The TrackPacer

A Senior Project presented to
The Faculty of Liberal Arts & Engineering Studies
California Polytechnic State University, San Luis Obispo

In Partial Fulfillment
Of the Requirements for the Degree
Bachelor of Liberal Arts & Engineering Studies

By
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Introduction

Competitive and recreational runners struggle to maintain a target pace during workouts and currently have no easy-to-see visual feedback on their pace. Lack of real-time, easy-to-see pace feedback makes it difficult for athletes to maintain a target pace and thereby makes their workouts less effective. Some GPS watches provide pacing feedback, but they are impossible to read while running hard.

Pacing is a basic yet essential component of track and field, no matter what type of running event is taking place. During practice, certain paces are prescribed to evoke certain physiological responses from athletes. For example, a coach might ask an athlete to run a pace in practice in order to increase their lactic threshold or their VO2Max, both very important factors of performance. Despite technology being a large part of our culture and sport, track and field is lacking in technological advancements to improve performance and marketability of the sport.

Currently, an athlete can only check if they are on pace once a lap, using splits, but these handheld devices cannot show if an athlete is falling behind or getting ahead during the lap. The TrackPacer provides a continuous indicator of pace during the entirety of the lap. Essentially, it lets the runner know where to be every second, on every point of the track rather than once or twice a lap.

The TrackPacer LED light rope provides a visual indicator of the desired pace for athletes to maintain. There are no other visual non-worn pace indicators. Presently, athletes rely on watches or other worn devices to monitor their pace. The LED light strip indicator is better than existing methods because it eliminates monitoring a watch or worn device and permits even a sprinter to determine whether he is maintaining target pace.

The TrackPacer is superior to sports watches due to its convenient, easily viewed placement on the inner perimeter of a track.

Description of The TrackPacer

The TrackPacer is an LED light strip containing closely spaced LED lights that sequentially light up at a given rate for athletes to chase in order to hit their target running goals. It is the visual embodiment of time. The light strip would be enclosed inside a weatherproof aluminum channel installed on the inner perimeter of a 400 meter running track.

The user can input their desired workout into the TrackPacer application that can be downloaded onto their phone. The application on the user's phone communicates over Bluetooth with a microcontroller that sends electronic signals to the light strip. The sequentially lighting LEDs appear as a traveling light throughout the light strip for the athlete to chase.

The TrackPacer application's interface will allow the user to preset their desired pace for a given distance in either miles/hour, time (i.e. a meet or world record time) for a given race distance, or sec/lap or min/miles. It will also allow the user to preset rest intervals and select the color of light they want. For example, a user could enter in that they want to run 1600 meters at 10 miles/hour. Once the user has set their pace, they would then push a "GO" button. Once the "GO" button is pushed, a 1-foot long segment of the light strip will flash in sync with the application's interface as it visually and audibly counts down 5 – 4 – 3 – 2 – 1 – GO at which point the user knows to begin running.

