Shane Wighton

Selected Work

Unless otherwise noted all aspects of all projects shown within were completed solely by myself.

Formlabs – Form 2

The Form 2 is a robust and well integrated 3D printer used by tens of thousands of users to print millions of parts.

I worked with three other company leaders on all aspects of the product to get it designed, working and shipped. I was responsible for all software systems including the embedded linux system on the printer, the desktop driver software, and the factory calibration software. I was also responsible for project managing the electrical systems, physical printing process and toolpath development.

Around the end of Form 2 product development I became responsible for the overall SLA product line including the Form 2 and future unannounced products.

Formlabs – Form 1 & Form 1+

I was the primary contributor to PreForm, the desktop print driver for both the Form 1 and Form 1+. I worked on all aspects of the application with my largest contributions centered around the core computational geometric algorithms for automatic print setup, toolpath generation, printer communication and the user interface. Much of my work is still in use today.

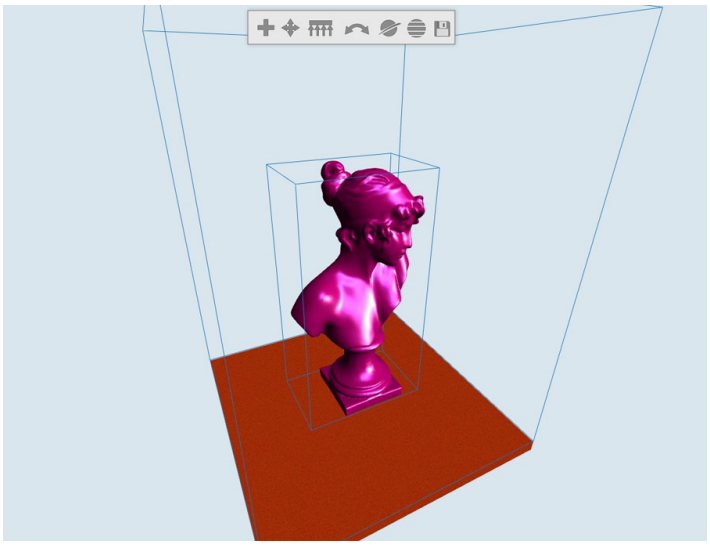
I designed and wrote the factory calibration software – a python desktop application that uses various transducers to measure machine variation at assembly time for software correction while printing.

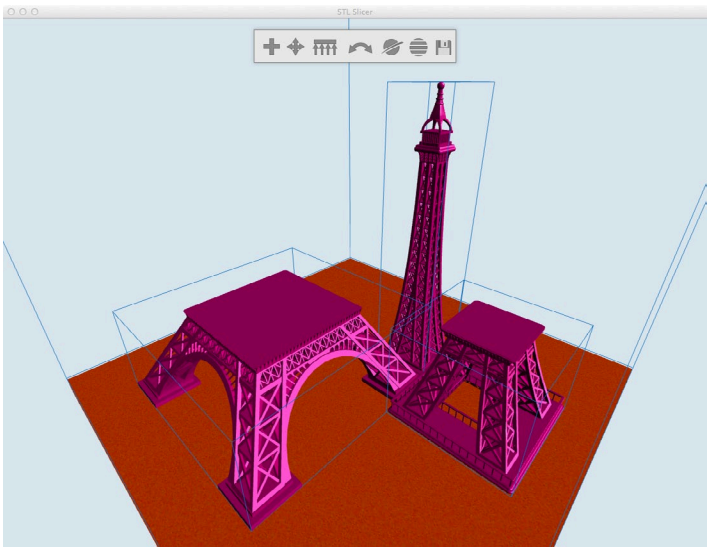
I built a team around PreForm and our other software products, guiding them through over 60 public releases.

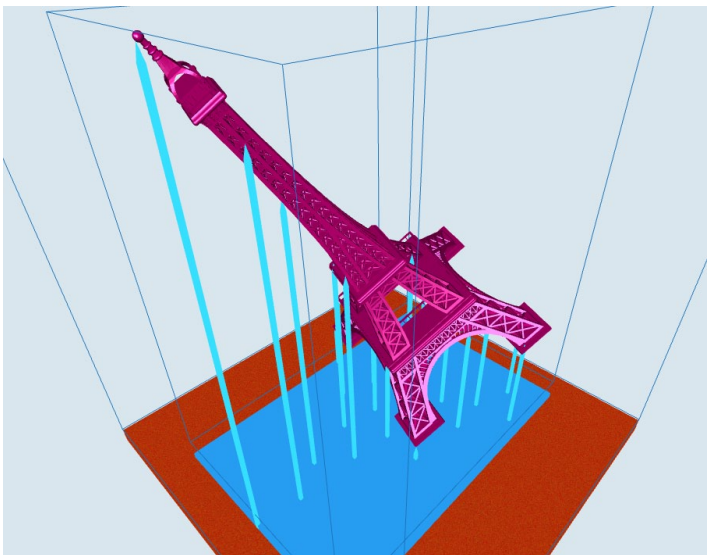
STL Pre-processor (2012)

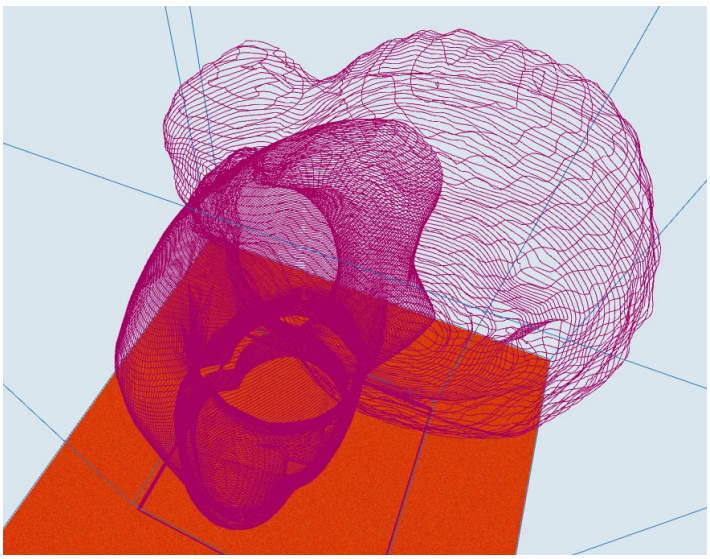
For rapid prototype machines

An application was developed to perform all of the processing necessary to convert an .STL model file into something that a rapid prototype machine can print. The application loads models using a custom .STL file parser and allows the models to be manipulated (translated, rotated, scaled). After manipulation it automatically generates a support structure to give the objects structural integrity while being printed, and then slices the objects up into thin layers which would be printed on a rapid prototype machine. The object slicing algorithm is implemented using OpenCL so that the computations can be performed on the computer's graphics processor which gives a massive speed boost of several orders of magnitude over a naive implementation. The application also has a tool to split .STL models which are too large to print into smaller pieces.

