he or she is doing, while still doing it.

Designers select things, put them in an arrangement, rearrange them, and move them around. Picking and pointing are natural and comfortable processes for designers. In the layout system, interaction is done by picking an object and pointing to it. This is done by using the puck and tablet. Menu buttons allow the selections to be made and slider controls are used to set the typographic parameters. The user does not have to type in codes for graphic elements as is done in most presentation graphic systems. All parameters are specified graphically.

Interaction is also the means by which a design is developed.

The basic concept in layout is to see the design develop as the

user makes a selection, not after the user makes several selections. Relationships between graphic elements occur and have drastic affects upon the overall image. Making a line longer and thicker will create a new relationship with the other visual elements surrounding it. Therefore, it is important that the designer not only see the affects that thickening and elongating will have on that particular line but also how will this action affect the neighboring elements.

# The Dynamic Overlay

The Dynamic Overlay addresses the first issue in the example mentioned above. How will a particular visual element look as it is being modified? Layout begins with the user selecting a visual element which is displayed and modified on an overlay plane.

Example: The user selects to work on the layout function AXIS. The axis matrix appears on the Dynamic Overlay Plane and the user begins by making an axis. The axis is created, modified, moved and colored by interactive use of puck and tablet with the results being immediate. That is, the user sees the axis grow or shrink, get thicker or thinner and get repositioned by gradual degree, not as abrupt start, stop and see methods. This action makes use of basic animation techniques where only parts of the image are redisplayed rather

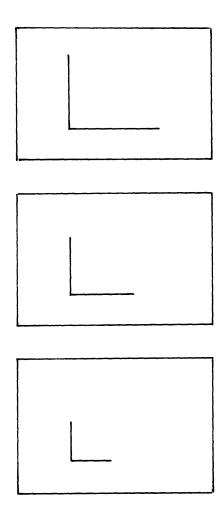
than erasing and redisplaying the total image. Therefore when a line is made thinner, only parts of the line will be erased. The whole line will not be erased and redisplayed creating an uncomfortable flash. The same principle applies when a line grows longer. Only those additions to the line will be drawn and displayed. The whole line will not have to be totally erased and redrawn. The results of this process, in addition to being more comfortable to the eye; will also create a moving image thus demonstrating more specifically how the element will look. See diagram 4: Dynamic Overlay/Axis Changing Size.

# The Trace Overlay

The Trace Overlay addresses the development of the total image by the relationships of the visual components. As one element is modified other elements are effected changing the overall appearance of the image. An element being modified on the Dynamic Overlay Plane can affect other elements. The ability to see the relationships as they are happening provides a more efficient decision making tool for the designer. The Trace overlay functions as a dynamic previsualization tool for the designer in making relationship decisions.

Example: A bar chart is being created. The designer is in axis mode and wants to see how a longer axis will affect the bars. In most systems the results are displayed after a design

Diagram 4: Dynamic Overlay/Axis Changing Size



decision is made. In Layout a decision is made after seeing a variety of results. The designer selects a visual element from the Trace Menu. This element, say bars, will appear on an overlay plane and respond with the modifications done to axis. See diagram 5: Trace Overlay/Bars changing with axis.

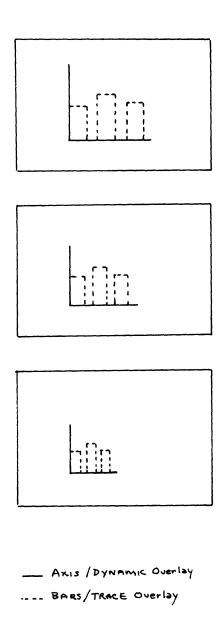
In this way, the designer can see element relationships as they are happening resulting in a more knowledgeable decision and a better designed chart.

The actual movement on the Trace Overlay is implemented with the same animation principles used in the Dynamic Overlay Plane, thus creating a more fluid, smooth moving image on the screen. See the menu section for a description of the trace buttons.

# Display

The display programs are central to the interactive quality of the chart layout module. The state of the Dynamic Overlay, the Trace Overlay and the Color Display are monitored throughout the layout process by a central display manager. The manager is responsible for updating what appears on the Trace and Dynamic Overlays and for redrawing the elements as they enter and leave the Color Display. A painter's algorithm is used to layer the chart elements in the Color Display so that choices of under and over can be made by the designer.

Diagram 5: Trace Overlay/Bars on trace overlay changing with changes to axis on dynamic overlay



# Data Entry

Numerical data and text are typed into the system at the terminal keyboard. Data can be entered just before layout or, if the designer chooses, can be called up from a previous session.

