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Computer Graphical Representation of design data in Embroidery Factories

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Abstract: - In embroidery factories the designs are coded on punched paper tapes. The code (punched holes or no holes) is proprietary by the manufacturer. This paper describes a method that reads those paper tapes into files, converts them to graphical representation, modifies and exports them to the required needlework format. The production stages benefit from this, since the produced outcome (graphic design) will be known in real time, enabling the user to perform corrections or alterations, with the aid of standard graphical tools available in the toolbars of the original design, including creation of new designs. The new or modified designs are saved in the appropriate code format required from each different embroidery machine.

Key-Words: computer graphical representation, design data, embroidery factories, punched paper tapes

1 Introduction

In embroidery factories the designs (artistic concepts) are coded on punched paper tapes in various codes, each one characterized (proprietary) by the manufacturer. This occurs on a manual operated stage. At this stage required designs are produced by an artist and then graphically improved by an HP Vectra, running a customized version of AutoCAD. This is transferred on a digitization board (linked to a computer running OS-9, UNIX), where it is manually digitized with the aid of a special keypad and requires highly skilled personnel with a deep knowledge of how the needlework machines operate.

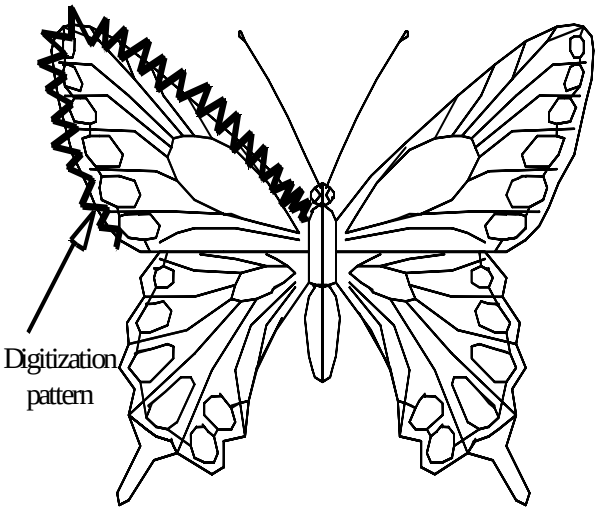

Fig.1 Manual digitization and coding

Thus the operator marks every point of the design, in this way coding all the details by using click combinations. This process is very long and tedious (it can take up to 8 hours for a medium size design) and the produced outcome is the punched coded paper tape. Those paper tapes are mounted on needlework machines (various types are available in the market) to produce the final products in multiplicity (lace, in-wrought textile etc.). Sample is shown in Fig.1

The digitization data output by the computer connected to the digitization board produces the punched coded paper tapes and a typical one appears in Fig.2.

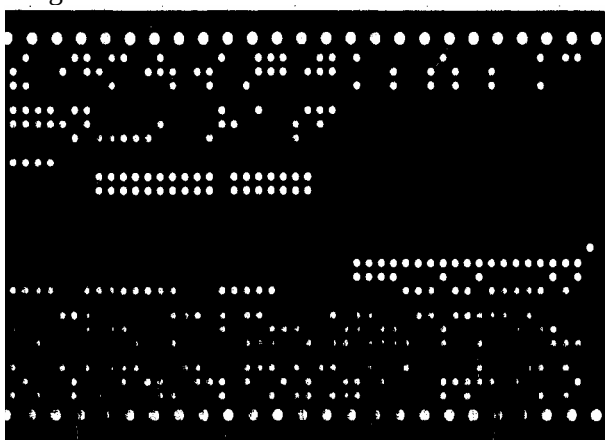

Fig.2 Typical punched coded paper tape

The following steps are needed for this procedure:

- Artistic concept (design),
- Design's scan and correction of imperfections, oversize plotting (x12),
- Manual digitization and data collection by a UNIX computer and

- Paper tape production, 14 cm wide, coded with holes (design's information).

An overview of a typical system appears in the Fig.3.