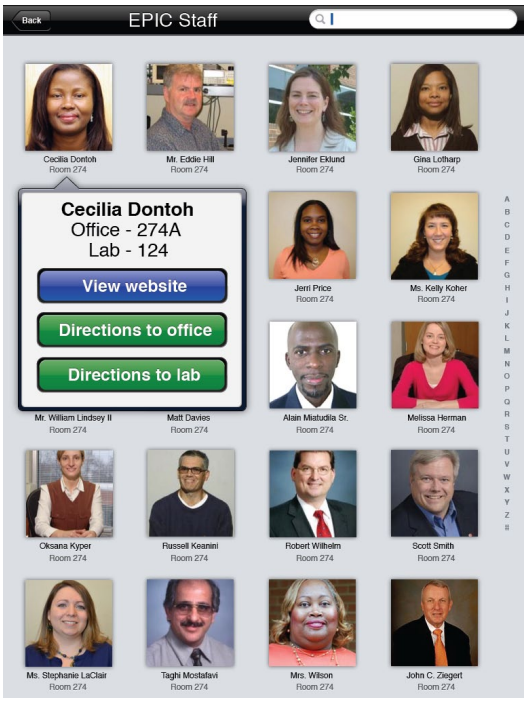


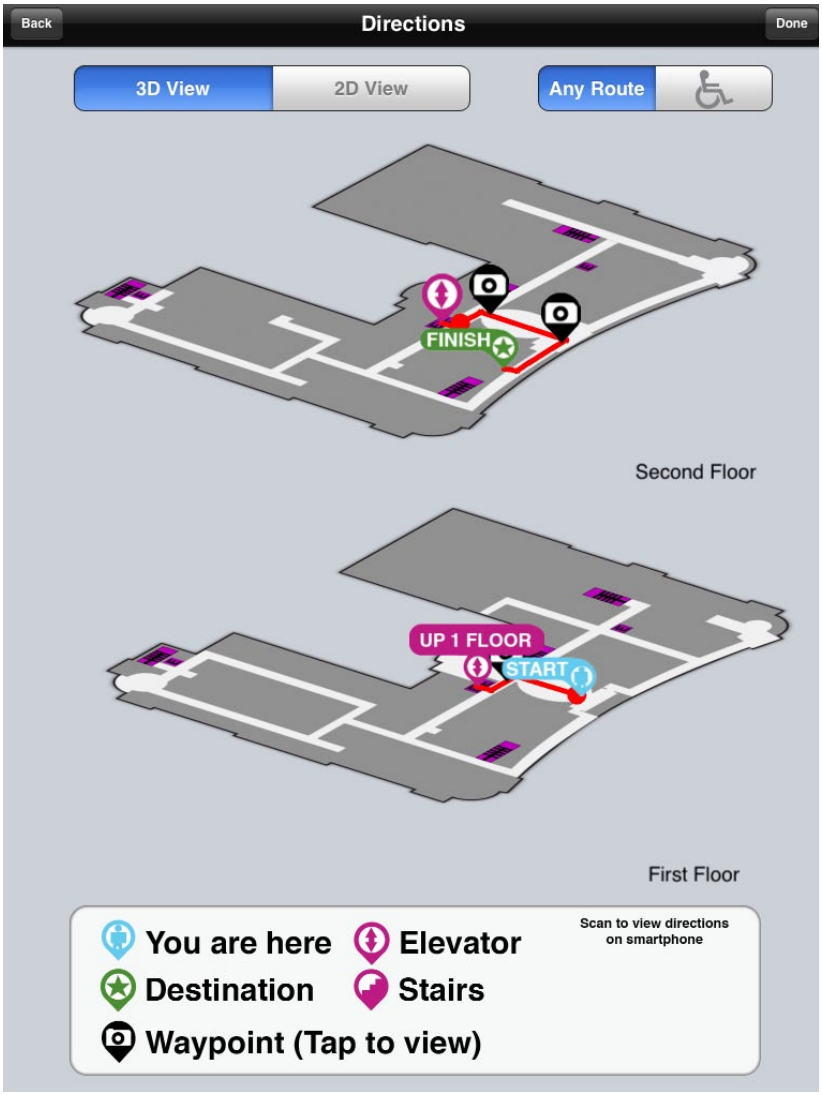


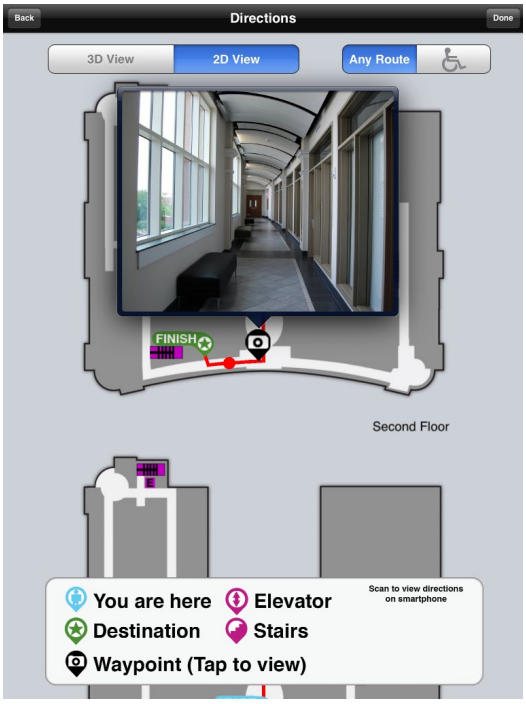




Building Route Finder







The wayfinder is a system designed to allow building visitors to get directions. A native iPad application is run as a kiosk which allows users to search for staff or rooms, and then gives them optimal walking directions to the chosen location, including photos of what it looks like along the way. It has 2D and 3D map views implemented in OpenGL. A web app was created to manage kiosk data, including a full featured interface to build the maps shown by kiosks. The floor plan editor was written using HTML 5 canvas and was later upgraded to SVG. It also includes web based direction viewing, in which the server calculates the optimum route and dynamically generate images with the route drawn onto them.

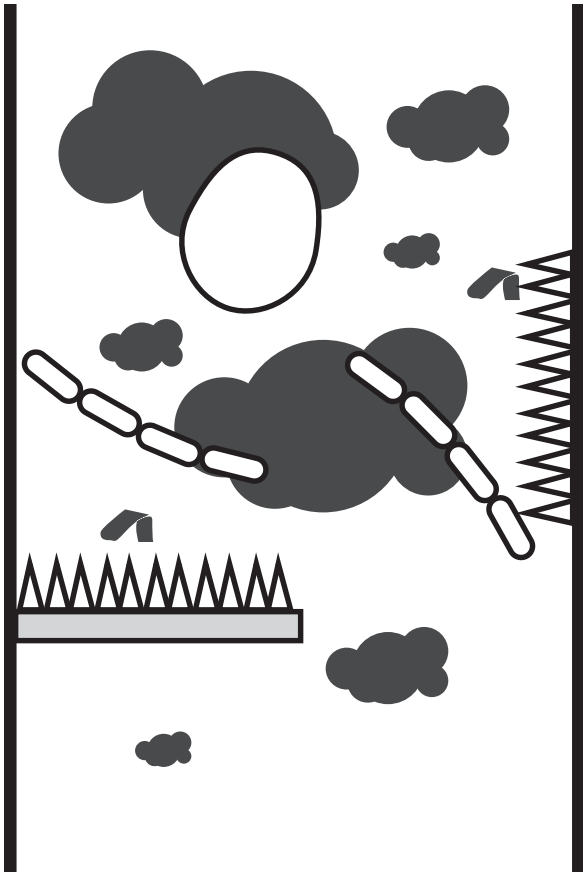
Video Game Playing Robot

Computer controlled robot uses real time video processing to win games.

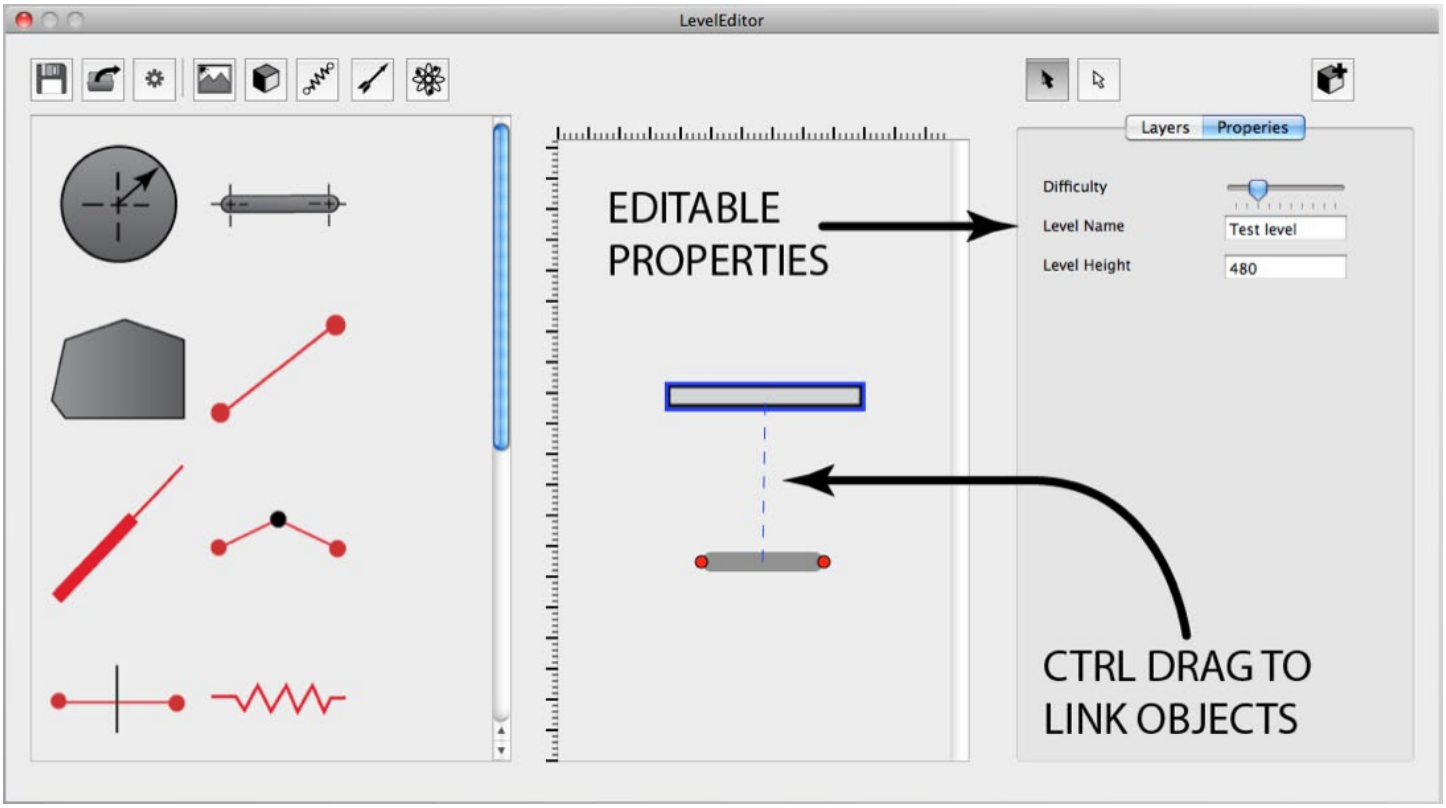
A robot that uses computer vision to play iOS games was designed and constructed. Engineering analysis was performed to specify components for adequate dynamic behavior. The platform motion is controlled by a microcontroller which communicates with a host computer over serial. Software was written to solve labyrinth style maze games. Images are taken from the webcam, processed to extract the maze walls, ball location, goal location, and then solve for the path from the ball to the goal. The ball is steered to the goal using a feedback loop to keep the ball on the path. A feed forward control system was designed to account for inertial effects when cornering.