The data is entered by a query and answer dialogue. This is written using design terminology for more user efficiency and comfort. The text is arranged in categories which correspond to the same category names seen on the menu buttons. Thus achieving more efficiency through consistency.

### Data Structures

The system primitivies consist of the four chart elements.

Axis, scale, icon and text are single structures with position, size, and other information. They are modelled in PLl structures and arrays. These structures were chosen for simplicity and flexibility, allowing complete graphical interaction and interactive editing. See the next four pages for samples of the data structures.

Lines of text are stored in linked lists headed by a text group attribute table. The attribute table consists of font specs, color, position, and other text information. The text itself is grouped in linked lists of line structures with relative position, orientation (flush left, flush right and centered), line length, number of characters, and the characters themselves. Because lines are positioned relative to their group's position, moving text as a group is facile. This allows the user more flexibility to move individual text elements around the page at will. Therefore a scale title can be moved and sized separately from the scale text, as desired. Keys and bar titles are groups of text groups, and use an array of offsets to point to text groups and line lists.

```
dcl chartdir char(168) vary init(" u mej p chartfiles");
dcl mj ptr:
dcl dat area (15000)based(mj);
dcl l uni based(mj),
      2 curpotx offset(dat),
      2 curkey fix,
      2 ap offset(dat),
      2 sp offset (dat),
      2 ip offset (dat),
      2 itp offset (dat),
      2 txp offset(dat),
      2 kp offset(dat),
      2 tpary[0.9] offset(dat),
      2 ctype fix,
      2 keymo fix,
      2 txmo fix,
      2 layomo fix,
      2 scadir fix,
      2 scatl fix
      2 curdov fix,
      2 curtov fix,
      2 scrcolor bit(32)init("c0c0c000"b4),
      2 scrn,
          3 scxl fix,
```

- 3 scyl fix,
- 3 scx2 fix,
- 3 scy2 fix,
- 2 fcap flt,
- 2 favwid flt,
- 2 fdescend flt,
- 2 hscale flt,
- 2 wscale flt,
- 2 hincr flt,
- 2 fname char (32) vary,
- 2 ftable(0:127),
  - 3 width flt,
  - 3 height flt,
  - 3 bline flt,

- Uni: This data structure houses all the global parameters. It also contains the general font information and font table. Uni is based on the pointer "mj". A PL/l area, "dat" is also based on "mj" and all offsets in the database are offsets into "dat." Generally there are two kinds of parameters:
  - A. Offsets
  - B. General System State Information
- A. Offsets: For each of the objects there are are offsets to other parts of the database.

  curpotx offset (dat) = This is the current piece of text ap offset (dat) = offset to axis

  sp offset (dat) = offset to scale

  ip offset (dat) = offset to icon

  itp offset (dat) = offset to text

  txp offset (dat) = offset to the beginning of text region

  in the structure file

  ky offset (dat) = offset to keys

B. <u>System State Information</u>: These parameters consist of fix and float variables describing the key system states. curkey = Index to curkey in key array ctype = These are the chart types (bar, line, area, pie)

tpary [0:9] offset (dat) = array of offsets to chart text

keymo = key mode

txmo = These are indices into tpary

layomo = layout mode

scadir = scale direction

scat1 = scale type

scrcolor = initial screen color

scrn structure = window within the chart appears

fcap = text parameters

favwid = "

fdescend = "

hscale = "

wscale = "

hincr = "

fnance = "

ftable = "

```
dcl 1 tg based,
    2 numlines fix,
    2 maxnchars fix,
    2 lip offset(dat),
    2 x fix,
    2 y fix,
    2 fname char(32) vary,
    2 pt size flt,
    2 leading flt,
    2 wdsp flt,
    2 letsp flt,
    2 color bit(32),
    2 orient fix,
    2 ondov fix,
    2 infb fix,
    2 fbsh fix,
dcl l li based,/*linked list of individual lines*/
    2 next offset(dat),
    2 yf fix,
    2 startx fix,
    2 leng flt,
    2 endx fix,
    2 numchars fix,
    2 chrs(0:3) char(1);
```

The text data structure is tg (text group). It is used to group a logical collection of text, like chart title. It holds the font parameters pertaining to the whole group, for example position, color, and orientation information. It is also the head of the linked list that contains the actual text.

The Li data structures form the linked lists of individual lines. There is one li data structure for each line in the logical text group.