Deliverables

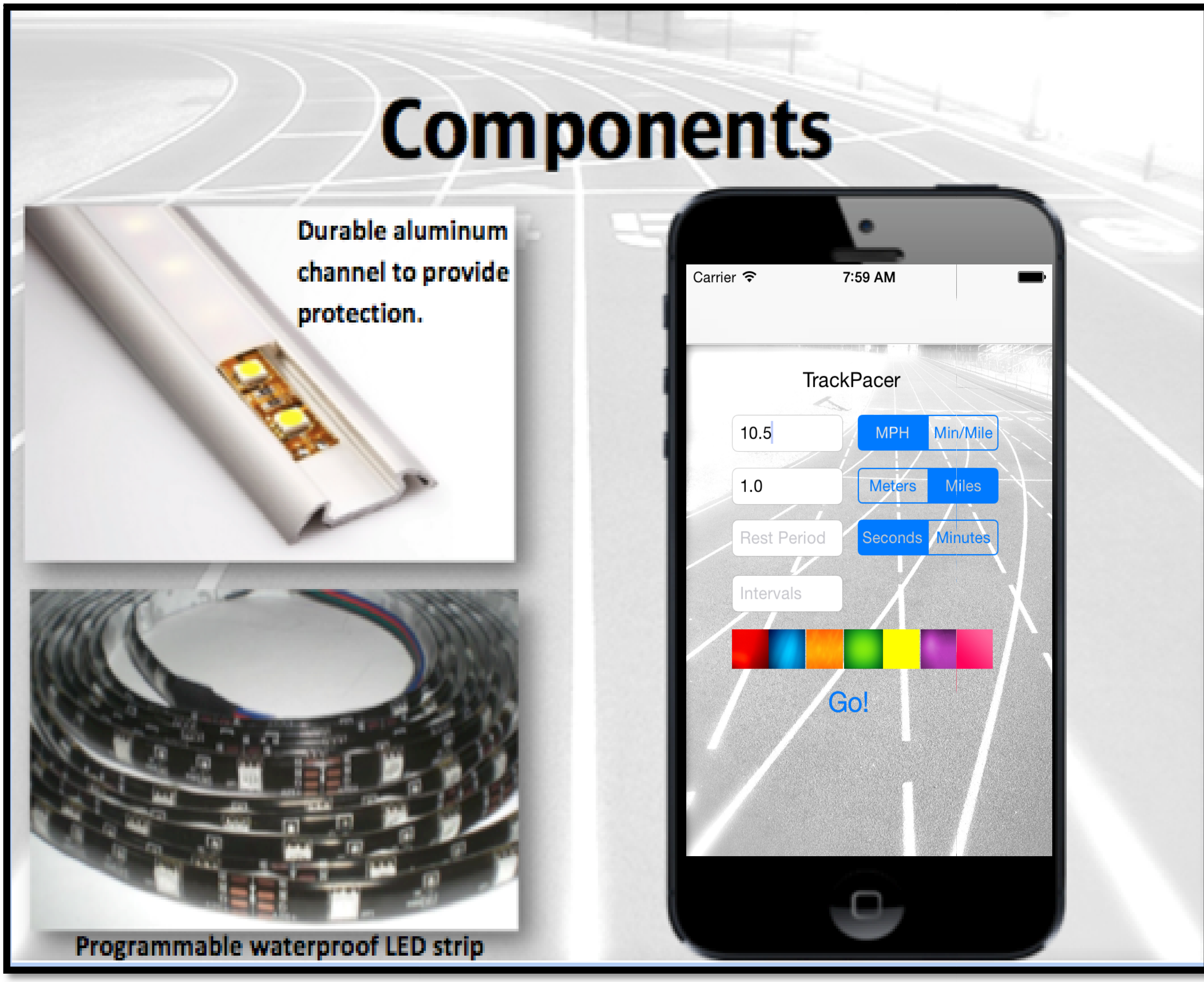
1. A miniature TrackPacer installed around a model 1/200-scale track to demonstrate how the TrackPacer functions and how it would be incorporated onto a running track

2. A 1/50-scale TrackPacer LED strip to demonstrate what the chasing light effect would look like on a full size track

3. A rudimentary functioning iPhone App to control the TrackPacer

The deliverables for the scope of this senior project are designed to fully convey the concept and test the functionality of the TrackPacer. From the scaled models, the requisite amount of power and flash memory were calculated in order to transfer the design principles onto a full size 400-meter running track.

The deliverables demonstrate the user options available, such as setting pace, color, distance, and adding simultaneous user workouts.



Project Goals

1. Learn to program an iPhone App
2. Learn how to give presentations to request investment funding
3. Learn how to present project proposals
4. Learn how to interview potential customers and implement their feedback into product design
5. Gain enough knowledge about microcontrollers, power supplies, and LED lights to develop a working prototype

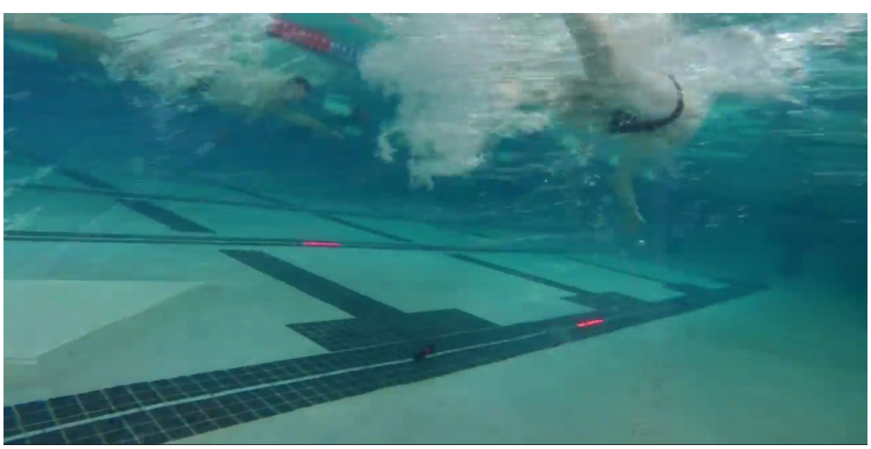
I began this project with no experience in programming and even less interest in learning to do so. However, my passion for the project and my determination to bring it to fruition made learning to program a high priority goal for me. After six months of stubborn commitment, I was eventually able to program both the microcontroller for the lights as well as the iPhone App.