iOS Application

Physics based iOS app using OpenGL and desktop level creator

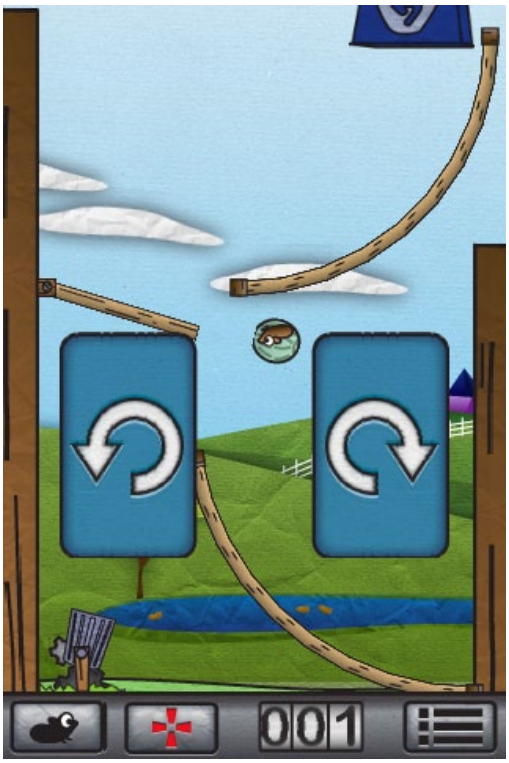


A physics based iOS game called Droplette was created in which a falling egg is guided downwards by drawing rope on the screen. The rope can be destroyed by flaming arrows, and the egg can be cracked by various dangers. The game is an endless sequence of progressively harder obstacles. Scores are determined by distance traveled, and uploaded to a webserver for global ranking. A desktop application was created to build the level sections for the game. The levels are stored in a SQLite database which is used by the game to load levels at runtime. The desktop application ties in with the physics engine and allows all physics objects and constraints such as physics bodies, joints, motors, etc, to be visually mapped to the corresponding scene objects. The desktop level editor has a very intuitive drag and drop interface.



iOS Application

A physics based iOS game



Burrow is a 2D physics based game created for iOS. The goal of the game is to launch a variety of creatures from a cannon and reach a recycling bin. “Portals” can be placed to teleport creatures from one area of the level to the other. The game has 50 levels. OpenGL is used for graphics, and the Chipmunk physics engine for realistic physics. One of the optimizations performed to decrease loading time for the application was to combine all images into a texture atlas. To facilitate this, a custom tool (shown below) was created that packs a set of images into an atlas, and creates all of the necessary metadata for the images to later be extracted. This game has had approximately 50,000 downloads and has reached the top 50 puzzle games in the iOS app store.

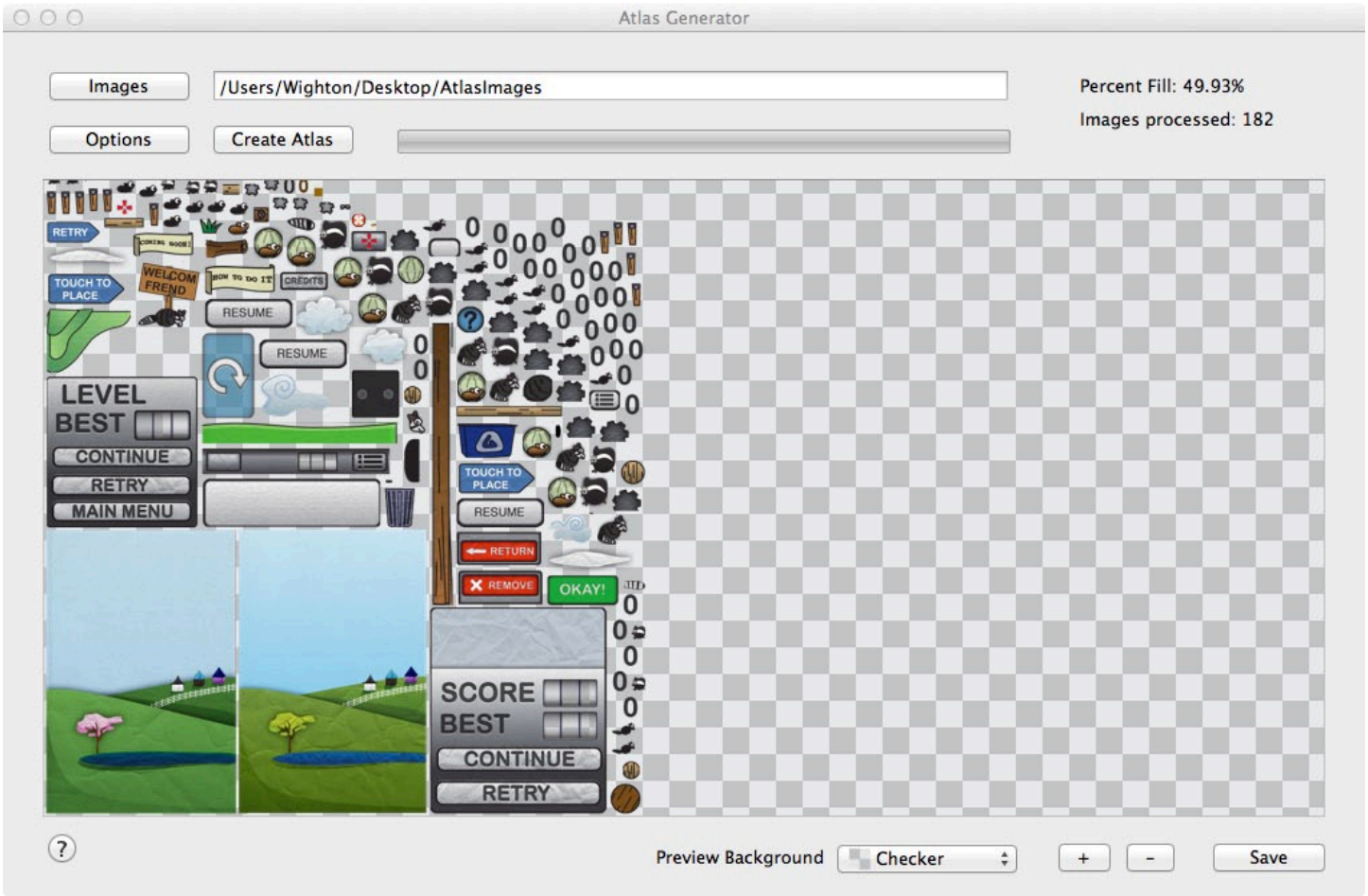
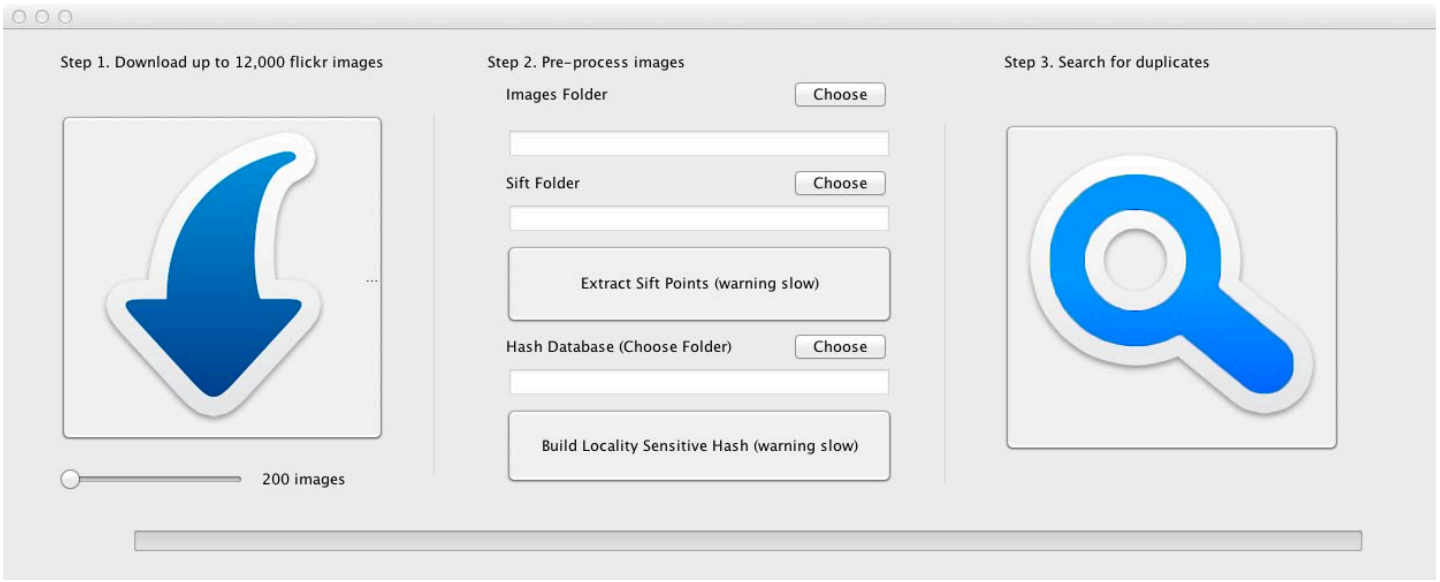
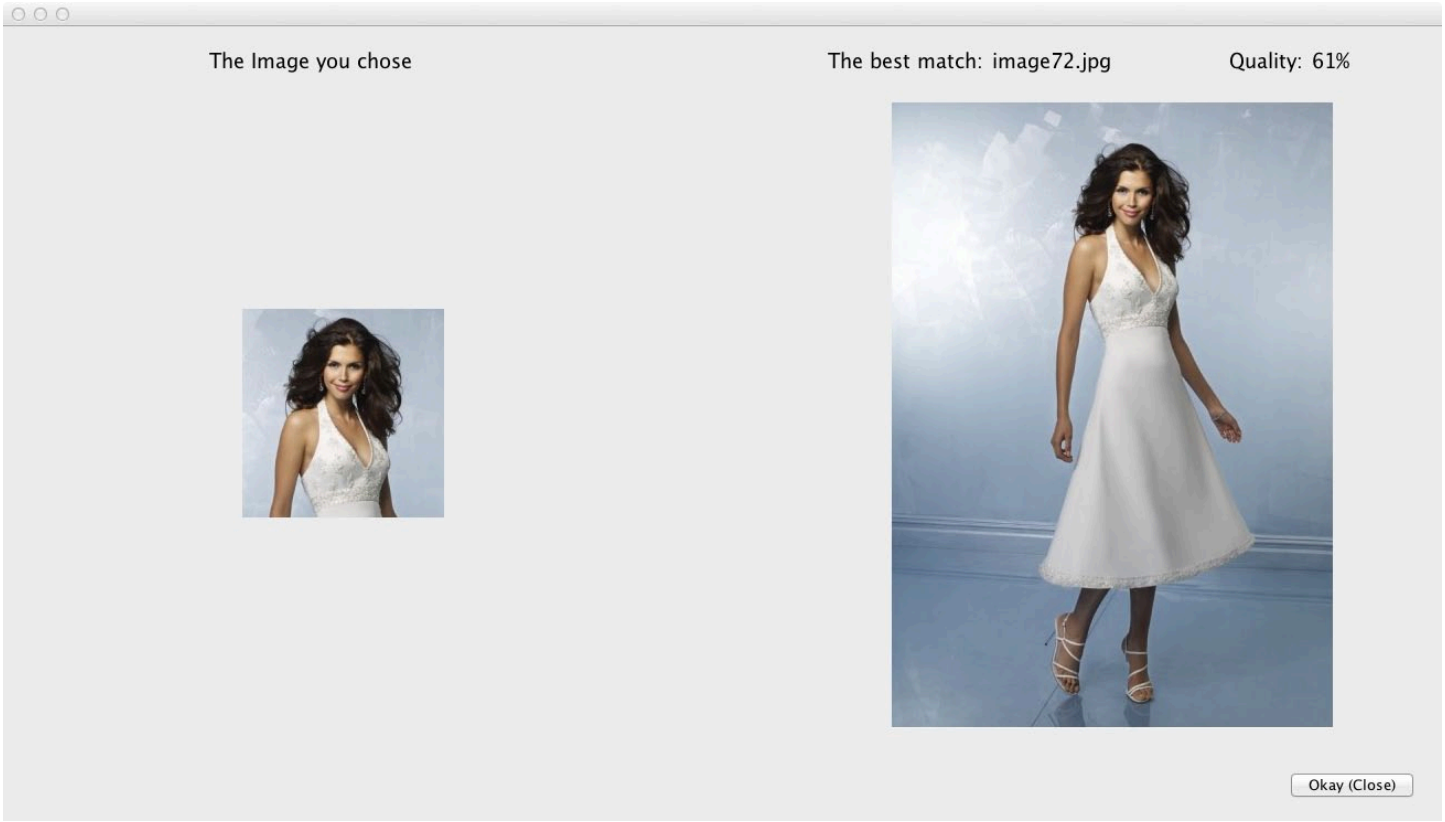