The key data structure is an array. There is one element in the array for each key--up to five keys. Keys consist of a box and a text group. Box parameters are height, width, color, and position.

The It data structure is the bar text pointer array. There is one position and an array of text group pointers. This is so all the bar titles, each a logical group of text, form larger logical groups of text, that can be positioned as a unit.

### Menus

The Layout Module uses the VLW "sys" button menuing system, with an additional menu for the Trace Overlay feature.

The Trace Menu

The Trace Menu consists of four buttons corresponding to the four chart elements. Each button will display one of the elements onto the Trace Overlay Plane. Hence, T AXIS will display an axis on the Trace Overlay.

These buttons act like toggle switches. When the user selects a chart element, the button lights up and stays lit till the user hits it again, changing its state. The Trace button set is only accessible with the user is in layout mode.

T\_ AXIS T\_ ICON T\_ SCALE T\_ TEXT

The Top Level Buttons

The top level buttons consist of the four system modules, plus a "Quit" button for easy exit.

TUTOR	REF	DATA	LAYOUT	QUIT

Tutor: This is the system tutorial. It explains the what, where, and how of the system. See the tutorial section in Part 4, The Chart Module.

Reference: This is the chart reference program. Initializes a group of interactive, instructional and referential programs concerning the making of charts. See the Reference Section in Part 4, The Chart Module.

<u>Data</u>: This program creates a chart database. A new or previously created data file is parsed for text information and data, and the chart data structures are created and initialized. An option exists for placing new data into a copy of a previously created chart. Thus design decisions of an old chart can apply to a new set of data. Data is entered by a query and answer dialogue.

<u>Layout</u>: Gives a set of subbuttons which correspond to the four chart elements. They are:

AXIS	ICON	SCALE	TEXT
1	1		

<u>Axis</u>: Gives a set of subuttons to make and modify the chart axis. They are.

MAKE-AX	SIZE	LINE-W	MOVE	COLOR
				1

Make Ax: Loads an axis matrix. User makes an axis by selecting lines from axis matrix.

Size: Axis size is adjusted by using puck and screen.

User selects axis line with Z button, and makes the axis line longer by pressing the #3 button, and shorter by pressing the #1 button. Axis line moves dynamically with button press.

<u>Line-W</u>: Same interaction as size button. Select with Z, press #3 for longer axis line and press #1 for shorter axis line.

Move: Whole Axis is moved around the screen. Interaction by moving axis with Z press and reposition by releasing the Z button.

<u>Color</u>: User colors axis by choosing from screen palette.
Selects color type by pressing Z button.

ICON: At present time layout can create only Bar charts.

Later, as the system is expanded other types to charts can be added. The icon menu button will give a subbutton selection such as this:

BAR	LINE	AREA	PIE

In the prototype the icon button gives a subbutton selection consisting of bar parameters:

STYLE	DIMENSIONS	COLOR
		i

<u>Style</u>: Gives a subbutton selection of solid (filled) bars or outline bars.

<u>Dimension</u>: Gives a subbutton selection of bar and bar space modifications. The buttons are:

LINE-WEIGHT BAR WIDTH BAR SPACE

<u>Line Weight</u>: Modifies how thick or thin to make the bar line.

Bar Width: Modifies the bar width

Bar Space: Modifies the space between the bars.

Color: Same as Axis color

<u>Scale</u>: Gives a subbutton selection based upon a vertical or horizontal selection. The user selects which part of the scale he or she wants to work on.

V STYLE	H STYLE
	1

<u>V Style</u>: This is the vertical scale or the unit of measure. It gives a set of subbuttons selection of scale style

TICS	LINES	NO-TICS	NO-LINES
1			

<u>H Style</u>: This is the horizontal scale on the unit of analysis it gives a set of subbuttons selection of scale style

TIES	LINES	NO-TICS	NO-LINES
		-	

The user can select to employ tics and/or lines in a chart.

The selection method shown above, consists of a tic marks
button and a grid lines button.

To erase a scalemark selection means pressing the buttons No-tics and No-lines. The user can have both tics and gridlines on the same chart, with tics always appearing over the lines.

Tics: Pressing this button selects tic marks. This gives a subbutton selection of modifications. See lines for definitions.

LENGTH	LINE-W	OVER	UNDER

<u>Lines</u>: Pressing this button selects grid lines. This gives a subbutton selection of modifications. Note that the modifications for tics and grid lines are indentical.

