Engineering Portfolio

Kai Elrick

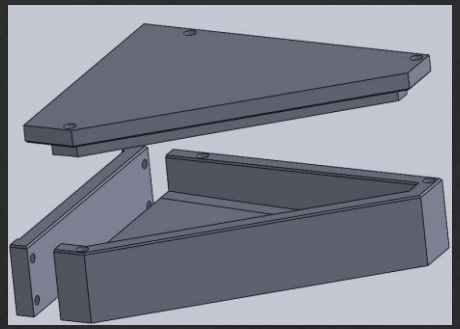
Carbon Fiber Fin & Compression Mold System

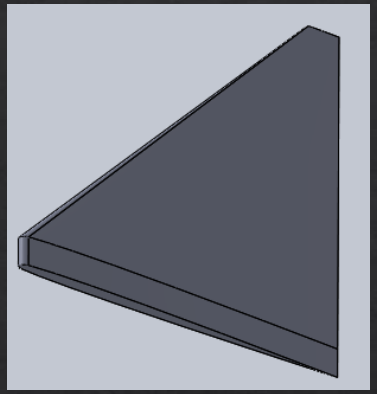
Objective:

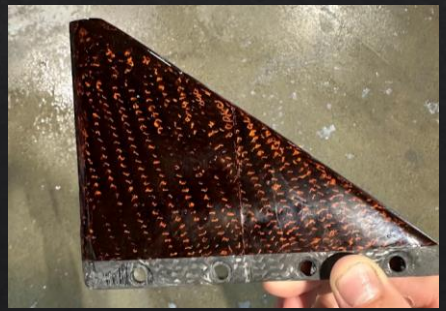
To design a more hydrodynamic fin for rowing shells (boats) and use carbon fiber offcuts for its construction to reduce waste of expensive material. As well as improving the aesthetic of the rowing shell and reducing the likelihood of bent fins.

Design overview:

I designed a new fin using SolidWorks, improving boat stability by adding a hydrofoil shape, and considering ease of manufacturing. I then designed in SolidWorks a three-piece mold system for the fin to be made from compression molded (forged) carbon fiber. 3D printed mold prototypes allowed me to lay up fins, resulting in multiple mold redesigns to allow for easier layup and release.







Low-Cost NIR Spectrometer (Research Internship)

Objective: To design and build a near-infrared spectrometer, utilizing a single sensor and compressive sensing techniques to drastically reduce costs compared to commercial alternatives, for use in brain oxygenation monitoring.

Design overview: Using a digital-micromirror-device (DMD) and a specialized set of projection masks, signal reconstruction of a spectrum can be achieved using only one silicon photodiode sensor (<$5).

Low-Cost NIR Spectrometer

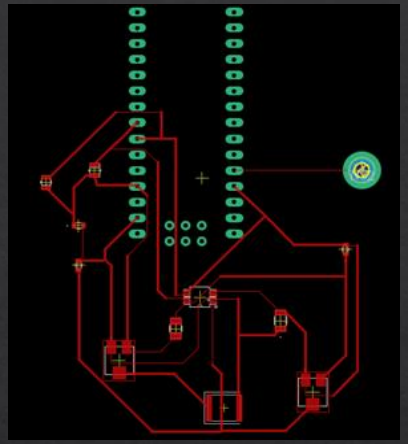
Implementation: The light source was split into a spectrum and aligned on the DMD. The reflected image was then concentrated onto the sensor, allowing for different DMD patterns to change the measured light intensity.

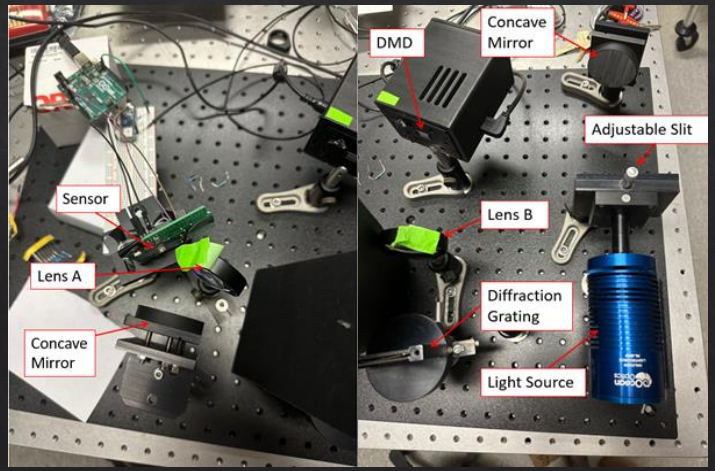
A custom PCB was designed in Fusion 360 which integrated the silicon photodiode with the necessary amplification and the Arduino to allow for measurement.

Two Arduinos (uno and nano) were used to coordinate control of the DMD and sensor PCB for sampling during the correct DMD position.