Image Search Engine

Web crawler, preprocessor, and image search engine all in one



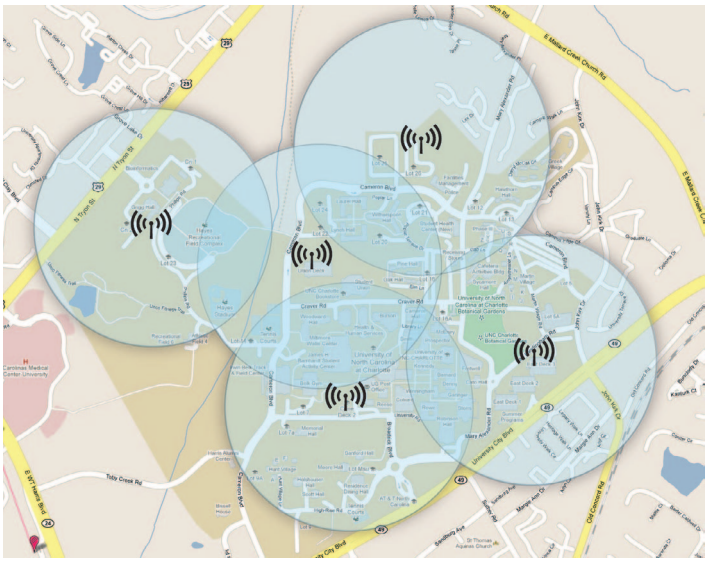
An application was created that performed all of the necessary steps to create an image based search engine. Application crawls flickr.com using a custom multithreaded web crawler created specifically for the application. SIFT points are extracted from all images, and then indexed in a SQLite database using locality sensitive hashing. Image matches are found by extracting the sift points from a query image, performing a locality sensitive hash on the SIFT points, and then querying the database for matching points. Matching images are ranked by the number of matching SIFT points. System can also be used to find all duplicate images in a large image set even if they are different formats, scales, etc.



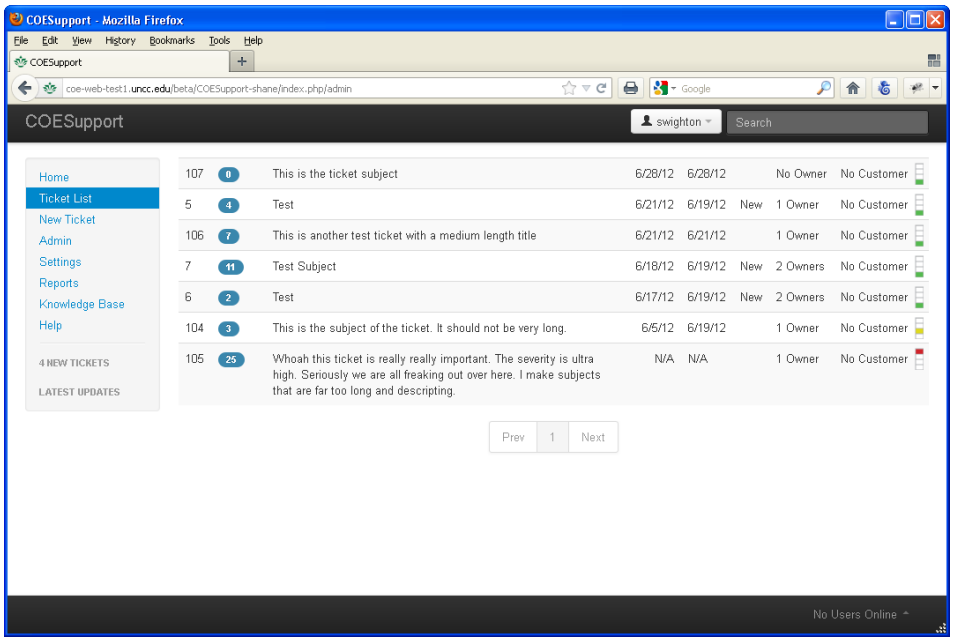
Campus Shuttle Tracker

Complete system to track real time position of campus shuttles

A complete system to track shuttles on the UNCC campus was designed (though not implemented due to funding issues). System tracks vehicles using GPS transmitters placed on the shuttles and communicates using a mesh network of solar powered receivers mounted strategically on light poles around the campus. Design includes the algorithms, transmitters and receivers, electrical and mechanical components. Extensive testing of transmitters and receivers was done to prove concept. Data from shuttles would be aggregated in near real time on a web server which would perform forecasting to determine when shuttles would arrive at stops. Riders would use a web app or native iOS and Android application to view shuttle locations.

