DYNAMIC GRAPHICAL DISPLAY OF DATA

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ABSTRACT

An interactive facility for the production of dynamic charts from a master visual model is under development. In this system a user is responsible for drawing the master chart and building a modification table. This table defines how a set of data will be used to modify the master chart to produce key frames of the dynamic chart. The computer can then build up a series of key frame charts using a set of data for each. NRC's key frame animation package can then be used to produce intermediate frames and to film the sequence.

The paper will include a description of this system along with an account of the communications techniques used for the production of the modification table.

L'AFFICHAGE GRAPHIQUE DYNAMIQUE DES DONNÉES

ABRÉGÉ

On met au point présentement un système à action réciproque pour l'établissement de graphiques (diagrammes) dynamiques à partir d'un modèle visuel principal. Dans ce système, l'utilisateur établit le graphique principal et le tableau de modification. Ce dernier indique comment un ensemble de données sera utilisé pour modifier le graphique principal afin de donner les images clés du diagramme. L'ordinateur peut alors produire une série de graphiques d'images clés utilisant un ensemble de données pour chacun. Le programme-produit mis au point par le C.N.R.C. pour l'animation des images clés peut alors être employé pour produire des images intermédiaires et pour filmer la séquence.

Le mémoire décrit ce système et les techniques de communication utilisées pour dresser le tableau de modification.

Introduction

An area which we feel merits investigation with computer applications in mind is the area of communications graphics -- the production of graphs, charts, and diagrams to display data. Much tedious work is expended when series of charts are produced, as all the drawing must be done by hand. Computers have been used in this field, but they have usually been restricted to the production of line graphs and histograms.

The need for a data display system is intensified by the current interest in dynamic models. These models are useful only if people can understand their data output. This understanding can be enhanced significantly if the data is displayed in a pictorial or graphic form. The best form is often dependent on the data. A package to facilitate pictorial display of data is being developed using NRC's key frame animation package as a base on which to build.

Key Frame Animation System

Over the past several years, NRC has developed a key frame animation package to aid in the production of animated film (1,2). Briefly this is a system whereby an animator prepares images at key intervals in the sequence, and on playback the program calculates the in-between frames by interpolating between the artist's key frames.

An important feature of the animation system is the method of communication used for the interaction between computer and artist. It was decided very early in the development of the system that ease of communication would be a primary objective. An animator should not need computer experience to use the system. These objectives led to the use of a sophisticated picture driven interactive language employing a CRT, graphics tablet, menus, push buttons, tablet buttons and thumb wheels.

The system has now been developed to the extent that footage has been produced for several CBC programs, two National Film Board films including "Hunger/La Faim", which will be shown at this conference, and the BBC/TV documentary series, "The Ascent of Man".

Requirements for the Data Display Package

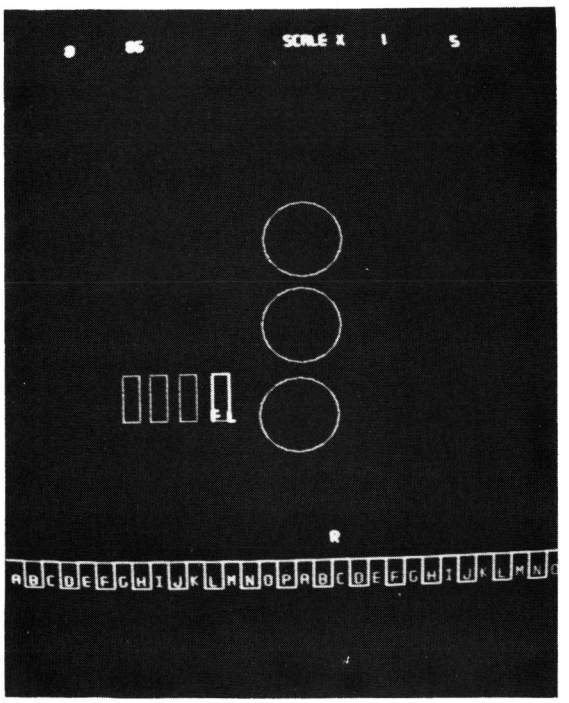
Consideration of the need for a system that aids in dynamic data display together with the experience gained in the development of the key frame animation package led to the definition of several requirements that would have to be met in such a system. First of all, a drawing facility, using a graphics tablet, similar to one currently in use for animation is a necessity. This allows great flexibility as a graphics artist may input easily any line drawing into the system. However, in charts used to display data, there is usually a number of often-used regular shapes. These include bars in bar charts, circles in pie diagrams, bands showing, say, air traffic between two points, etc. The computer program can provide the convenience of a facility for adding these standard figures to the drawing.

