MECH 4V96
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Mechanical Engineering
Erik Jonsson School of Engineering and Computer Science
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Embroidery Project
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Alejandro Cerna   **Jessica Johnson**   **Rohit Kommaraju**

Executive Summary

This project was conducted in order to provide a low cost, high value solution to the project workshop students and faculty of the University of Texas at Dallas. The embroidery machine combined with the engineering software taught by the school give a unique opportunity to gain hands-on learning for students and understand vector based modeling. It also provides a professional, uniform look to have the UTD logo given to each student and faculty member that participates in the project workshop.

a)   b)

Fig. 1. Image of the final embroidered design

Fig. 2. Image of the set-up embroidery machine

Section 1, Problem Identification

Currently, there are no ways on campus to learn the basics of designing and executing embroidery projects. As a result, mechanical engineering students end up purchasing pre-embroidered products, and not learning to incorporate CAD into embroidery.

Section 2, Define Criteria and Goals

The **purpose** of the project is to set up an embroidery machine and design an embroidery project that can be given to a class of 15 students. The **criteria** applied require setup of the machine itself and pattern-making software with the appropriate add-ons and a detailed set of instructions that allow students to use the system without guidance. The **goal** is to introduce students to creating their own embroidery projects.

Section 3, Research

The team's first objective was setting up the Brother PE535 embroidery machine, which was a simple matter of following the instruction manual step-by-step. The steps required to be done before every embroidery project is reflected in the instruction guide developed for the beginners' embroidery project. Through set-up, it was discovered that the machine will take in PES files for embroidery patterns. The machine also comes with preloaded designs that can be used for testing out the machine.

In developing the project, market research was conducted for three items, namely:
- What software can be used to create embroidery patterns?
- What types of fabric are usable for the machine model?
- What project should be used to introduce students to the machine?

Feasible embroidery software include:
- Inkscape

Inkscape is a free design software that allows users to create their own designs. The designs can be exported via .jpg to its extension software Inkstitch for the final step of creating an embroidery design.
- AutoCAD

AutoCAD is a design tool similar to inkscape that allows users to create a design on a vector based program. In order to create an embroidery design from an Autocad file, the user just needs to export it as a .dxf to embroidery software for the final touches.
- Inkscape: Ink/Stitch Extension

Inkscape is a software that takes pictures and drawings either downloaded or made by users and turns them into files that can be read by embroidery machines through its Ink/Stitch extension. It does this by importing .jpg or .dxf files and converting them to .pes files through the process of vector image processing. Essentially, the user programs where stitches will occur and how they will occur. The user can program which path the machine should stitch the design demonstrated below, when the machine chooses to jump the thread, or where there

are color changes. All of these must be programmed into the design to tell the machine how to perform the embroidery operation.
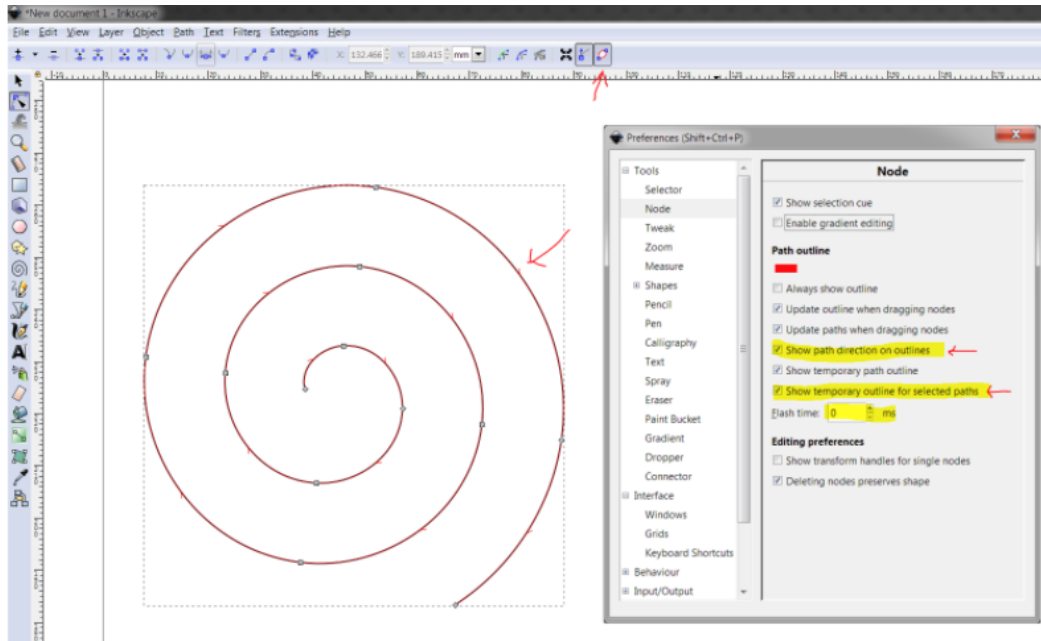