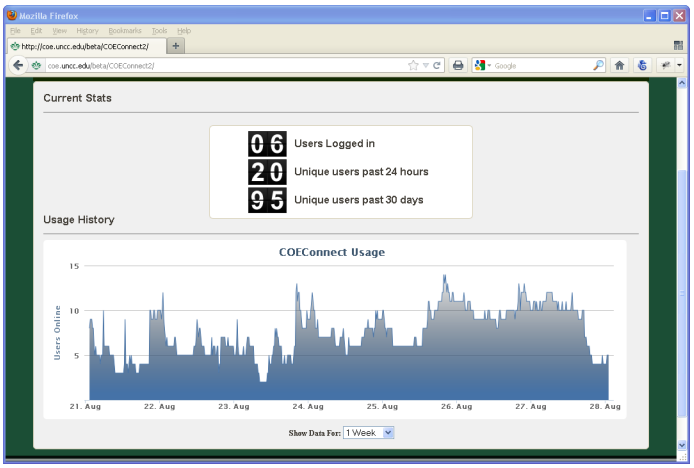


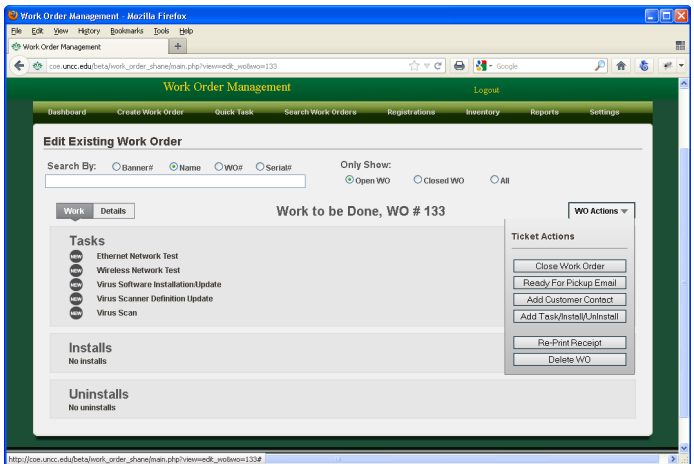
Web Applications



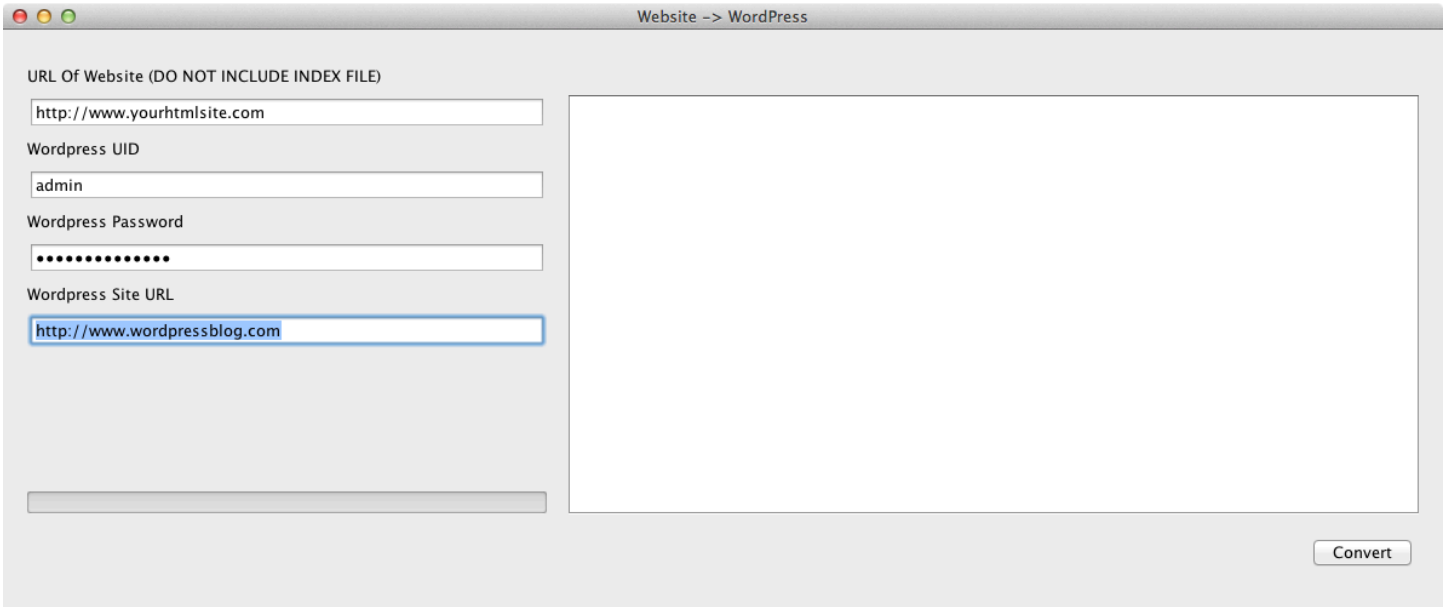
Several web applications were taken from inception to release. Applications were designed to replace existing hard to use desktop applications. Applications were written primarily using PHP, MySQL, Javascript. A special version of the Code Ignitor framework was created that facilitates authenticated web services over AJAX. Applications created include:

- A support ticketing system. Has a responsive UI, real time chat system, push notifications for ticket information, integration with a knowledge base and indexes all past support tickets to augment the knowledge base.
- System to manage all engineering printers. Tracks printer supplies, allows remote job cancellation, also acts as interface to manage student print quota.
- System to manage custom remote desktop connection application. Logs all uses of remote desktop, as well as errors that occur. Has report generation, SVG based graphs, and direct as well as broadcast message system to send messages to remote desktop users.
- Work order and inventory system. System allows progress on hardware work orders to be tracked, as well as inventory for loaner computer systems and accessories. Stores all receipts and other transactions, and has extensive reporting capabilities.





Website to Wordpress Converter

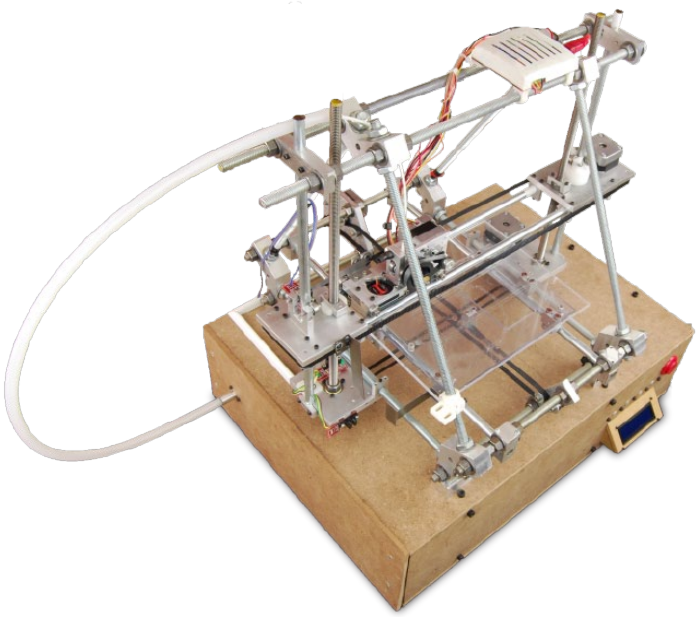


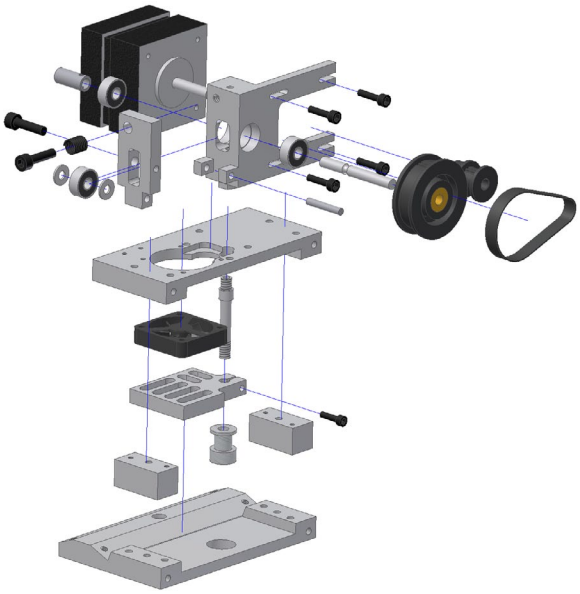
Tool developed to convert an HTML website to a wordpress website. Integrated crawler collects all reachable webpages in HTML website, generates connectivity graph of pages, performs a topological sort, then simulates a user on the wordpress site to log in, create a wordpress page for every HTML website page, build a nested menu system according to the topological sort, and then re-write all inter-site web page links to point to the new wordpress pages. Also downloads images and documents from HTML website and uploads them to the wordpress site, re-writing links to point to the new files. When finished, the tool generates a report of every action taken in an easily browsable HTML website. Was used to automatically convert approximately 50 websites to wordpress in the span of a few hours, saving hundreds of hours of manual labor.

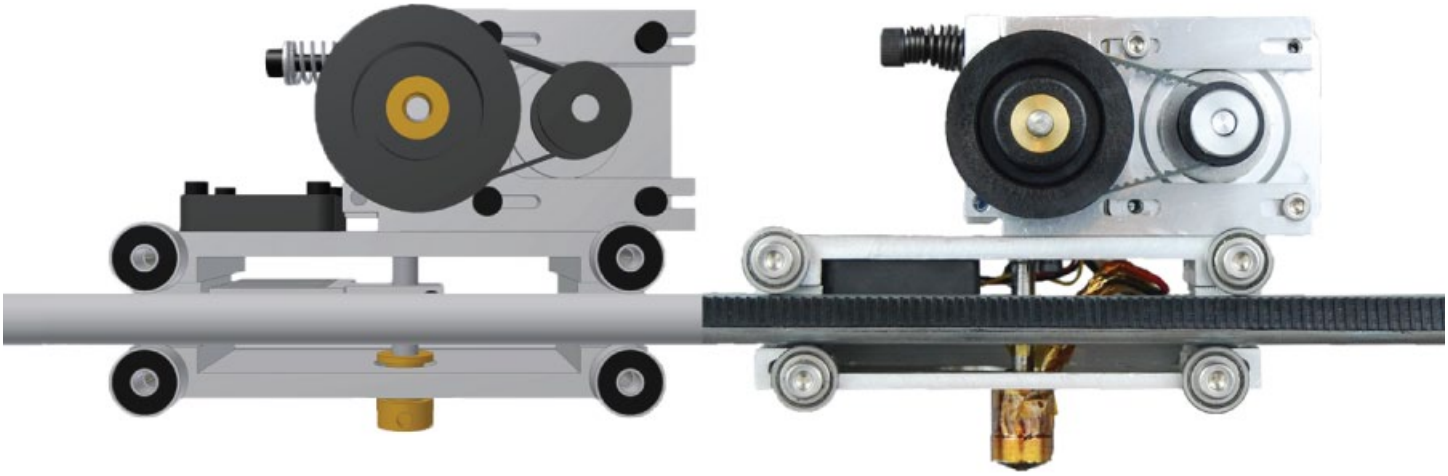
Video frame interpolation

An algorithm was designed to generate intermediate video frames to reduce jitter when performing time warp on video. Due to high time complexity, the algorithm was redesigned using dynamic programming techniques. This reduced time complexity from $O(n^{3.3})$ to $O(n^{2.3})$ with n being the number of pixels in a single frame. Approximations and optimizations are being explored to further reduce the time complexity.