LENGTH LINE-W OVER ONDER	LENGTH	LINE-W	OVER	UNDER
--------------------------	--------	--------	------	-------

Length: Modifies the length of the tic mark or grid line. The system displays a default set of scales which appear flush to the axis. The length button allows the user to extend the scales beyond the axis line.

<u>Line-W</u>: Modifies the line weight. The system displays a default set of scales which can be thickened and thinned.

Over: Allows the user to determine whether the ticmarks or grid lines will appear over the other visual elements they come into contact with. This button displays the scale marks over bars and axis.

Under: Allows the user to determine whether the tickmarks or gridlines will appear under the other visual elements they come into contact with. This button displays the scalemarks under bars and axis.

Text: Gives a set of subbuttons which are labelled according to the data file catagories in the input data file. The text menu selection consists of text objects and actions performed upon those objects. Text is selected by the general catagories, Display Type and Text Type. These categories divide into specifics such as chart title, scale title, scale text, keytitle, keybox, etc. This allows the user the flexibility of individual text selection, modification, and manipulation. For each text object there are three upper level actions that can be performed. The text must be specified,

colored, and set. This level gives a subbutton menu of more specific actions.

In the prototype the menu buttons reflect a scaled down version consisting of three text categories, Chart title, Scale type, and Key type. The action buttons consist of spectype, settext and color.

CHTITLE	SCALE	KEY	SPECTYPE	SETTEXT	COLOR
		l		<u> </u>	

Chart Title: This calls the corresponding data file text
category.

<u>Scale</u>: Gives a set of subbuttons which are a selection of scale categories.

BAR TITLE	UNIT TITLE	UNIT TEXT
	i	

<u>Key</u>: Gives a set of subbuttons which are a selection of key elements

KEY BOX	KEY	TITLE	вотн

<u>Spectype</u>: This gives a set of subbuttons to enable the user to specify the typographic parameters and set the position.

Orient: This gives a set of subbuttons to define the type orientation

FLUSH LEFT	FLUSH RIGHT	CENTER

Specs: This gives a set of subbuttons to enable the user define the type specifications. This program makes use of the "Compose" slider controls for specifying the type attributes.

PT-SIZE	LEADING	WD-SPACE	LET-SPACE

Move: This gives a set of subbuttons to specify a vertical or horizontal move.

H-MOVE	V-MOVE

 $\underline{\text{H-Move:}}$  Vertical action upon the text. This gives a set of subbuttons for

FLUSH-LEFT	FLUSH-RIGHT	CENTER	FREE MOVE

 $\underline{\text{V-Move}}$ : This gives a set of subbuttons for lateral action upon the test.

r		
CENTER	ALIGN	FREE MOVE

<u>Settext</u>: When this button is pressed the current text group is typeset. Until settext is selected, text appears as greeking. If the text has been positioned, and goes into the color display, then it appears as greeking in the color chosen for the font. The greeking characters were designed to closely assimulate the appearance of type, and be fast to draw.

<u>Color</u>: User selects font color by making selection from palette. The Z button on the puck is pressed to make the color selection.

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## References for The Chart Module

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REVIEW OF THE FIELD

The following section includes information on the thirteen companies that produce a work station approach to presentation graphics. Information is presented in a matrix form to allow for quick and easy reference.

Company:

Autographics

100 5th Avenue

Waltham, MA 02154

890-8558

Model:

AGX 100

Hardware:

Guidelines Operating System

48K Byte Microcomputer

2 Monitors

(B/W)

(Color 397 x 479)

Terminal/Keyboard

Peripherals: Digitizing Pad

Puck

300 Baud Modem

Software: Cosmos

Output:

IDS Printer B/W Dot Matrix of representation of

slide. No slide service center.

Notes:

Menu driven off B/W Terminal screen by commands.

Instead of the final chart, a rough representation is displayed on the screen. User selects a chart type from the Guideline system.

Heavy reliance on format charts. User modifies the format chart by going into a free form.

Objects are moved by keyboard commands or by using tablet (optional). To make a change, screen paints over the area to be deleted and redraws on top.

Company:

Centec

11260 Roger Bacon Drive

Reston, VA 22090

(703) 471-6300

Model:

Centec Presentation System

Hardware:

IBM Personal Computer

2 monitors

1 B/W

1 Ramtek Color

Total Colors 256

Colors at one time 16

2 Floppy Disks

ADM Terminal

Peripherals: Digitizing Pad/Light Pen/Puck

IBM Display Writer

Plotter

ACT color ink jet printer

Visicalc

Modems (300-1200 baud)

Software: Pascal

Menu Driven (not for chart programs)

Output: Slides: Image Processor Camera

Hardcopy: SX 70, Plotter (B/W and color), color ink jet

printer, large screen video (driven by monitor

directly to projection screen).

