EXECUTIVE SUMMARY

Book scanning is a rapidly developing field, largely due to the demands created by libraries digitizing their collections of literature. Through partnership with Google Inc., the University of Michigan was able to scan 4.4 million books of its 8 million-book collection. Currently, the university digitizes approximately 10,000 books a year even though their collection increases by 100,000 books in the same time span. The best commercially available tools are only able to reliably scan 200 pages per hour and can cost as much as $100,000. In 2009 Dany Qumsiyeh, an employee at Google Inc. built an automated prism shaped book scanner for $1,500 that was able to scan 200 pages per hour but lacked reliability. The objective of this design is to create a more cost effective alternative to commercial scanners based on this initial prism book scanner for the University of Michigan library in order to increase the number of books that they scan annually.

After meeting with our sponsors and the expected scanner operators, the user requirements for the scanner included: low cost, wide scan range, portable, user-friendliness, and a low noise level. Using a Quality Function Deployment (QFD) chart these user needs were translated into engineering specifications. The most important specifications included: pages per hour, failures per hour, range of book size, max book weight, time to operator proficiency, device lifetime, device price, device weight, and noise level. The most important of these being the pages per hour, and failures per hour. Using the initial prism scanner as a baseline, it was determined that this linear book scanner should be able to scan at least 200 pages per hour and minimize failures per hour.

Several concepts were evaluated, all of which were based on the original prism design. Essentially an extruded prism with a slot that pulls a page into a channel on one side with a vacuum slot, and then has the page exit the opposite side of the channel. The final design chosen was a shortened version of the initial prism scanner, where the page exits the channel on the reverse stroke in order to reduce the total length. This was chosen because of its high rankings in ease of manufacturing, assembly, scanning speed, and portability. This final design is almost completely made from sheet plastic (Delrin and Acrylic) so that it may be quickly cut on a laser engraver. The Delrin allows lower friction on the book while the Acrylic was more cost effective for structural members. This design also has an adjustable vacuum slot to locate the page suction in the optimum position, an improved saddle to provide better book support and an electronics chassis to allow easier access to the systems electronics.

The final design relies heavily on laser cutting of sheet acrylic and Delrin to reduce the manufacturing skill and labor. A unique fastener geometry was used that eliminates tapped holes, this greatly reduces labor. A sheet metal brake is required to bend 4 Delrin panels that the book slides on. Finally a mill and lathe are necessary to make the needed geometry in the vacuum tube.

The total cost of this design was under $900, which is a significant reduction from the previous prototypes cost of $1500. Upon testing the final design at 350 pages per hour a reduction was found in the number of failures compared to the initial prism scanner, and we also see methods to reduce the failures that have occurred.

A major challenge was the outfeed geometry. Several revisions were made to develop the unique geometry necessary to turn cleanly turn a page – this geometry may still need further refinement. The final prototypes base also has room for improvement. Overall the final design shows improvements to the initial prototype and has met most of the engineering specifications except for keeping the unit under 20lbs, even though in many regards it is actually more portable then the initial prism scanner.