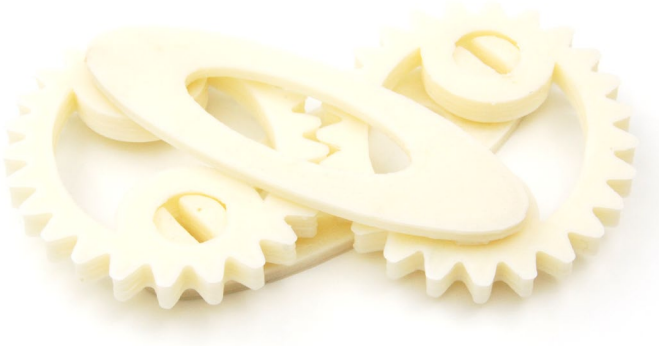
FDM Machine

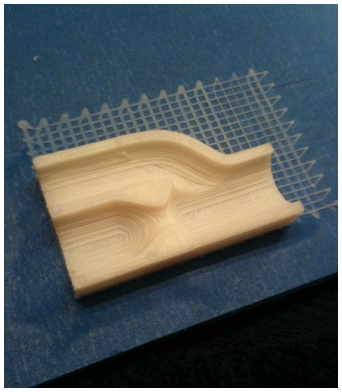


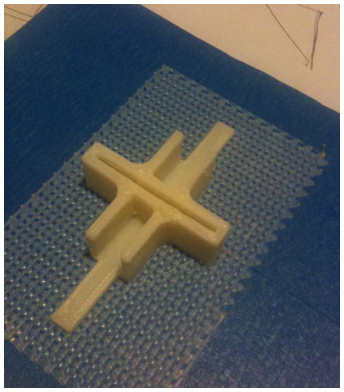




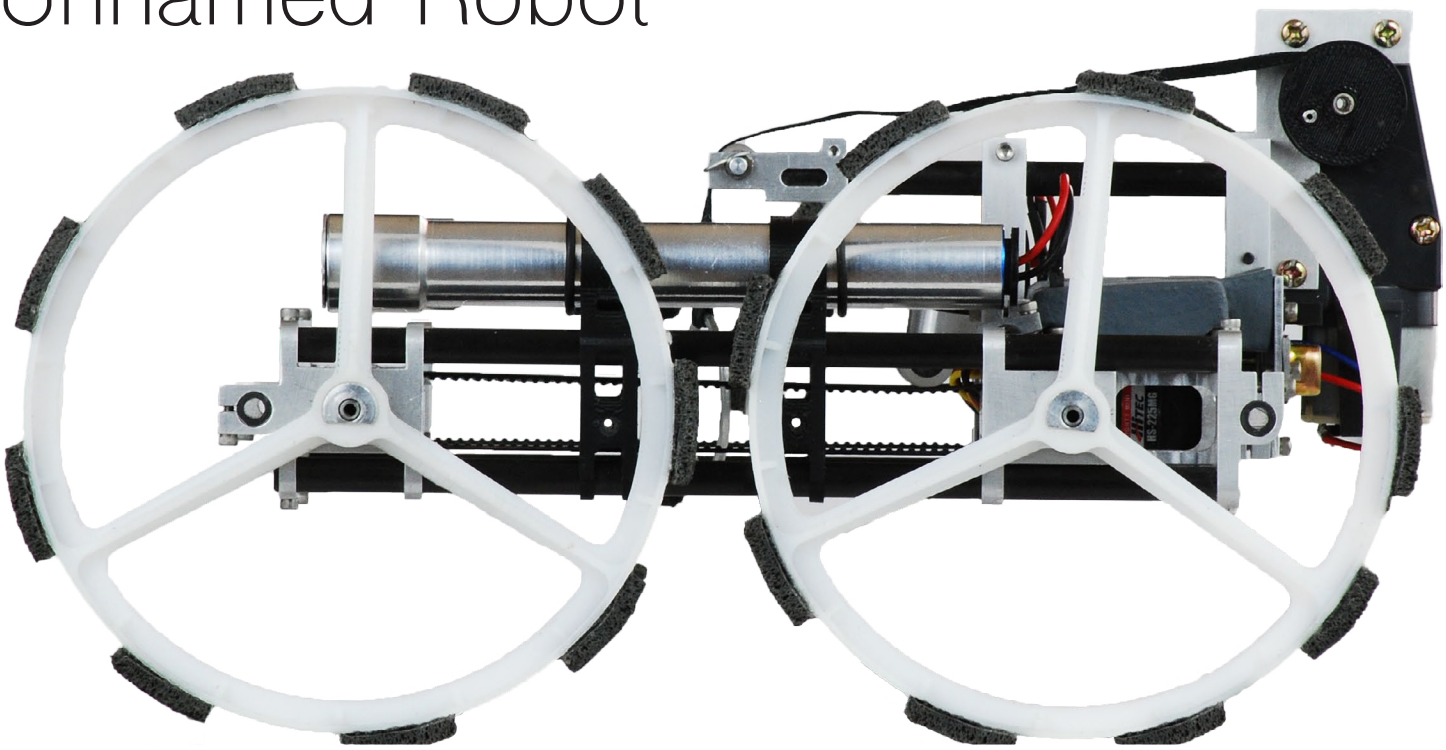
FDM machine based upon the open source RepRap project was developed and built. The device was re-designed to be machinable. The extruder design for the RepRap project was very poor at the time the printer was built, so a new extrusion head was designed to solve all of the identified issues with the existing design. The full design process was used including a comprehensive thermal-fluids analysis of the hot end to properly specify input power, and to design the thermal block (a heat sink with forced convection), as well as to properly size the drive motor.



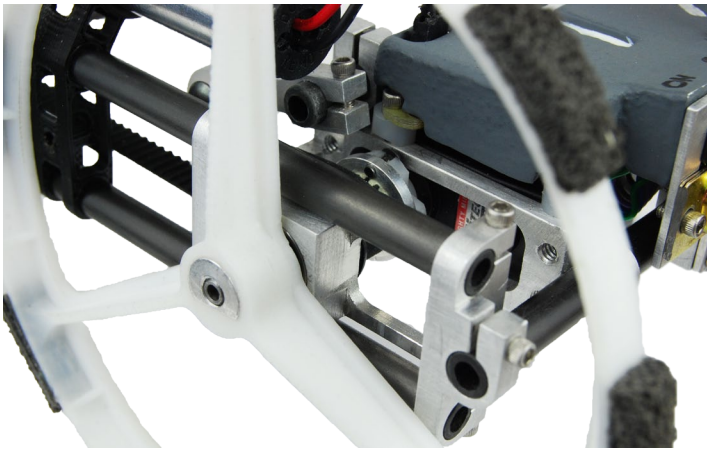


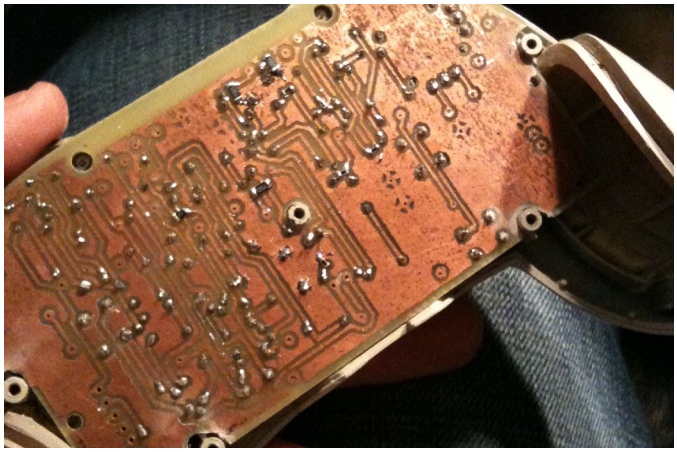


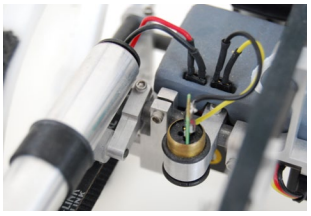
Unnamed Robot

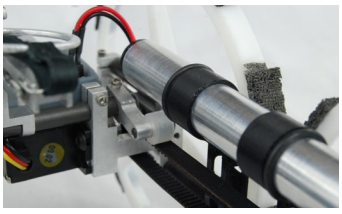


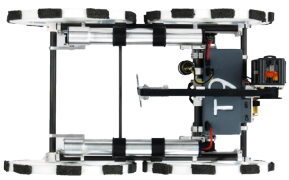
This robot was designed to lift 2.5lb weights using a winch system and transport them over various obstacles. Weighing in at 1.1 lbs, this tightly integrated this robot is the lightest robot ever made for the mechanical design course. The design was refined continuously until every possible gram was removed. The analog electronics were designed, laid out, etched, and constructed. The robot was later converted to microcontroller control. Some machining performed by others.











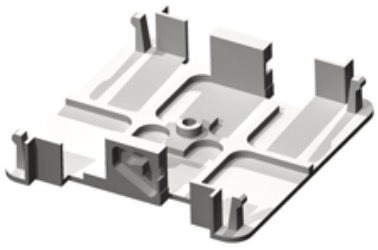
USB Hub

Hub designed to be manufacturable and attractive.