Notes: Data and chart system separate.

User enters data at terminal by filling out a

questionnaire

Then system asks for a chart type

User next sees the finished chart on color

monitor - can select other chart types for same

data

No tablet or puck used by user for charts

Color Terminals International

799 Stephenson Hwy.

Troy, Michigan

(313) 528-2787

Model:

ARTIS

System 1 (new)

Hardware:

Terminal/Keyboard

Color Monitor (2048 x 2048)

Peripherals: Modem (input and output)

Word processing

Video dual screen system

Software:

ARTIS

Output:

sx-70

Slides

Video presentation package

Notes:

This company is owned by Creative Technologies.

They are expanding into video and graphics and have new model coming out this year. The new system will contain a paint system, animation package, dual disk drives, and bit pad. New system to be more interactive, menu (off screen) driven.

Computer Pictures

20 Broad Street

Boston, MA

(617) 720-1700

System:

Micro Based

Hardware:

10M byte Wincester disk

19" color CRT CP/M

Terminal/Screen

Peripherals: Touch Screen

Software:

Trend Spotter pkg.

Output:

Slides

Hardcopy: Matrix

Dunn

ink-jet plotter

xerox laser plotter

Feature:

Universal Interface to Data Base

Automatic Update

High Speed Output

Notes:

This system is designed more for use by the corporate manager, as an analytical tool, than as a Presentation Graphics. Workstation to be used by a graphic designer. It does have a graphics mode for making individualize charts and graphs but the primarily means of interaction is by keyboard.

Comshare, Inc.

3001 S. State Street

Ann Arbor, MI

(313) 944-4800

Model:

Execuchart

Hardware:

Z80 Processor

20 M Byte Wincester Dish

96 K Byte Memory

512 x 512 R.G. B. Monitor

Peripherals: 1200 Baud Modem (input and output)

Digitizing Pad

Mouse

Light Pen

Software: Execuchart

Output:

35m. Matrix Camera

Monitor to Video Presentation

Modem

ACT Printer

Xerox 6500 color laser printer

Notes:

User types in all data and selects chart type at keyboard and terminal. Has 16 colors to choose from (8 pure color, 8 shades of original 8 colors). Screen area is divided into chart space and menu space with menues taking 1/5 of screen. User selects items from menu, i.e., color, chart type. Doesn't see final chart till all data entered into the system and all graphics decisions have been made.

Data Business Vision

11035 Roselle Street

San Diego, CA

(714) 450-1557

Model:

Business Graphics Workstation

PGM (Presentation Graphics Model)

48 bit processor

Keyboard/terminal

Ramtek Color Monitor (512 x 512)

Chomatics Color Monitor

Peripherals: Digitizing Pad

Mouse/Stylus

Modem (output)

Software:

Issco

Output:

Dunn Camera

Xerox

Monitor to video screen for close circuit

Notes:

This system very keyboard oriented. Menu driven from keyboard and terminal. Graphic elements chosen from command level. User enters data and sees final chart.

Company: Datapoint Corp.

9725 Datapoint Drive

MS-T-60

San Antonio, TX 78284

(512)699-5267

Model: 9680 Color Business Graphics Systems

Hardware: Datapoint Processors 8600 and 6600

20 M Byte Disk

Ramtek Color Monitor (512 x 512)

Peripherals: Digitizing Pad

Mouse/Stylus

Modem (300-1200 Band)

Word Processing

Datapoint Integrated Office Equipment

Multiplan (like visicalc)

Software: ARC/Dos

Output: 35mm film recorder

Notes:

This is advertised as a presentation graphics system. Software consists of 5 separate phases.

- 1. Phase
- 2. Chart Phase
- 3. Library
- 4. Output
- 5. Playback

User enters the system and selects a phase.

Phases are interchangeable, user can move from chart and draw and modify chart made in the Chart Phase. User enters data at terminal/keyboard by query-and-answer process. Most of the interaction is accomplished by answering system questions. Example: after user selects a chart title the system asks "How do you want to position the title?" The user responds with center, etc.

The playback phase allows user to structure a presentation. That is, it stores already created slides or video, which user edits.