Matlab was used to characterize the spectrometer and correct for a linear relationship between light source intensity and sensor voltage.

Results: I successfully built a working prototype, proving the concept is viable. Were I to continue the project to a commercially viable design, I would improve the amplification on the PCB to allow for increased resolution and redesign the optical setup to repackage into a smaller footprint.



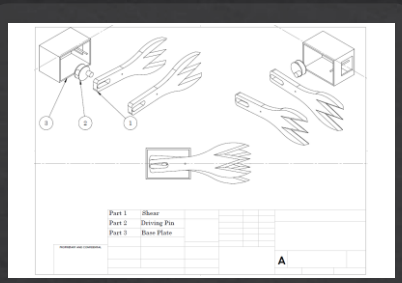


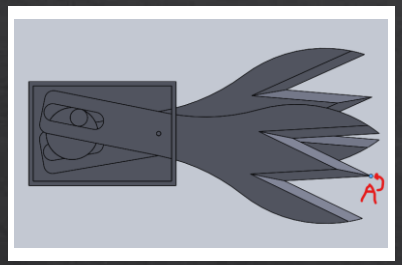
Dynamic Oarlock Assembly (Professional)

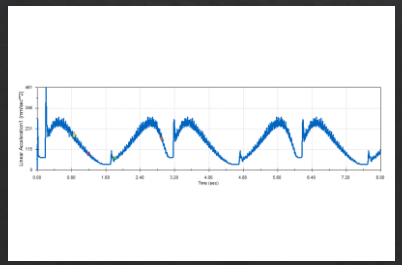
Objective: To complete a redesign of a prototype oarlock which improves mechanical advantage for a rower at key points in their stroke. The design must take the proof of concept to a commercially viable product which holds up under the high stress of rowing and integrates smoothly with Fluidesign's mounting system.

Design Overview: I used SolidWorks to design the oarlock pin and bracket, which would be welded to the mounting bracket already in use. I verified the design using SolidWorks Simulation FEA, showing that they could theoretically hold up under normal use. I worked with a machinist to build a prototype pair, and then assembled and tested them myself on the water.

Results: The oarlock performed well, however, the mounting bracket borrowed from the existing boats bent under the new loading conditions. I redesigned the mounting bracket, and the design may be incorporated into future offering by Fluidesign pending approval from the rowing governing board regarding new innovations.







Motion Analysis of Garden Shears (Academic)

Objective: To compare and contrast the results of position, velocity, and acceleration analysis of Garden Shears using three methods of analysis.

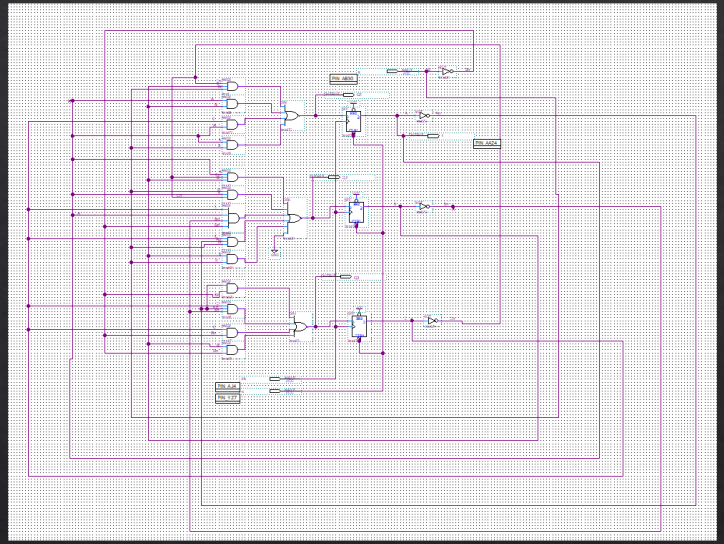
Project Overview: I created a mock-up set of garden shears in SolidWorks within specified design criteria. As a group, we conducted the analysis using three methods: graphical (polygon) method, analytical (loop-closure) method, and SolidWorks Motion Analysis. I was responsible for the design and motion analysis in SolidWorks, as well as the communication of the results as a report.

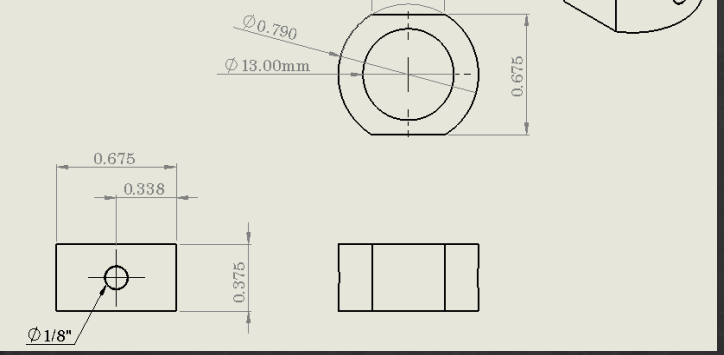
Results: Our results showed that both Motion Analysis as well as loop-closure provided very similar and accurate results, while graphical methods introduced compounding errors as we moved from position to velocity and acceleration. Graphical methods could be used for rough results, and any precise calculations should be verified with multiple methods.