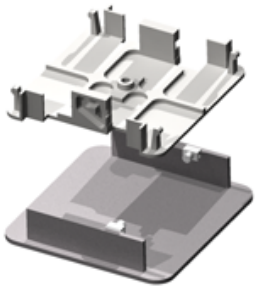
An aluminum USB hub was designed for manufacture. The goal of the design was to have a USB hub for use on laptops that allows the cord to be coiled around it when not in use. The hub has a mechanism that allows it to be expanded with a light touch. The design was refined until the part count and assembly steps were minimized. The device has a single screw, with the remaining parts snapping together. The primary components of the device are:

- Base created using extruded aluminum channel
- Injection molded plastic piece which integrates all complex functions and features into a single molded piece.
- Simple aluminum cover

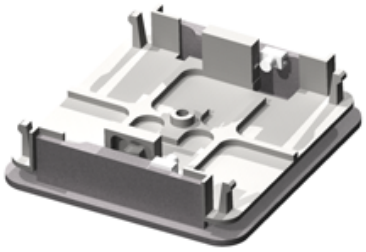
INTEGRATED PLASTIC PIECE



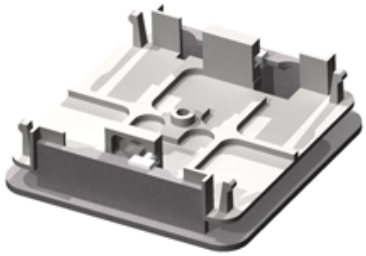
PLACE 'SLIDERS' ON ALUM. BASE



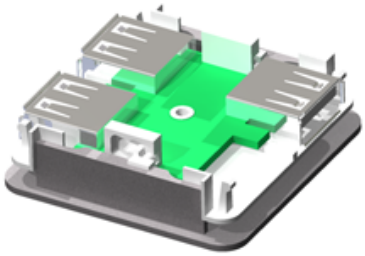
INSERT BASE INTO PLASTIC PIECE



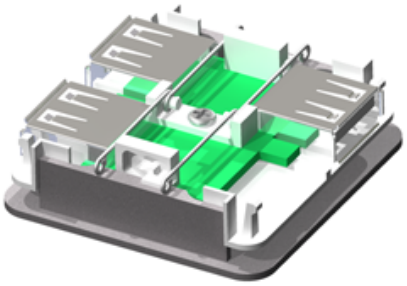
SLIDE 'SLIDERS' OVER RAMP INTO CHANNEL



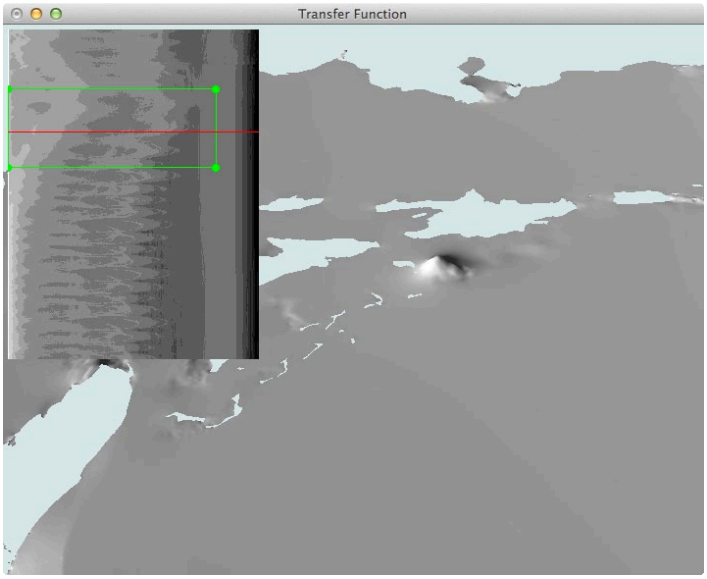
INSERT CIRCUIT BOARD



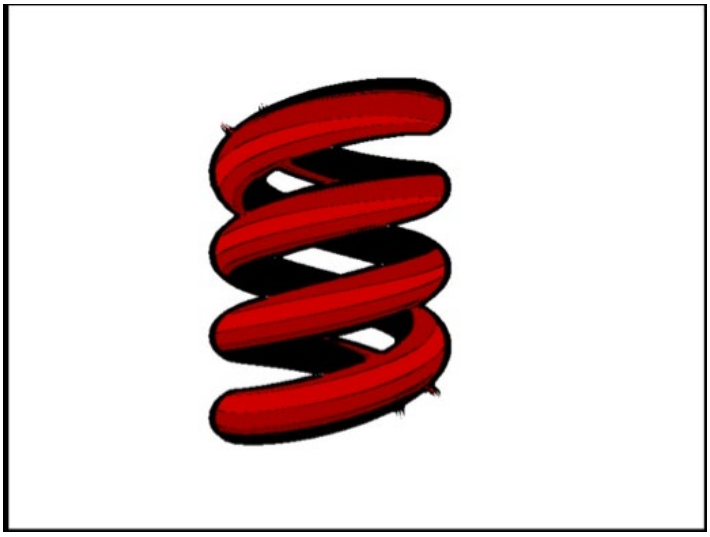
ATTACH RESET SPRING BRACKET WITH SCREW, SECURING CIRCUIT BOARD



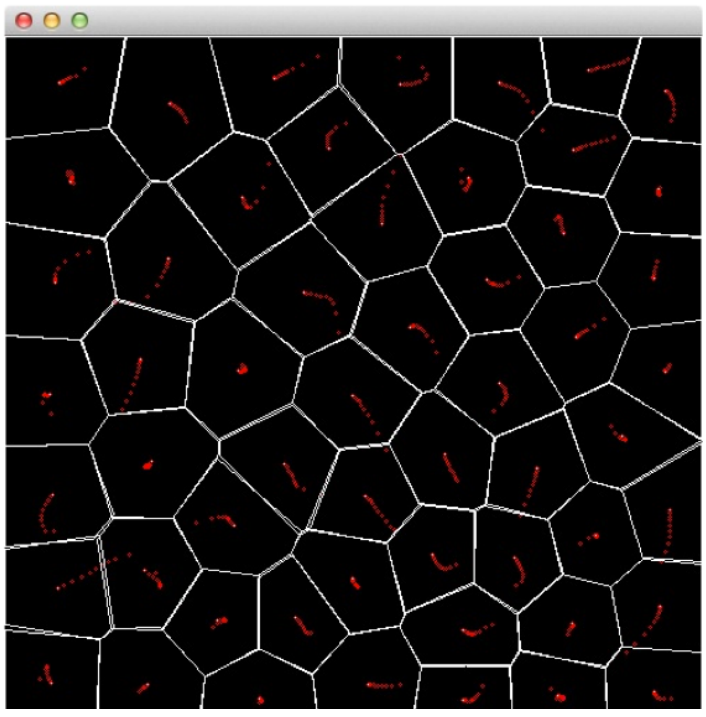
Assorted visualizations and Computational Geometry



A tool to visualize a very large temporal data set for a hurricane was developed. Has interactive tools for exploring and manipulating the data. Uses OpenGL for rendering.



A GLSL shader for toon shading was combined with an image space algorithm for edge detection and implemented in GLSL. Edge detection treats image as height field, a degree two polynomial was fit to the neighborhood around each pixel in image, then solves for the eigenvalues and eigenvectors to determine principal curvature which is used to determined if point is an edge or not.



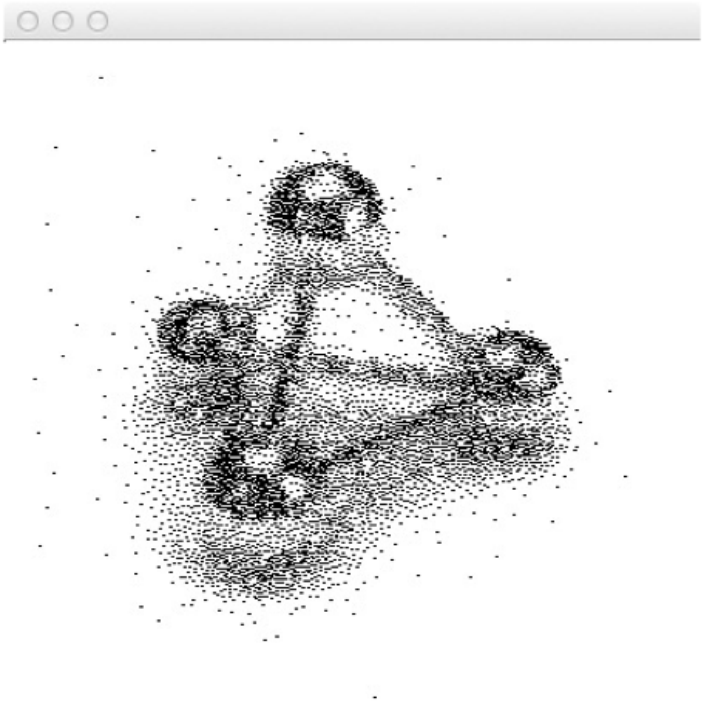
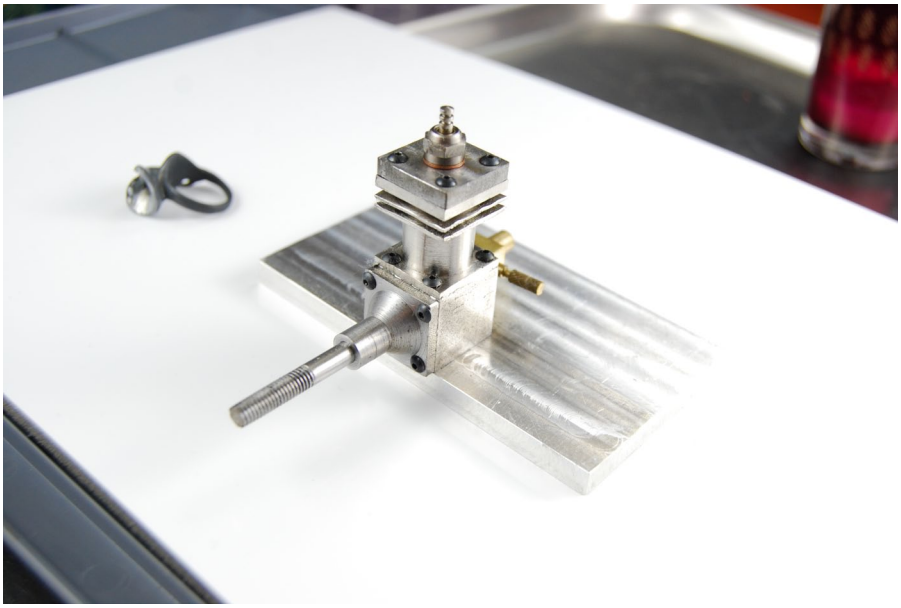
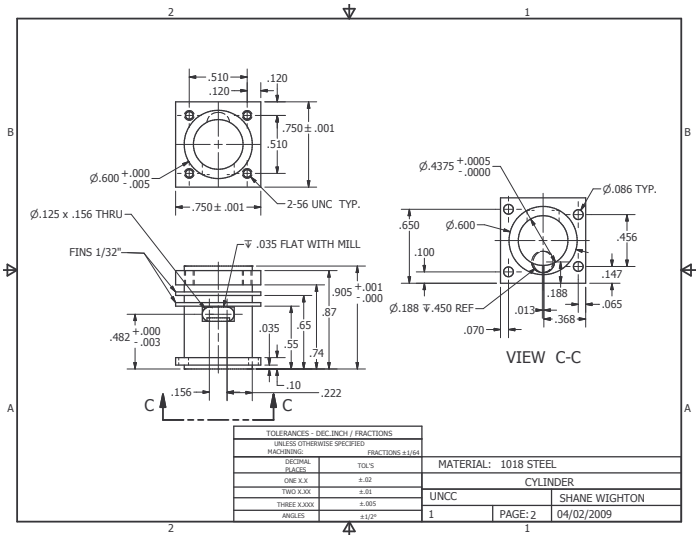