Dicomed

9700 Newton Ave. S.

Minneapolis, MN 55431

(612) 887-7100

Model:

D-38 Design Workstation

Hardware:

13" Color Monitor

32 K bytes internal memory

Dual 8\* floppy disks

Terminal/Keyboard

Peripherals:

Tablet/Mouse/Light Pen

Modem

Software:

Dicomedia for standard business graphics Flexigon

for smooth lines and curves

Output:

Slides: D148S Slide System

Notes:

This system is the most interactive of the

designer workstations being reviewed. it has a

complete layout package including such items as a

paint program, grid programs, logo program and chart programs. Interaction is divided between terminal and menues. Graphic elements can be created, sized, moved, and copied by using keyboard documents or pointing with keyboard cursor to menu.

Company: General Electric/Genigraphics

Electronics Park

Bldg. 1

Syracuse, New York 13221

Model: Graphics Group 100B-03

101 Artists Console

201 Graphics Processor

301 Film Recorder

401, 2, 3, & 4 Operating Programs

Graphics Library

Hardware: Color Monitor

Image Processor

Keyboard/Terminal

Dual Diskette Storage

Peripherals: Digitizing Tablet

Light Pen

Modem

Software: Digital RSX 11M

(full color business graphics with text

integration) optional software packages

Output: Slides

PDP 11/34 Film Recorder

Notes:

Genigraphics produces a family of equipment, each unit contributing a special function to the overall system. This modular design facilitates growth according to clients needs. Artwork is created primarily through keyboard commands, including the sizing, placement and coloring of a visual elements. There is a symbol and format library included as a system option.

Artwork is stored on diskettes, with 40 spaces to 200 records per diskette depending on the complexity of the image. There is automatic indexing and recall for image mixing, update, revisions, real-time display, transmission and photography.

Gravitronics and System Engineering

3014 Shatluck

Berkeley, CA 94705

(415) 644-2230

Hardware:

Data General (Nova, Eclipse)

125 M Bytex Diskette

Ramtek Color Monitor (512 x 512)

AED Color Monitor (512, 767, 1024)

Peripherals: Digitizing Bit Pad

Puck

Joy Stick

Modem

Word Processor

Tape Drive

Software: GDS-V5

Output:

Film Recorders

Xerox 6500 color laser printer

Seiko color printer

Versa plotter

Monitor/video presentation system

Notes:

This company specializes in adding graphics for Data General products. Because it develops systems for clients on a one-to-one basis, it does not sell a predesigned package.

Menu driven system off of keyboard and terminal rather than off of monitor screen and puck.

User enters data at keyboard following a system query and response format.

User selects a chart type and a chart menu.

User goes into draw mode. This consists of selecting visual elements to be displayed and choosing colors. User can make his own palette of up to 16 colors.

Default system images appear on screen.

User enters changes via menu but doesn't see the changes being made. Screen displays new image.

User can make own prompts - software is programmable.

Company: Iconix Corp.

10441 Bandley Dr.

Cupertino, CA 95014

(408) 255-5500

Model: AUTOGRAF 1

Hardware: Z80 CPU

CRT/DOS Operating System

Keyboard/Terminal

Dual floppy disks

Peripherals: Light Pen

Digitizing Tablet

Software: Basic Business Charting

Output: Slides

Xerox

Notes: Interaction is accomplished primarily from

keyboard command level. Visual elements are

created, sized, moved, changed and copied by

entering keyboard commands.

Company: Management Graphics, Inc.

7336 Ohms Lane

Minneapolis, MN 55435

(612)835-9764

Model: Table Top Slide System

Hardware: PDP/11-CPLL

Terminal/Keyboard

13" Color Monitor (640 x 480 resolution)

10 Mega Byte Controller Disk

Peripherals: Tablet/Mouse

Software: BGL (Business Graphing Language)

FTP

Palette color editor

Output: Color Video Projection

35 mini film recorder

Notes: Three software packages built into the system,

layout program, BGL, Quick Chart. User can work in any one of the three programs but must go to BGL or Quick Chart to create a chart, then to layout, where chart can be modified.

Layout:

Tablet with surface commands query-and-answer keyboard.

User enters layout commands by typing at the terminal or by pointing to a tablet area, and pressing button on puck. Interaction not real time, must clear screen and redisplay. User sees representations of visual elements, doesn't see final chart until in slide form. Menu driven via keyboard and terminal in addition to tablet.

BGL:

Keyboard and terminal
User types in answers (chart data) to system
queries. Given a command to show, system
displays chart. User can switch to "layout" to
further modify the chart.

## Quick Chart: Keyboard/Terminal

User types in answers to system queries, enters chart data, sees finished chart. User can switch to "layout" to finish modifying chart.

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