Fig, 3. Illustrating the Inkscape software

Based on research, the best embroidery fabrics include:
Medium weight fabrics that do not wrinkle easily. These fabrics will not require ironing before embroidering and are thick enough to withstand the embroidering process without being too thick to damage needles frequently.

In developing the student project, the following embroidery projects were researched and taken as inspiration:
- Patches
- Pennant Flags
- Embroidery Designs on Shirts

Section 4, Brainstorm

The following morph chart shows how the main two design paths, or draw lines, became clear. The design with a green line is to import a UTD logo image from offline to Inkstitch to be embroidered on a felt pennant flag. The design with the orange line dictates utilizing AutoCAD to develop an original image to be imported to Inkstitch, which will be embroidered on a medium weight material such as a button up shirt or sweatshirt.

Table 1. Morph chart for the proposed design

540	Feature	Type 1	Type 2	Type 3	Type 4	Type 5
3	Image Software	AutoCad	Inkscape	Download Image		
3	Embroidery Software	Inkstitch	Bernina	Brothers		
3	Fabric	Felt	Thin	Medium		
4	Logo Design	UTD Logo w/ half circle "MiU"underneath	Comets Logo w/ "MiU" on side	UTD logo w/ "MiU" centered underneath	Comets Logo w/ "MiU" underneath	
5	Product Type	Pennant Flag	Patch	Button up / Sweater	Lab Coat	T-Shirt

Section 5, Analyze Solutions & Develop Requirements

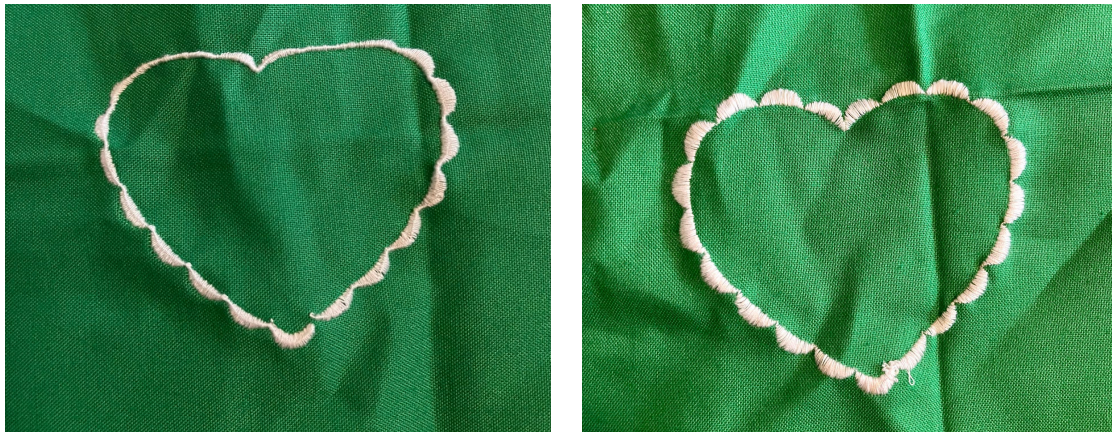The following table includes the requirements originally set by the team.

Table 2. Stating the project requirements.

#	Requirement	Pass/Fail	Proposed modifications
1	Designs must fit in 5"x7" area		
2	Designs must incorporate engineering software		
3	Design colors must take into account thread switching		
4	Fabric must be easily accessible		
5	Final product needs to be easily presentable		
6	Production method cannot exceed limitations of machine (i.e. needles, hoop, etc.)		
7	Final Product must be able to fit into hoops without alteration		
8	Cost under $50		
9	Final Product produces at least 15 designs		

The orange draw lines seen in Section 4, above, meet the requirements above and will be pursued in development and testing.