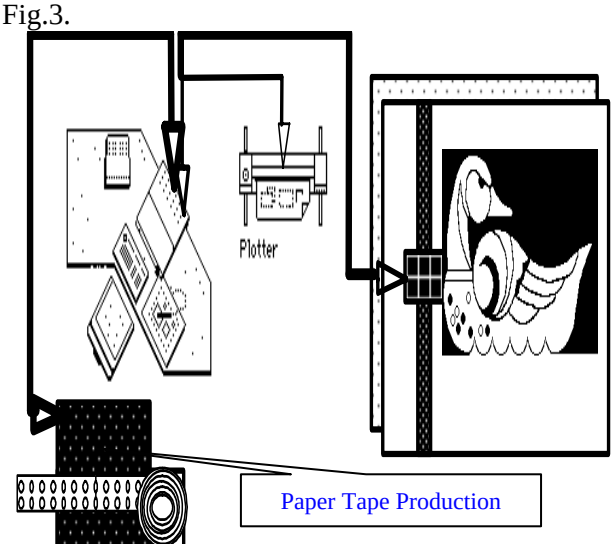

Fig.3 Typical Design Creation Stage

In a previous paper [2] a procedure to convert these data to an electronic file was demonstrated. However, these files contain data in raw form and they have no graphical meaning to the end user not to mention the miscellaneous formats available.

In this work a method was demonstrated [Patent Number 930100411, 10-1993 OBI (Greek Industrial Property Organization)] on how to acquire the signals responsible for each hole and create an ASCII file equivalent to the punched coded paper tapes, which resulted in a very efficient production of data storing, scheduling and file classification system. As a matter of fact the ASCII file had completely substituted the coded paper tape. As a consequence, hundreds of designs stored in paper tapes have been converted to electronic ASCII files ready for production (Patent Number 930100412, 10-1993 OBI [Greek Industrial Property Organization)]. However those files represent no graphical information to the operator, depriving him from an actual knowledge of what each file actually represents. This deficiency has some how limited the usefulness of the method's application.

Fig.4 shows the typical appearance of such a file (typical representation of the ASCII file), at which the operator can only save, retrieve, rename or modify the data by locating the cursor in a particular location and changing the 0s to 1s and vice versa (assuming that he is appropriately trained to recognize the meaning of the 0s to 1s) but still without him knowing what the impact on the graphical design is.

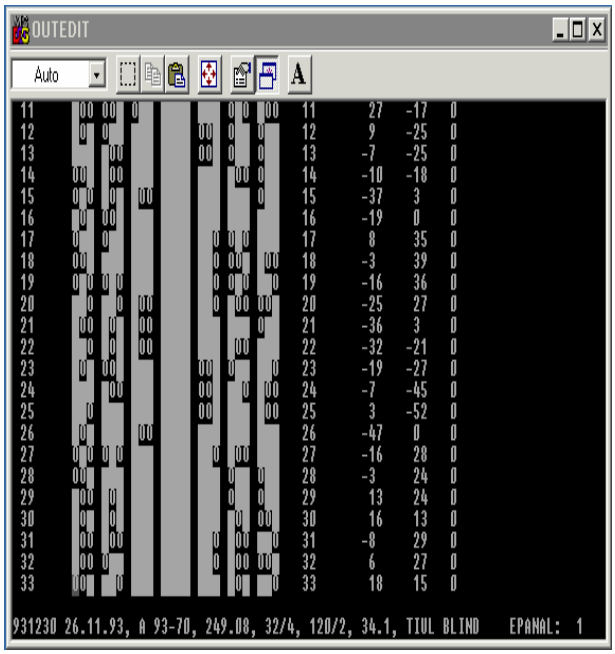

Fig.4 Equivalent to a graphic design DOS ASCII file

The above restriction has limited the wide acceptance of the method in organizing and administrating the embroidery production line. The industry has demanded the exploitation of the possibility of not only obtaining a graphical representation of the data file, but also having the ability of performing basic operations in a graphic design so that modified versions of the original graphic can be achieved. Those basic operations could include the cut, copy, paste, or deformation, thus producing various versions of the original design. Bearing those requirements in mind and interacting with production and scheduling, an engineer's software named Ariadne has been developed to meet the industry's needs.