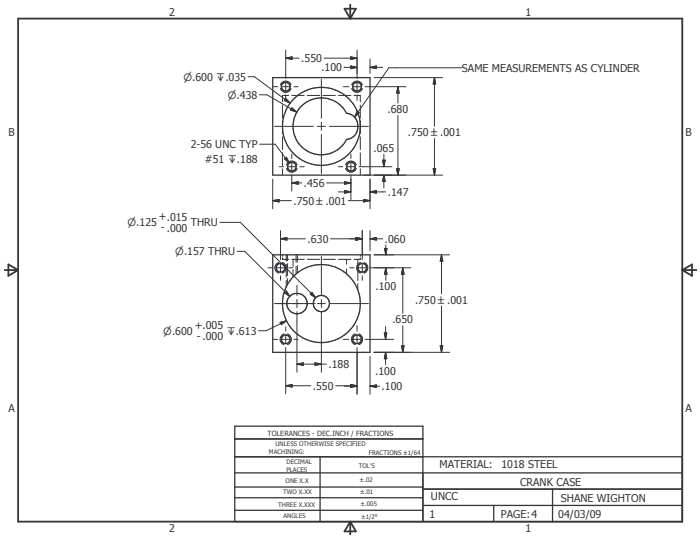
Image stippling was combined with iterative voronoi relaxation to give quality stippling results with a low number of stipple points. Implementation includes algorithm for calculating the Voronoi cells.

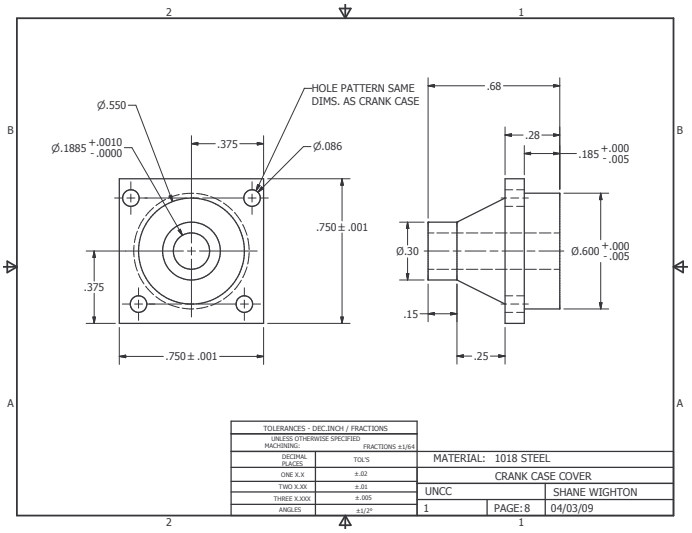
Two Stroke Engine

Only student at university to design and manufacture functional internal combustion engine.



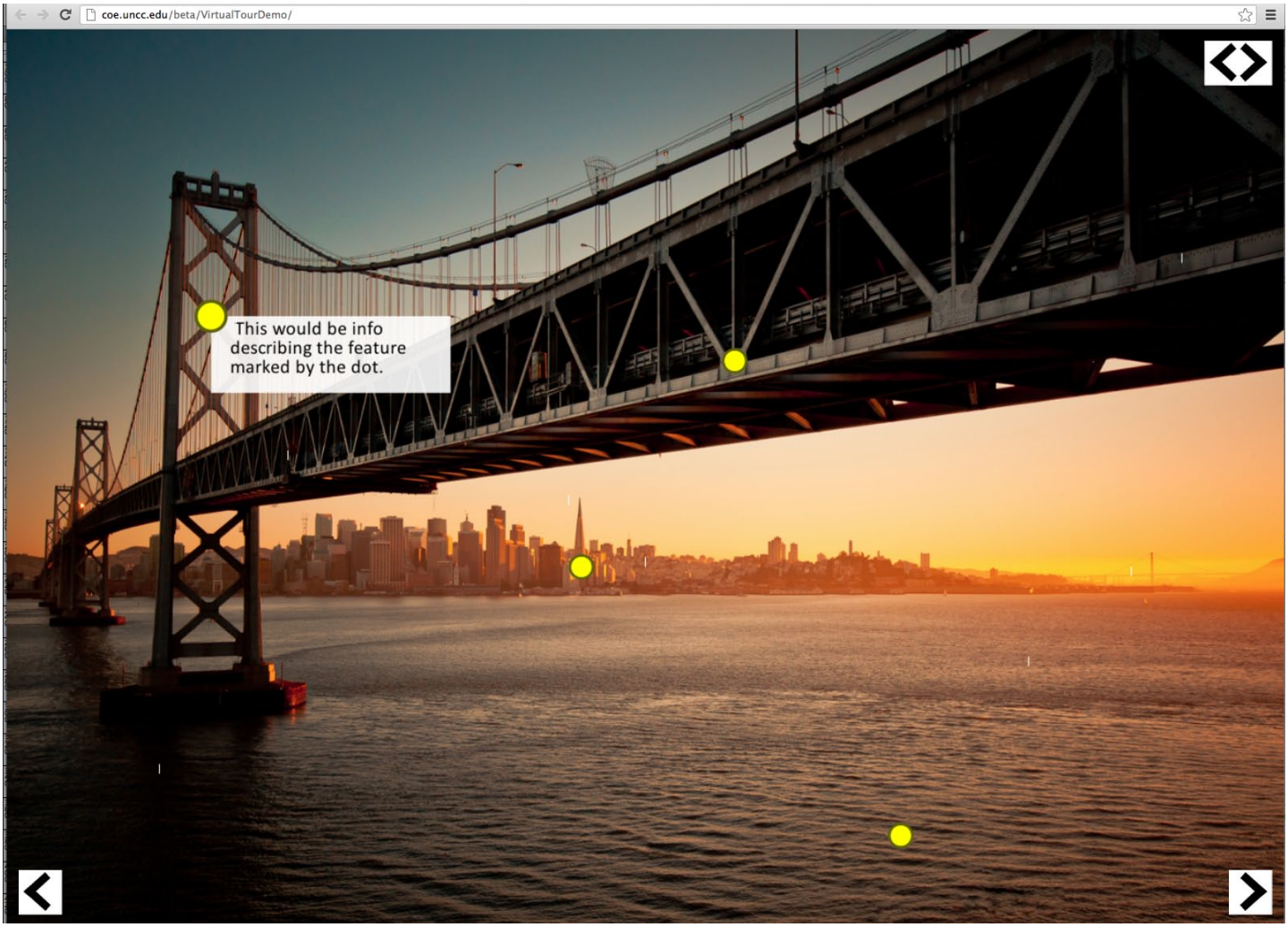






A functional two stroke engine was designed and manufactured for a design class. At the time it was the only successfully designed and manufactured internal combustion engine by any undergradute student at the university.

Interactive HTML5 Slide Show



Interactive slide show system written using HTML 5 canvas. It has fully animated transitions, allows arbitrary points of interest to be tagged in slides, and allows sub-content to be embedded such as videos, powerpoints or animations. Sub-content is shown by splitting slide in half vertically to simulate theatre curtains. A lightweight framework was created to allow animations to be made using HTML5 canvas.

Other work

- Scene graph library for hierarchical rendering
- Augmented reality on iPhone 3GS. Used GPS + accelerometer to render building information on top of camera view (OpenGL).
- Binary search tree library using AVL and red black trees
- Hashing library (linear probing and double hashing)
- Designed novel algorithm for determining reachability in digraph.
- Sorting library that implements quick sort, merge sort, radix sort, and counting sort
- Several web crawlers to crawl specific websites or subsets of the internet
- Huffman coding to compress text data
- OpenGL matrix math library
- Dozens if not hundreds of other smaller projects to act as utilities, or for personal learning.