

Department of Mechanical Engineering

Engr 460 Design Report 1

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Abstract (Executive Summary)

This document is a template for technical report writing. It uses custom styles to achieve a uniform look. The contents attempt to document “proper” use of the template and MS Word in general for preparing reports. The reader will greatly streamline their workflow by reading and applying the hints and suggestions contained in the document.

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# Introduction

* 1. Background

Recently a large collection of old 28 mm movie films that were made between 1915-1918 has been found in Victoria. These films were used for instruction and entertainment in schools during this period. The projectors for these films have not been made for the past 90 years and now the films are beginning to decompose at a very rapid pace. The films represent a cultural heritage valuable to scholars of social science and history and it would be a great loss to future generations if the films were to be disintegrated before they could be rescued.

* 1. Objectives

The objective of the project is to construct a film transport mechanism that will capture each image from the film and recombine the stills in a computer to recreate the entire movie. The core components of this project would include: transport mechanism to advance the frames, film gate to flatten and align the film, drive system to rotate the outtake and intake of the film, source of illumination for project images, and create a mounting point for the camera.

[insert picture here]

# Manufacturing Method

The parts to be made in this project can be manufactured by machining the parts in the machine shop or printing them using a 3D printer. If the part is to be machined then the material will most likely be made out of aluminum. If the 3D printing method is used then the part would be made out of ABS plastic. Both methods of manufacturing methods have its strengths and weaknesses as shown in Table 1. Depending on the application, one method may be preferred over the other.

Table – Manual machining and 3D printing comparison

|  |  |
| --- | --- |
| **Cost** | Although the price of ABS plastic is more expensive per kilogram than aluminum ($40/kg for plastic as opposed to 2$ per Kg for aluminum), it can actually be less expensive to print parts using the 3D printer because less material is wasted in the process of making the part. |
| **Weight** | ABS plastic has a very light density of 1.03 g/cm3 compared to aluminum which has a density of 2.70 g/ cm3. |
| **Durability** | The durability of aluminum is much greater than ABS plastic. Aluminum has a tensile strength of up to 69 GPa compared to ABS Plastic which only has 30 MPa. Therefore parts can be thinner with aluminum and still provide lots of strength. |
| **Application** | One of the limitations of the 3D printer is the size of the part. Typical commercial 3D printers offer a space no more than 10 cm by 10 cm by 10 cm. Larger parts must be done with machining. However, many complex geometric shapes can be achieved with 3D printing that would normally be impossible using machining techniques. |
| **Precision/Reliability** | The precision and reliability of the 3D printer also falls a bit short. The error of the desired part can be as great as ± 0.5 mm. Higher accuracy components should definitely be machined. |
| **Speed** | With the 3D printer, the speed at which a part is prototyped is very fast. Since the process is automated, a 3D model drawing can be directly transferred from the computer without going through a machinist. Machining the part would take more man hours which also contributes to the cost. |

# Film Gate Concept Designs

The film gate is necessary part in any movie projectors or Telecine machines to center and align the film while the frame is being exposed and projected. Three different design concepts were developed to satisfy the requirements from the client. Due to the precision necessary to position the film, this device will be machined out of aluminum in the machine shop. However, the mounts attached to the film gate for the LEDs and camera can be made using the 3D printer to save weight and cost, but this will be discussed further along in the design process. The main criteria for the film gate are as follows:

* Allows film to pass through without moving too much from side to side
* Keeps the film reasonably flat
* Has an opening to allow light to pass through and illuminate the film
* Must advance the film without any significant stress, drag or damage.
  1. Design Concept #1: Rail and Pressure Plate

The first design concept for a film gate is to align the film using a set of fixed rails and a pressure plate on top. The pressure plate utilizes springs with screws for adjustment to keep the film resting on the gate while the rails on each side prevent the film from moving side to side. The advantages of this design is that it is easier to machine and has less parts to assemble compared to the other concepts. The problem with this design is that there is no flexibility in the adjustment of the film from side to side due to the rails being fixed. This could cause issues if the film gets caught between the rails which could damage the film.

[insert picture here]

* 1. Design Concept #2: Side Adjusting Plate Design

The second design concept is based on the first design but a side plate is also implemented to allow more adjustment and flexibility regarding the side to side movement of the film. Similar to the pressure plate, the amount of pressure the side plate acts on the film can be adjusted using the two screws and if the film begins to exert forces against the walls, the spring mechanism will displace to relive the stress on the film. The major issue with this design is that the side plate is in one whole piece and it also rests directly against the base plate. Having the side plate as a single piece would mean displacements on one end of the film gate will directly affect the other. The side plate also rests directly on the base plate and if it is not properly machined, the plate movement could either cause too much friction or leave a gap for the film slide through.

* 1. Design Concept #3: Flexible Side Plate Design

This design is based on the second design but attempts to fix some of the flaws that are associated with it. Instead of having the side plate as a single piece, it is cut into two pieces so that the adjustments of the plate are independent of one another. Channels were also cut into the base plate so that the side plate has room to overlap. This allows for a higher tolerance when machining the parts since the side plate is not flush on the base plate and it also reduces the amount friction on the side plate during movement. The obvious disadvantage with this concept is that there is more complexity in machining and assembly of the parts, but it offers the best alignment quality.

* 1. Comparison and recommendation

After reviewing the three concept ideas a comparison table was created. The categories in this table are based on the client’s requirements and our ability to make the components for the concept.

Table – Scoring table for the film gate design concepts.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | Ease of Manufacture | Ease of Assembly | Keeps Film Flat on Plate | Resistance to side to side movement. | Reliability, Minimize Damage to Film | Total Score |
| Concept #1 | 2 | 3 | 3 | 2 | 1 | 11 |
| Concept #2 | 2 | 2 | 3 | 6 | 3 | 16 |
| Concept #3 | 1 | 1 | 3 | 10 | 8 | 23 |
| Max Score | 3 | 3 | 3 | 10 | 10 |  |

As shown from Table 2 concept #3 scored the highest because it best satisfies the client’s criteria for the project. Concept #1 and #2 is more simplistic would have scored higher in reliability if the film were perfectly flat and is in good condition. However, due to the extensive age, the film itself is falling apart so extra mechanisms is required to keep better alignment. Concept #3 is recommended because it would be the most reliable in terms of minimizing the possibility of damaging the already deteriorating film and spring mechanism will ensure proper alignment of the frame.

# Choosing Illumination Source

In order to capture the images on the film, a bright light source is required to project the image. Although many different types of illumination methods do exist, LEDs with a light filter would be the best option for this project due to its low heat output, reliable lifespan, and high lumen/watt values. LED illumination tend to cost more, but the low heat output and low power consumption is necessary if the machine is to run for a long periods of time. Table 3 shows the comparison between 3 common light sources.

Table – Light sources comparison

|  |  |  |  |
| --- | --- | --- | --- |
|  | **LEDs** | **CFLs** | **Incadescents** |
| **Lifespan** | 50,000 hours | 10,000 hours | 1,200 hours |
| **Cost** | $35.95 | $3.95 | $1.25 |
| **450 Lumens** | 4-5 Watts | 8-12 Watts | 40 Watts |
| **Turns on Instantly** | Yes | Slight Delay | Yes |
| **Heat Emitted** | 3 btu/hr | 30 btu/hr | 85 btu/hr |

# References

1. EarthEasy. [Online] [Cited: May 24, 2012.] http://eartheasy.com/live\_led\_bulbs\_comparison.html.