Another goal I set for myself was learning to present project proposals and request for funding. It was daunting at first to approach coaches and athletic directors to explain and propose my project. However, I pressed on, motivated by entrepreneurs who encouraged and advised me, until I felt more confident and at ease with presenting my project.

Literature & Technology Review

The concept of LED light strip signaling for pacing athletes exists, but exclusively in the context of swimming. I extensively researched patents relating to pacing athletes by means of a non-worn visual light indicator and met with a patent attorney to review existing patent applications that appeared similar to the TrackPacer. After a careful review by the attorney, he determined that there is no patent specifically making claims that the TrackPacer would infringe upon if it were to be patented.

A company called LumaLanes has licensed a patent for LED light signaling for swimmers. LumaLanes' LED light strips are laid on the bottom of a pool for swimmers to pace off of. The LumaLanes system is easily portable which also distinguishes its concept from the TrackPacer. Due to the risk of the TrackPacer light strip getting punctured by track spikes, having shot puts dropped on it, and getting run over by trucks, it is crucial for the TrackPacer to be a permanent installation in order for it to be adequately protected in an aluminum housing. The LumaLanes system also comes with an App that can be downloaded onto a smartphone and has similar features to those of the TrackPacer.



LumaLanes' LED light pacing system

Technology Overview

All of the requisite technologies that comprise the TrackPacer exist. They include the LED light strip, a microcontroller, power supply and Xcode in which the App was built. The LED strips were selected because of their tremendously long life span, about 60,000 hours, their affordability, functionality, and professional appearance. The Arduino and Xcode programs were selected due to their compatibility with the LEDs as well as being commonly used programs for which numerous tutorials can be referenced. Although the concept of the TrackPacer is straightforward, the execution of it was unexpectedly complex.

LED light strips: The variety of different types of LED strips was overwhelming at first. They all come in different voltages, wattages, waterproof ratings, type of lamp body material and use different types of microchips and LEDs. They also come in non-programmable, programmable, and individually programmable varieties, as well as many other options. I spent over a month just educating myself and researching what type would be best. The first sample strip I ordered turned out to be programmable rather than individually programmable. At the time I did not realize there was a difference, largely due to the language barrier of communicating with Chinese suppliers. Even once I found the exact type of LED strip I needed, I emailed two-dozen suppliers for quotes and data sheets. After sifting through the information, not to mention reviewing the credentials of the manufacturers, I found an excellent supplier who provided exactly what I needed.

Model	YHH-WS2812-30
Working Lifetime	50,000 hours
LED Source	SMD5050
Emitting Color	RGB
LED Quantity	30LEDs/M
IC Quantity	30ICs/M
Input Voltage	DC5V
Power Consumption	9W/M
PCB Size	5000*10*4MM
PCB Color	Black
Waterproof Grade	IP68
Working Temperature	-25℃ to 45℃
Lamp Body Material	Copper
Warranty	2 years

Power Supply: My first power supply had 5V and 2A and was nowhere near powerful enough to drive 400 meters of LED light strip. It could only light about 15 meters. Fortunately, because I would only ever need to light a small segment of the strip at any given time, I did not need to have as large of a power supply as I would have otherwise. However, line loss, or power lost throughout the length of a very long wire, is not negligible which necessitates a surprisingly powerful power supply.

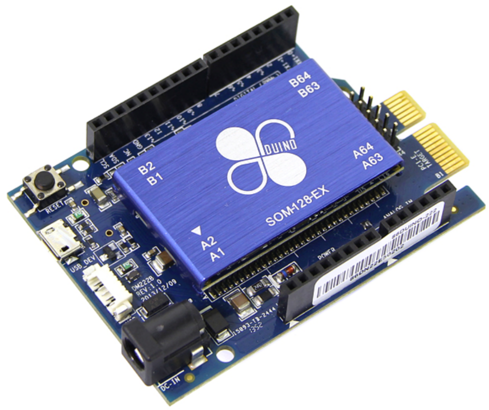
I explored a host of different power options such as employing several 5V 10A power supplies along the length of the light strip. The issue with this option is that there is only one power outlet at the track, so extremely long extensions cords would have to be run across or under the field to reach the far side of the track. The impracticality of using a 100-meter long extension cord was immediately apparent because of the significant line loss, the possibility that athletes would trip on the cord, the potential for mowers on the field to shred it, and the difficulty of alternatively burying it.