Method for expanding leads to quality control and facilitates composite structure [3] reinforcement and tailored fiber placement to minimize stress concentrations [1].

2 Description of the Software Tool

The developed software is an E.D.A. tool, composed of a front compiler able to read the ASCII file produced from the punched cards (or other old-fashion media used) at any format by using the appropriate intelligent front-end software. After the data are read, they can be analysed and organized by the main software. When the desired functions are performed, the new data are exported through a second compiler and stored in ASCII file on the available media, thus facilitating the job of the designer in the embroidery industry. Fig.5 represents

the basic operating function of the software control program.

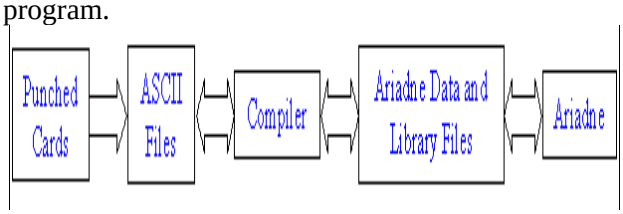

Fig.5 Software Control Process

One significant feature of the E.D.A. tool is that it enables the designer to create reusable libraries from old designs and apply several transformations to them (e.g. move, rotate, resize, change stitch density and resolution, etc.) in order to generate new designs, using parts of existing designs (post processing). This process has the benefit of generating reusable components for easy needlework creation, incorporates a friendly user interface and has enhanced graphics, and acceleration keys to speed up the designing procedures.

2.1 Ariadne file format

According to Greek mythology, Ariadne gave Theseus a skin (ball made with thread) with which to find his way out of the Labyrinth. We gave the name of Ariadne to this EDA tool due to its involvement with threads and stitches and due to the solutions it provides to the designer of the embroidery industry. The data I/O format of Ariadne is quite similar to the HPGL language [4], since it employs information relative to the line (thread) width and the location of the stitches. However, the embroidery machines require proprietary formats. For this reason separate software must be developed in order to compile the Ariadne software to the required proprietary format of the embroidery machines. This compiler differs for each type of machine and it should be developed separately. In our case we have developed a format compiler for the Adolph Saucer Ltd. embroidery machines. The development of a compiler may be considered as an easy job that requires the knowledge of the data I/O formats, both of the machine and Ariadne. The Ariadne data file incorporates header information related to the needlework properties followed by sequential data representing the differential stitch distance, the thread type and a field with information that is concerning the specific machine. The header information includes data related to:

- Name of the needlework,
- Designer's Name,
- Revision,
- Date,
- Comments,
- Estimated time required for the needlework,
- Number of types of threads used,
- Number of stitches,
- Length of the following information in bytes and
- Information related to the embroidery machine (this information is used for regenerating the data file for the embroidery machine).

Afterwards, information regarding the type of the employed threads is stored sequentially to the file. For each type of thread, assigned in the header, the following information is stored:

- Drawing colour,
- Line width,
- Length of the following information in bytes and
- Information related to the type of thread (this information is used for regenerating the data file for the embroidery machine).

Finally, information regarding each stitch of the needlework is stored sequentially to the file. The structure of the information for each stitch holds data regarding:

- Differential movement in the horizontal axes,
- Differential movement in the vertical axes,
- Type of thread,
- Length of the following information in bytes and
- Information related to the machine's head movement (this information is used for regenerating the data file for the embroidery machine).

Following the structure of the information of the data file, the software of the compiler is able to compile the Ariadne's data format to the embroidery machine and vice-versa.