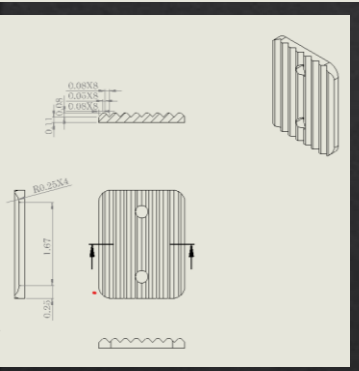
Design and Implementation of Sequence Detector (Academic)

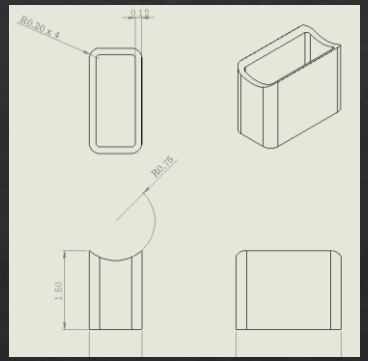
Objective: To design a sequence detector which detects a 4-bit “on” signal, and a different 4-bit “off” signal, model the circuit in Quartus, and implement it on an FPGA board.

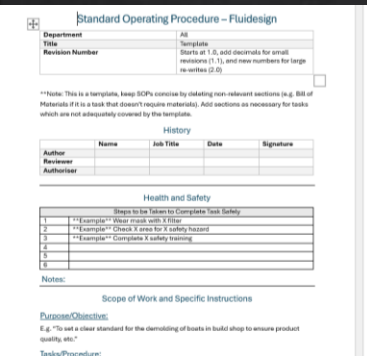
Project Overview: I designed the Moore-model sequence detector using two different state assignments. I minimized the cost of each design using K-maps and picked the lowest cost design to be modeled using Quartus. I then implemented my design in the software and verified the results using the waveform tool. I then programmed the FPGA board in the university labs and demonstrated the results of the working design. I communicated the design process and the positive results with a detailed report.










Standard Operating Procedure – Fluidesign

Department	All
Title	Template
Revision Number	Starts at 1.0, add decimals for small revisions (1.1), and new numbers for large re-writes (2.0)

**Note: This is a template, keep SOPs concise by deleting non-relevant sections (e.g. Bill of Materials if it is a task that doesn't require materials). Add sections as necessary for tasks which are not adequately covered by the template.

History

	Name	Job Title	Date	Signature
Author				
Reviewer				
Authorizer				

Health and Safety

Steps to be Taken to Complete Task Safely	
1	**Example** Wear mask with X filter
2	**Example** Check X area for X safety hazard
3	**Example** Complete X safety training
4	
5	
6	

Notes:

Scope of Work and Specific Instructions

Purpose/Objective:

E.g. "To set a clear standard for the demolding of boats in build shop to ensure product quality, etc."

Tasks/Procedure:

3. Reference material numbers where needed to be clear about specifics (what type of carbon/adhesive/tape, etc.

4.

Materials:

Material #	Material Name	Use	Notes
1	**Example** Scotch Weld 6310	Bonding of decks	"This is the green one" or "make sure you don't use 6330"
2			
3			
4			
5			

Additional Instructions/Notes:

Add more specific instructions or address common concerns/mistakes here.

Reference Material and Pictures

**Add any helpful aids such as pictures here or add engineering drawings or other reference material for documentation.

Read By

NAME	JOB TITLE	DATE	SIGNATURE

Parts Database & Documentation

Parts Database:

At Fluidesign Composites, I created a parts database by reverse engineering parts currently in production which were not well documented. This allowed for easier production changes, and reduced risk of manufacturing disruptions.

Documentation:

I created updated standard operating procedures and project report templates. These templates were implemented company-wide and helped improve communication and clarity between engineering and production teams.

Get to Know Kai

Hi, my name is Kai, I am a third year Mechatronic Systems Engineering Student at Western University. In my free time, I love everything outdoors. I grew up ski racing, mountain biking, and scuba diving.

At university, my passion for the sport of rowing has allowed me to spend time outdoors with my friends while excelling academically and in sport. I am extremely proud to represent team Alberta rowing and hope to race for team Canada in the near future.

Career-wise, I am passionate about applying new technologies to big issues in sustainability and sport. I am excited to continue to develop my engineering skills and learn lots of interesting things!