Another power option I researched was that of using several external batteries incorporated throughout the strip. The very apparent drawback of this solution is the requirement for the batteries to be routinely removed, recharged, and replaced as well as determining a means to protect them from the elements.

The idea of solar power was, and still is very appealing due to the fact that almost all running tracks are fully exposed to the sun making solar power a very viable option in sunny states such as California. Several companies make portable solar panels intended for powering small devices on backpacking trips. The problem I discovered with using solar power is that it would require a very large number of these portable panels to supply enough power for the lights. The alternative would be to install a larger, permanent solar panel installation similar to those used on homes, however this option is cost prohibitive. I have not ruled out the idea of solar and would like to implement it in the future of this project provided organizations would be willing to financially support it.

The power supply option I decided upon was a Singpad 5V 20A 100-watt power supply designed for driving long LED strips. This power supply was cost effective and advertised for driving long LED strips. The challenges with this power supply were that it is not user friendly, does not have any instructions, and is manufactured by a Chinese company so the quality is questionable.

Microcontrollers: I initially used an Arduino Uno for the microcontroller to control the LED strip, however with its limited Flash memory, it was only able to control up to 8 meters of LED light strip. I researched many options to the problem as well as met with an Electrical Engineering professor, consulted a microcontroller manufacturer, and consulted classmates with experience using microcontrollers. Options included employing two LSD Hypnocube controllers, four Arduino Megas, a single 86Duino, as well as a multitude of others options.



I most wanted an Arduino product because that would eliminate the problem of altering or rewriting the code to be compatible with another type of microcontroller. Many microcontrollers exist with sufficient Flash memory, but they all would require extensive reprogramming of my existing Arduino code because the Arduino libraries that I was using would not work with other types of microcontrollers.

Unfortunately, Arduino does not make a microcontroller with sufficient Flash memory. My Arduino Uno has 32KB of flash memory, which is only enough to control 8 meters of the strip. It is possible to have the Arduino Uno control a longer segment by streamlining the code; however doing so deteriorates the timing precision of the lights.

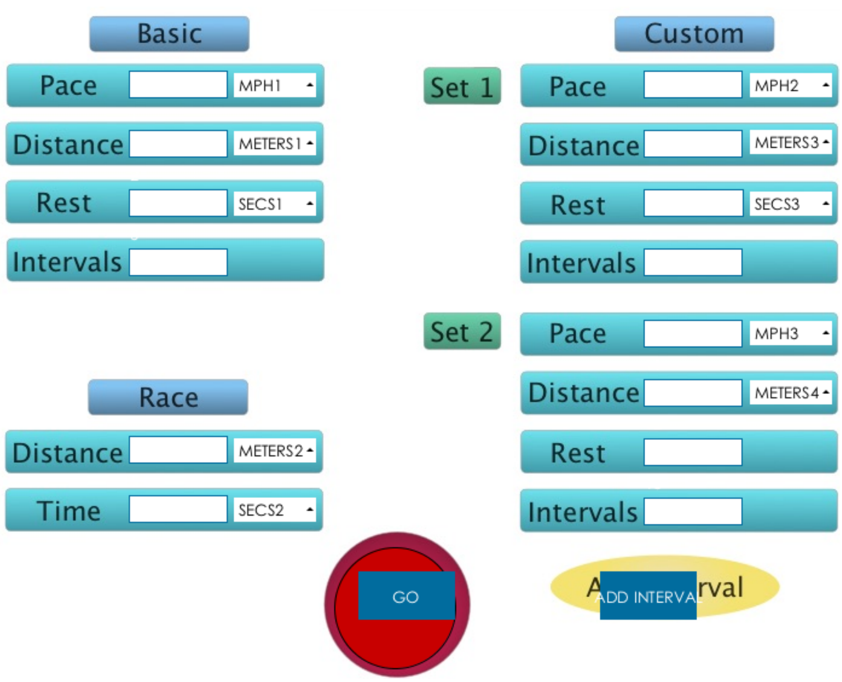
The Arduino Due has 512KB of Flash memory, which would theoretically be able to control just over 100 meters. However, because Arduino Due operates at a different voltage from the LED strip there would be compatibility challenges that would risk damaging the board.