2.1.1 The structure of the Ariadne

Ariadne employs a Multi Document Interface Form (MDIForm) so as to be able to handle several needle works at the same time. This is a strong demand since it enables the designer to combine parts of needlework to generate a new one. The main child form of the software handles needlework and it is able to copy data to the clipboard so as to paste them to a same child form. Several auxiliary forms are employed for facilitating the designer's work. These forms are concerned with the properties and the statistical data of the needlework and to the preferences of the designer for software behaviour. The Ariadne has been developed mostly using the

Visual Basic IDE, while several functions handling time consumable procedures have been developed using C language and are assembled in one DLL.

The software has been developed in a modular fashion using forms and modules. Most of them serve the so-called 'user friendly interface' resulting in a precious tool for the designer of the embroidery industry. Most modules have been developed using the standard methodology commonly used for development under Microsoft Windows environment. This software, however, deals with very complex needlework that employs several thousands, even hundreds of thousands stitches. Obviously, to draw such a complex needlework on the screen or to apply a rotation transformation is a time-consuming procedure. Thus, the software achievements are closely related to high speed processing of large needlework data. The main form of the software handles needlework and employs two dynamic arrays that store the same data imported from the needlework data, but each one is sorted using different criteria. This is required for speeding up software procedures such as the redrawing of the needlework and the positioning of a particular stitch on the needlework drawing. Thus:

- the first array is the generic array that stores the needlework data sorted by the sequence of the needlework and
- the second array handles the same data sorted by the coordination of each stitch.

The combination of these arrays is used for generating a third one that has significantly smaller size, and handles an abstract shape of the needlework. This array is used for fast animation and redrawing during the move, the rotation and the resizing procedures. A replica of the above mentioned arrays is used for handling the 'selected' part of the needlework. This is required for speeding up the procedures applied on a part of the needlework.

Several transformations may be applied on these arrays, such as repositioning, rotation, resizing and modifying their stitch resolution. Additionally, cutting and pasting of a part of the needlework is supported. Obviously, after each transformation a re-sort of the arrays is required. All these procedures are applied on arrays of several thousands of elements and may introduce significant delay to the software. To reduce the time required by the array transformations, we developed the required functions in C language, which are assembled in a Dynamic Linked Library. As a result, the transformations last a negligible time non-noticeable by the user of the software.

The most time consumable procedure is the redrawing of the needlework. To reduce the time required for this procedure, two actions have been taken. The first one is to use the line method only when this is required. Thus, using the two-shorted arrays we can learn very fast if a stitch is inside or outside the drawing area and use the line method only for these stitches that are inside the useful area. The second action that has been taken is to use the line method when this is meaningful. Thus, we use the line method for stitches that are more than a pixel apart in the view area and we are not required to use the line method for all the stitches when the resolution of the window is low, relatively to the needlework. As a result of these actions, the redrawing of the needlework is very fast, while at the same time it does not reduce the information required for proper presentation of the needlework on the screen.

2.1.2 The Software Design Tools of the Ariadne

Ariadne offers precious tools and facilities to the designer of the embroidery industry. To facilitate the operation, a menu bar with the available function is added on screen. Fig.6 displays the menu bar as well as the graphic data retrieved from an ASCII file.