Section 6, Develop and Test Models

To test the machine, materials and assumptions, the PE635 Brother machine was run on scrap material with a preloaded design on the embroidery machine. The test was run twice because the first time the material slipped within the hoop and caused the design to not be completed. Both trials are shown below with trial one on the left and trial 2 on the right.

a) b)

Fig. 4. Illustrating results of the first embroidery trial

The trials show that thin fabric does not work for designs that have a lot of stitching. The trials also gave insight into how much threading was utilized and the team found out that they have enough thread from the starter kit to make enough designs.

The following Table includes the requirements as finalized by the team for the final design (Orange Path from Section 4).

Table 3. Illustrating the project outcomes

#	Requirement	Pass/Fail	Proposed modifications
1	Designs must fit in 5"x7" area	Pass	N/A
2	Designs must incorporate engineering software	Pass	N/A
3	Design colors must take into account thread switching	Pass	N/A
4	Fabric must be easily accessible	Pass	N/A
5	Final product needs to be easily presentable	Pass	N/A
6	Production method cannot exceed limitations of machine (i.e. needles, hoop, etc.)	Pass	N/A
7	Final Product must be able to fit into hoops without alteration	Pass	N/A
8	Cost under $50	Pass	N/A
9	Final Product produces at least 15 designs	Pass	N/A
10	Process needs to be repeatable	Pass	N/A

An additional requirement was added to accommodate for the main requirement that the project must be able to be given as a lesson for 15 students.

Section 7, Make a Decision (CDR Presentation)

The CDR was given on February 11, 2022 with the entire class and Dr. Fadda present. All team members were in attendance during the meeting.

After the presentation, the design was approved by the instructor and class as it met all the parameters set at the beginning of the project. In preparation for design fabrication, Dr. Fadda suggested that the team use only one color for the final design. The use of multiple colors of thread was an additional parameter set by the team that is not part of the overall requirement and would be best used for a separate embroidery project. Other than this, no other comments or suggestions were made regarding the design.

Section 8, Communicate & Specify

The gear and logo AutoCAD drawing, editable inkscape file and final .pes embroidery file is included in the submission of this report, along with a document describing the editing process using inkscape and operating the embroidery machine. In creating this project, the following materials were used:

Table 4. Bill of Materials

#	Description	Link for item to be purchased	Quantity	Price Each (USD)	Total Price (USD)
1	Orange Thread	Provided for free	1 Spool	0.00	0.00
2	Bobbin	Provided for free	1	0.00	0.00
3	Collared Shirt	Provided for free	1	0.00	0.00
Grand Total					0.00

No material is purchased for this project. Items 1 and 2 came with the embroidery machine, while item 3 was provided by the instructor.

Section 9, Implement

The design was loaded into the embroidery machine using a flash drive, and the prompts on the embroidery machine screen were followed for the machine to begin embroidering, as shown in the machine's user manual. Based on the team's experience with the machine, the user manual offers clear and concise instructions as to setting up and operating the machine, and troubleshooting issues, and should be used by students in case the team's instructions are not clear.

The comment made by the instructor were applied:
- Only orange thread was used for the design. In doing so, only the gear and orange part of the original design was used so that the design was still recognizable. However, an actual redesign was not needed as the embroidery machine had the option to skip certain colors, or parts of the design (in this case, the green circle and whitespace in the design was not embroidered).

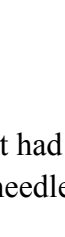**Fig. 5.** Illustrating the design embroidering in progress.

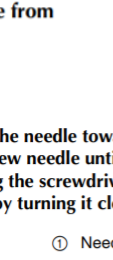The following issue was encountered during fabrication:

1. In the middle of embroidering the design, the embroidery needle broke as it had worn down after multiple uses. The machine was immediately stopped, and the needle was replaced following the instructions in the user manual (shown below).

a)

b)

c)

Fig. 6. Illustrating the steps to replace a needle.

Section 10, Review and Assess

The embroidery machine worked well and was deemed fully operational after the project design was completed, photos of which are included below:

The device requires occasional cleaning using a dry paper towel or cloth rag. The cover should be kept on the machine when not in use to protect the machine from dust and debris. Additional bobbins, thread and embroidery needles should be purchased as needed for machine maintenance (i.e., depending on whether the thread and bobbins are enough for a project, or if all provided needles break). Instructions for software and machine operation are provided in a separate document.

a)   b)

Fig. 7. Image of the final embroidered design

Fig. 8. Image of the set-up embroidery machine

Moving forward, the team recommends a project to be done for instructions on efficiently replacing embroidery threads and bobbin threads for a multi-color embroidery project. Future teams may use the .pes file designed by the current team, or create their own design using the instruction manual provided by the current team.