Another solution I researched was to use four Arduino Mega controllers placed at regular intervals around the 400-meter track. The challenge with this solution was that of syncing all four microcontrollers. Bluetooth would not work with any reasonable practicality, because the normal range of Bluetooth is only about 10 meters compared to the almost 100 meter range the track would require. Even with expensive Bluetooth boosters, the software development for syncing four microcontrollers is very complicated and would exceed the timeframe of the project to develop.

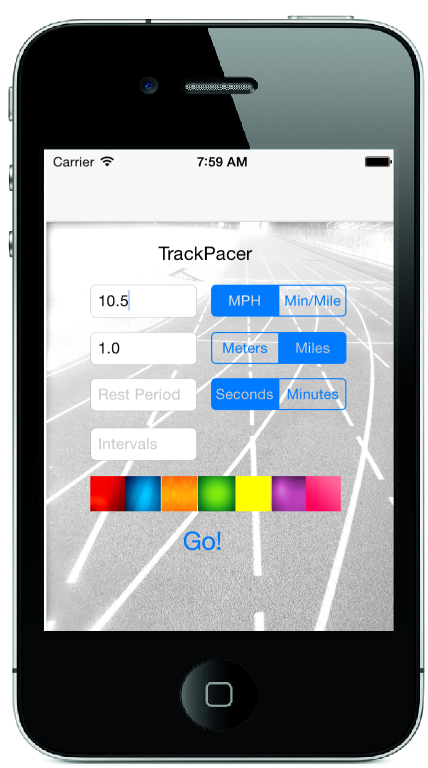
I finally decided upon the 86Duino Zero with its 8MB of Flash memory and "Arduino Compatibility." I anticipated that I would need to troubleshoot coding issues with the 86Duino in order to make my existing Arduino Uno code compatible. My prediction was correct. Despite the reprogramming challenges I am pleased with its capability.

App Development: I first programmed the App's interface in Processing for several months. I was able to create a rudimentary interface but realized the challenges with having it deployed onto a device as well as having it communicate with Arduino. I did establish basic communication between Processing and Arduino so that I was able to blink an LED using the interface made in Processing but struggled to program it to do much else.

I later discovered Apple's Xcode and started the interface development all over again. Xcode offers developers the use of existing buttons and other features common in Apps that would be in keeping with Apple's design style. Xcode synchronizes the interface view with the coding, which streamlines and eliminates sizeable portions of coding. Apps can be developed in Xcode using Swift code, Apple's new programming language, which is the most user-friendly programming language to date. It is accompanied with extensive tutorials and manuals on how to use it. By purchasing an Apple Developer account, I was able to somewhat easily deploy the App I had made onto an actual iPhone. A user could then enter in a pace, distance, and color, and the program would enter the values into equations that would output values that the Arduino code could utilize. For example, a user could enter in 10MPH for pace and the App would recalculate 10MPH in terms of milliseconds per LED and then feed that number into the Arduino code.



Primitive interface in Processing



iPhone interface in Xcode

Channels: I learned that trucks are routinely driven over the track and onto the inside field meaning the channels that would contain the LED strips need to be exceptionally tough. Additionally, the channels would need to be easily removable in segments because a section would need to be removed during steeplechase events. The inside path runners take during steeplechase necessitates the removal of a segment of channeling to prevent runners from possibly tripping over it during a race. The channels I found are completely waterproof and advertised as very durable. However, their ability to withstand trucks and dropped weights needs to be verified.