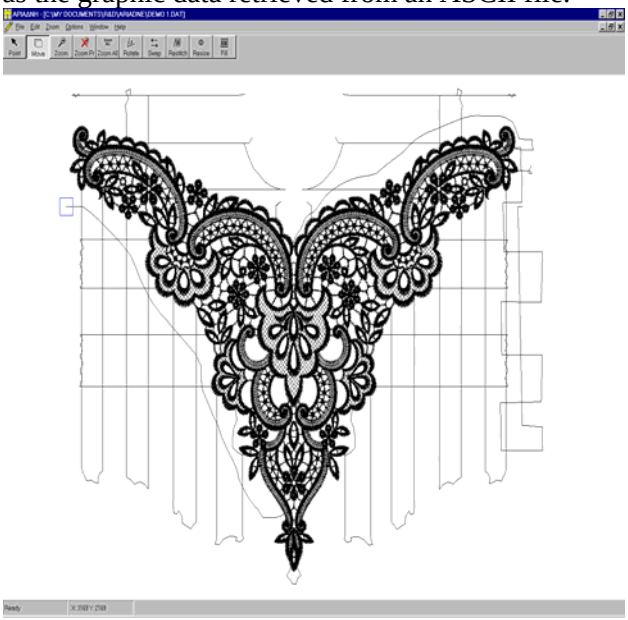

Fig.6 Ariadne after the end of an artwork

The standard procedures such as *select, copy, paste, insert, delete, undo* and *redo* on one or more stitches are fully supported. Additionally, Ariadne is able to execute commands like *Save, Save as, Print* and *File Properties*. *File Properties* enables the designer to add several types of comments to a needlework file and to see the number of stitches, the length, the type and the colours of threads

required and the estimated manufacturing time for the particular design.

Common transformations regarding part of the needlework or even the whole needlework can be applied. Thus, the designer can *move*, *rotate* and *resize* the whole or the selected part of the needlework at real time and interactively. These transformations are applied using the movement of the mouse displaying at the same time the result of the transformation. Alternatively, the designer can input the data of transformation (e.g. center and angle of rotation).

Ariadne also supports enhanced transformation such as *Fill* and *Re-Stitch*. The *Fill* transformation requires two paths and a fill pattern that can be selected from the fill methods. Furthermore, the designer can train Ariadne to his or her preferable fill method. The *Re-Stitch* transformation can change the resolution of the selected part of the needlework without changing the artistic concept (Fig.7).

In addition, the software gives the ability to insert a needlework library file into a specific point of the needlework. The designer, by storing a part of needlework in order to reuse it in the future, can create library files.

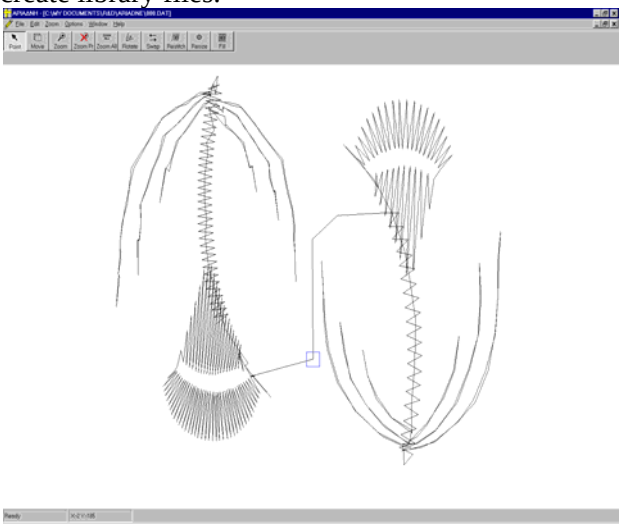

Fig.7 A simple needlework on the right and its replica after applying the rotation and re-stitch transformations

The library files have the same format as the needlework files and additionally they include a medium resolution bitmap for accommodating their access. Finally, Ariadne is able to apply a background picture for facilitating the designer to generate a new needlework.

3 Conclusions

The described Ariadne tool is a method that further automates the embroidery production by importing data originated from coded paper tape and graphically representing them to the operator. Additionally, it creates user selectable library modules, the combination of which significantly speeds-up the generation of new designs. Furthermore it offers the ability to resize a part of or a whole design while keeping the stitch resolution, resulting in easy creation of similar designs in a minimal amount of time. Enhanced transformations aid in fast modification of the needlework. The ability to apply a background picture is helpful for creating new designs from scratch. Ariadne is able to handle very complex needlework and apply the above-mentioned transformations at high speed, thus retaining the artistic concept of the designer.

This software tool has been tested in real production lines and has been proven to be precious and easy-to-use tool for the designer of the embroidery industry, helping him to increase the productivity and the quality of the needlework.

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