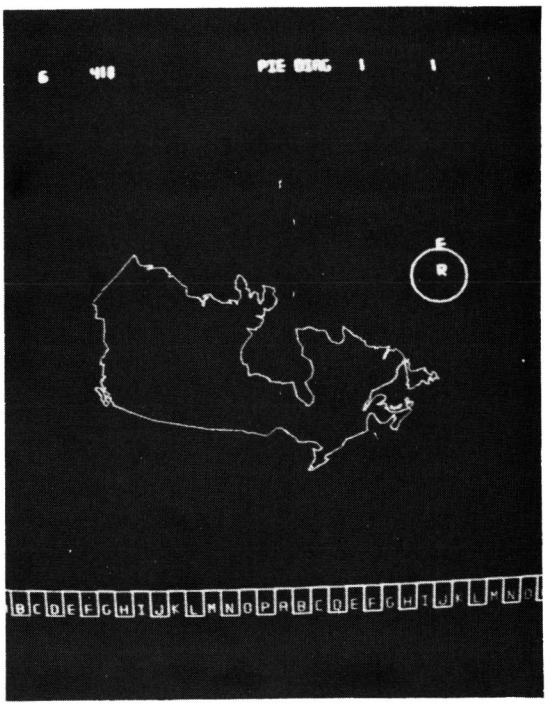
In most filmed dynamic charts, or series of static charts, the basic form of chart does not change. A single master diagram can be used as a visual model of the entire series. The items in the chart that do change do so in a definable manner. For example the heights of bars in bar charts are dependent on the data, the visible portion of a circle in a pie diagram is similarly dependent. This leads to the second requirement, a method to define the relationship between the picture and the data.

The vehicle used to define the picture-data relationship we call a linkage table. This table contains an entry for each data-controlled modification that is to be performed on the picture. In addition to defining the type of modification, several pointers are needed in each table entry. Two picture pointers are needed to define that portion of the picture that is to be modified. Since many types of modification need a base point or reference point, each table entry has space for a third picture pointer for this purpose. There is also a pointer to the value in the data table to be used to control the extent of modification.

Data Display System

With the above requirements in mind, we are building a system with which a user is able to create images by drawing on a graphic tablet. At any stage during this operation, he may switch from this draw mode to an assignment mode which allows modifications or additions to the linkage table. Figures 1 and 2 show pictures in the





Figs. 1, 2 - Typical CRT display in "assignment" mode

assignment mode. We are able to extend the picture-driven language to aid in building the linkage table in the following ways. The type of modification is chosen by selecting the desired tablet button. A label at the top of the screen reflects the choice. The three picture pointers are set by moving the letters F, L, and R with the tablet pen. When a letter is over a point of the picture, a push of the pen will lock it to that point. F and L indicate the first and last point of the field of modification respectively. That part of the diagram that lies between the F and L is displayed at a brighter intensity than the rest of the picture. In Figure 2, the F and L are tied to points that have the same coordinates and hence are displayed one on top of the other. The R pointer indicates the reference point. A thumb wheel allows the user to flip back and forth through the linkage table. The second last number at the top of the screen refers to the current position in the linkage table. The example in Figure 1 shows that the first entry of the linkage table is a SCALE X (horizontal scale) modification, the field of definition is the bright section of the fourth box, the reference point has not yet been set, and the fifth item in the data list will be used for this modification.

The addition of predefined shapes is accomplished by choosing another tablet button. Positioning, scaling, and in some cases shaping may be accomplished interactively by the user. These new additions may be referenced by linkage table entries in the same manner as the hand drawn portions of the image.

Figure 3 shows a master diagram after the drawing process has been completed. The linkage table contains ten SCALE Y entries, one each for the ten boxes, and two PIE DIAGRAM entries for the two circles. The intention of the diagram is to show the production (left box of each pair) and consumption (right box) of energy by region. The top circle gives Prairie production of energy as a percentage of Canadian production; the lower circle represents Prairie production as a percentage of Canadian consumption. The regions are defined as B.C. and the Territories, the Prairies, Ontario, Quebec and the Maritimes.