Timeline

- Purchased LED strip, Arduino controller, and related components – *August*
- Built functioning 1/200th scale prototype of TrackPacer – *August*
- Finalized design and layout of Interface in Sketch – *November*
- Programming interface in Processing – *November-December*
- Streamlined LED design by eliminating need for aluminum channel fabrication by opting for IP68 submersible grade LEDs – *December*
- Established a link between Processing and Arduino – *December*
- Met with electrical engineer Alberto Jimenez – *December*
- Submit patent application – *December 30*
- Switched from Processing to Xcode for interface – *January*
- Ordered, received, and tested sample LED strip #1 – *January*
- Ordered, received, and tested power supply #1 – *January*
- Ordered, received, and tested sample LED strip #2 – *January*
- Ordered 400m of wholesale LED strip through Alibaba – *January*
- Completed functioning interface in Xcode and deployed on iPhone – *February*
- Met with CEO and entrepreneur King Lee and Henry Hernandez–*February 9th*
- Met with Mr. Eckund, Athletic Director at Mission Prep – *February 12th*
- Met with Adam Basch, Head Coach at SLO High – *February 12th*
- Attended District School Board Meeting – *February 13th*
- Presented proposal to Ashley Offermann, Cal Poly Development Director for Athletics, as well as Katie VanMeter – *February 13th*
- Receive LED strips – *February 15*
- Met with Professor Oliver regarding electrical issues – *January 24th*
- Met with Tom Leden, patent lawyer – *February 26th*
- Applied to Innovation Quest – *February 28th*
- Ordered power supply #2 – *March 1st*
- Ordered high performance microcontroller – *March 2nd*
- Received and tested new microcontroller – *March 10th*
- Final Presentation – March 19

Analysis and Verification of Success

My project assessment factors evolved throughout the course of the project due to unforeseen aspects that arose. Earlier in the project, I had the following three assessment factors:

1) Operational 2 meter prototype on felt board with functioning iPhone interface
2) Installation of at least 50 meters on a full size track
3) Present funding proposal for the TrackPacer to CLA Dean for Advancement, Athletic Director of Development, CLA Public Affairs, and directors of the LAES program.

As the project developed I needed to adjust the 2nd assessment factor due to the constraints I discovered with the first microcontroller I had. The period of time it took to assess the problem, research solutions, and order a different microcontroller exceeded the timeframe of this project but will be pursued after graduation. I did largely succeed in meeting the 1st and 3rd criteria listed above. However, I also am adding two more factors I feel are important aspects of this project. The first is successfully obtaining a provisional patent and learning the details of the intellectual property law and existing patents in order to prepare a non-provisional patent in the future. The 2nd is acquiring the tools, knowledge, and confidence to pursue bringing the TrackPacer to life as a business. Below is my revised list of assessment factors.

Assessment Factors:

1) Functioning iPhone interface
2) Prototype to exhibit TrackPacer functions
3) Present funding proposal for the TrackPacer to Athletic Director of Development, CLA Public Affairs, and directors of the LAES program.
4) Obtain provisional patent and determine non-provisional patentability
5) Build necessary skills and confidence to start a business

How to assess factors:

1) Intuitively programmable interface
2) High quality scale model
3) Funding proposal presentation executed professionally and receive feedback that advances the project
4) Receipt of provisional patent and consultation with patent attorney
5) Plans prepared to pursue business after graduation

Gradations of Success:

1) A: The interface is professional in appearance and function, and new users are able to program any workout they can think of.
   C: The interface can do limited things
   F: There is no interface

2) A: There is a professional looking and operating scale model
   C: The model does not look professional or function
   F: There is no model

3) A: Presentation includes professional prototype, a well written funding proposal, a clear PowerPoint and rehearsed presentation that clearly explains the need for the TrackPacer and the concept for its implementation.
   C: Poorly done prototype, mediocre funding proposal, and unrehearsed Presentation
   F: No funding proposal takes place

4) A: Provisional patent obtained and meeting with patent attorney provides valuable information
   C: Only one of the two criteria were met
   F: No provisional patent attempted or meeting with attorney

5) A: Application to Innovation Quest submitted and future business plans made
   C: Some confidence to pursue business but no plans pursued
   F: No plans for the project following graduation

From the gradations of success listed above, I give myself a B+ for the interface. I am proud of what I was able to accomplish given that I had not programmed before, however there are a few more functions I wish I had been able to figure out how incorporate before the end of the project. My interface was professional in appearance and used Apple icons to keep it looking uniform. Users could program almost any desired workout, however, I would like to add a feature that allows the user to change the start point to different locations on the track.

I would give myself an A- for the prototype since it had a clean appearance that clearly demonstrated the concept of the TrackPacer. I also believe that I earned an A- for the project proposal presentation since it included the aforementioned prototype, a well-written funding proposal, as well as a clear PowerPoint that had been critiqued by several people. I had rehearsed my presentation many times in front of my friends until I felt very comfortable explaining my proposal.

I obtained a Provisional patent in January that allows me one year in which to file a non-provisional patent. I also met with patent attorney Tom Lebens, who spent over an hour reviewing similar existing patents with me, explaining the legalities of prior art, infringing claims, and informed me that the TrackPacer was patentable with respect to similar patents. I feel that I earned an A for the patent process.

I have begun to make plans with Viget, a company that assists startups launch. I also applied to Innovation Quest. My next immediate plans are to focus on getting the 400-meter prototype powered successfully and have runners test it out in order to validate the concept prior to investing any more money in the project. I believe I also earned an A developing the connections and plans to further the business.

Societal Impacts

The TrackPacer will benefit the competitive running population by being the first product to introduce pacing technology directly onto running tracks. The TrackPacer enhances and encourages fitness, and helps athletes hit prescribed paces for workouts. The TrackPacer can make running on the track fun for recreational runners and thereby promote fitness. Runners who enjoy the precision of treadmill workouts will be encouraged to run outside instead if they can know their precise pacing and distance. The TrackPacer could also increase the number of spectators at track events because the real-time race feedback, similar to virtual graphic overlays on televised Olympic swim and track races, engage the audience.

The pacing system uses energy-saving LED lights that are rated to 60,000 hours of continuous use. The installation of the TrackPacer would be non-intrusive and would not require any chemical agents to bond to a running surface. It is completely waterproof and would resist weather damage, meaning it could be left on the track year round without worrying about replacing it.

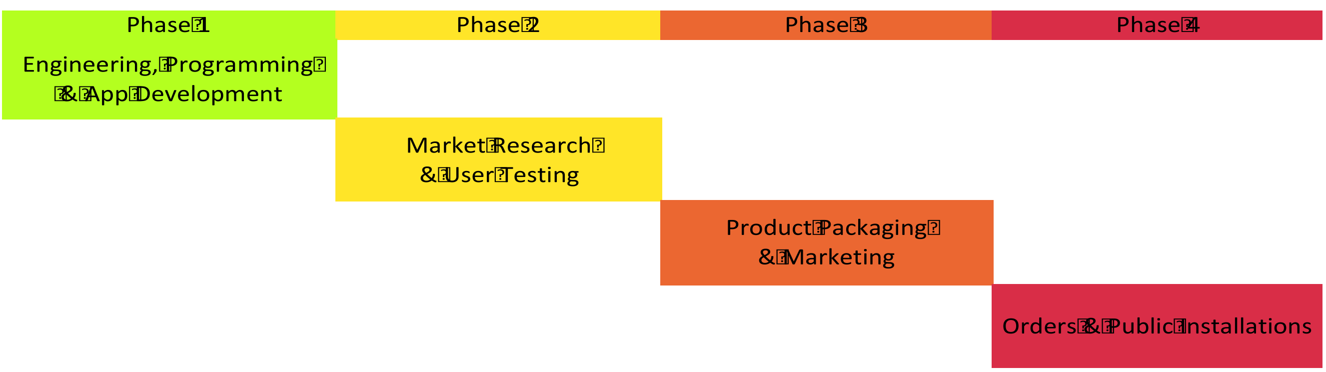
Future Work

After a full size TrackPacer is successfully developed, I aim to install it on the running track of a high school or university. I have verified a need for the TrackPacer from my interviews with track coaches and athletes. The next step I am considering is partnering with a company, Viget, that specializes in assisting startups get to market. They have programmers, graphic designers, hardware specialists, and marketing experts available to assist with any aspect of a project. It is a step between trying to do every aspect of the business myself and hiring employees. They specialize in the early stages of business development and would bring a lot of needed experience to the project. I have selected Viget because of their vested interest in the success of my business because they do not get paid until the TrackPacer turns a profit. The table below shows the cost estimate for installing a TrackPacer on a collegiate track.

Component	Cost
400 meters of LED strips	$2,620.00
Electrical & Microprocessors	$1,190.00
Aluminum Channeling	$3,560.00
Installation & Maintenance	$3,000.00
Total	$10,370.00

I plan to personally install the first few TrackPacer systems, but will eventually sell a packaged system that could be installed by the customer. This would make the TrackPacer scalable and repeatable across any running track in the world.

I've broken the TrackPacer project into the four phases shown below. The scope of this senior project spanned phases 1 and 2 and I intend to execute phases 3 and 4 in the coming years. The next immediate steps I am taking will be to file for a non-provisional patent and partner with Viget to take the project to the next level.