A program called the processor uses the master diagram and the linkage table to produce a modified picture for each set of data (3), two examples of which are shown as Figures 4 and 5. In this case, the processor was used once for each set of yearly data, producing a series of pictures showing the annual progression of energy supply and demand.

At this point the procedure for producing a film from this series of images is the standard process in the animation system. Each picture in the series is considered a key frame and the user tells the computer the number of intermediate frames desired between each pair of key frames. The sequence may then be filmed including raster scanning of predefined outlines which produce coloured areas. If different components of the picture are set to different cel levels, hidden lines and overlapping areas of components at lower levels are removed. The result is a graph smoothly changing from a display of one set of data to the next. An alternate end product, a series of

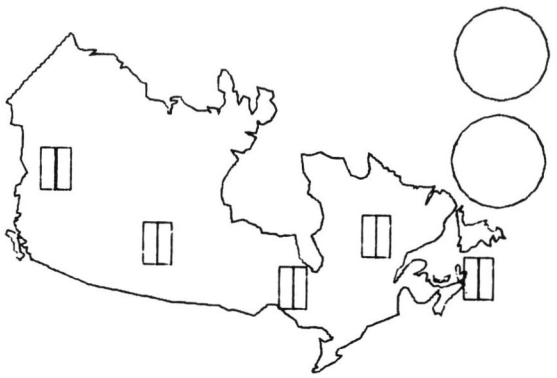
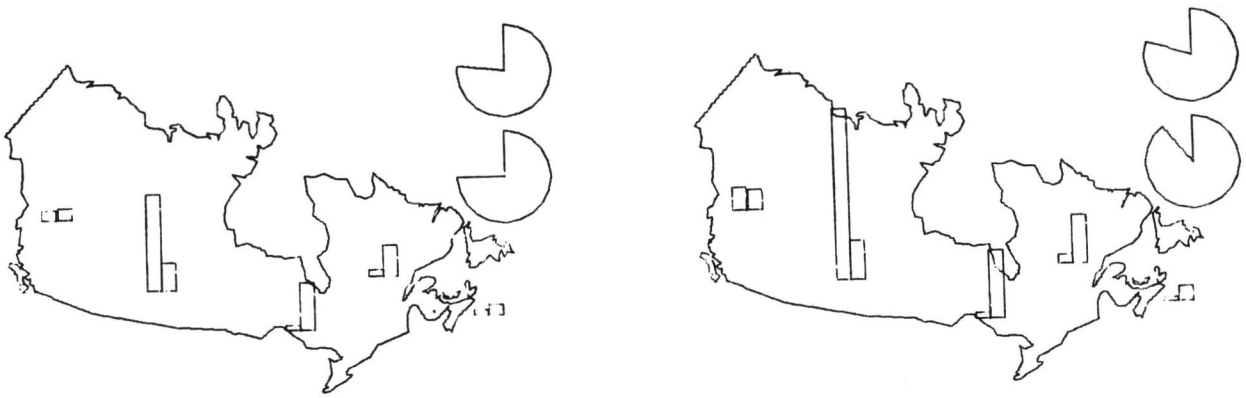


Fig. 3 Sample master diagram as might be drawn by graphic artist



Figs. 4,5 Two in a series of data modified versions of Fig. 3

Fig. 6,7 Two frames from the final filmed dynamic display. Hidden lines and areas have been removed. The remaining areas have been coloured in.

charts on paper may also be obtained, either from a film of the key frames produced with the above method, or by using a plotter.

Conclusion

The system is still in its infancy, and, at the time of writing has been used only by people with a computer background. We feel, however, that it has a great potential in many areas where effective display of data would be an asset. The ease of managing the system should make it useful to many graphic artists. They will be able to experiment with different methods of displaying data to maximise the effectiveness of their display. Once a display method has been settled on, and the master diagram and linkage table built for displaying a specific style of data, similar data may be run with little additional work. For example, the master diagram and linkage table used to display results of one run of a model may be used to display the results of a second run. Similarly census statistics from one province may be displayed using the set up for another province. We hope that the system will increase the ability of graphic artists and illustrators to achieve more effective visual communications while eliminating some of their more dreary duties.

References

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