Conclusion

The TrackPacer would be a wonderful asset to competitive and recreational runners who struggle to maintain a desired pace. The LED light rope will enhance their training and performance. The TrackPacer could be installed on any track in the world for recreational or competitive training at a small fraction of the cost to install a track itself, making it a very affordable addition.

I have learned a tremendous amount from completing this project; from giving project proposals, attending school board budget meetings, meeting with electrical engineers, entrepreneurs, and a patent attorney. I've learned the basics of programming in three different languages, a lot about LED light strips and how to program them, and successfully made an iPhone App. I've also gained knowledge about intellectual property laws, how to navigate imports from China, as well as gained a more in depth understanding of electricity and power supply. The project was tremendously rewarding and I am excited to take it to the next level.

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Appendix: Funding Proposal

XX/XX/2015

[Name of Who it Concerns]
Director of Development for Athletics
[University Name]

RE: TrackPacer for [University Name]

Dear [Name of Who it Concerns],

I've developed a system that gives runners real-time pace feedback after exploring the need for runners to be able to accurately pace themselves on the track without having to check a watch or mentally calculate splits. The TrackPacer consists of an LED light rope that is installed around the inner perimeter of the track that can be programed to sequentially light up at a predetermined rate, giving the runner a light to chase. The TrackPacer is advantageous in several ways:

1) Runners, even sprinters, can hit their splits without a watch
2) Psychological benefit of having a tangible time to chase
3) Increase the popularity of track events for spectators

Our proposal offers Cal Poly the opportunity to be the first school to incorporate this training technology into its track. Our proposal asks for financing for the fabrication and installation of the first TrackPacer at a cost of $10,370.

We very much appreciate your consideration and assistance for the development of the TrackPacer for the benefit of Cal Poly's athletes. Please give me a call at 314-313-5065 if you would like any further information concerning this proposal.

Thank you,
Alexandra Kline
TrackPacer Project Manager
2915 Johnson Ave
San Luis Obispo, CA 93410

The TrackPacer: Improving Runner Performance

Submitted to: Cal Poly Development for Athletics

Date: February 13, 2015

Alexandra Kline
TrackPacer Project Manager
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e-mail: amkline26@gmail.com
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San Luis Obispo, CA 93410

ABSTRACT

The TrackPacer project is seeking funding for its very first installation with the goal of making Cal Poly the first ever school to offer its athletes real-time pacing feedback to improve athletic performance. The TrackPacer would help Cal Poly gain recognition for promoting athletic excellence, reinforce its motto of 'Learn By Doing,' as well as increase the spectator appeal of track events. The TrackPacer was developed based on the need for accurate pacing as requested by Cal Poly athletes as well as the overwhelming spectator response to the virtual world record line real-time overlays on television during Olympic swimming and track events. The amount of $10,370 is needed for the TrackPacer components and installation.

1. NEED FOR THE PROJECT

Competitive and recreational runners, cyclists, and swimmers struggle to maintain a target pace during workouts and currently have no easy-to-see visual feedback on their pace. Lack of real-time, easy-to-see pace feedback makes it difficult for athletes to maintain a target pace and thus makes their workouts less effective. Some GPS watches do provide pacing feedback, but they are impossible to read while running hard.

The TrackPacer LED light strip indicates to the athlete whether he is maintaining his target pace. Additionally, the TrackPacer adds the psychological element of having an opponent to compete with, making workouts more effective. The LED light strip indicator is better than existing methods because it eliminates monitoring a watch or worn device and permits even a sprinter to determine whether he is maintaining target pace.

The TrackPacer is superior to sports watches due to its convenient, easily viewed placement on the inner perimeter of a track.

2. DESCRIPTION OF THE PROJECT

The LED light strip contains closely spaced LED lights that sequentially light up at a given rate input by the user. The user can input their desired pace into the TrackPacer application that can be downloaded onto their phone. The application on the user's phone is connected by Bluetooth to an Arduino microcontroller that sends electronic signals to the light strip. The sequentially lighting LEDs appear as a traveling light throughout the TrackPacer for the athlete to chase. The TrackPacer application's interface will allow the user to preset their desired pace for each lap in either miles/hour, time (i.e. a meet or world record time) for a given race distance, or sec/lap

or min/miles. For example, a user could enter in that they want to run four laps at 75 seconds per lap. Once the user has set their pace, they would then push a "GO" button. Once the "GO" button is pushed, the application's interface visually and audibly counts down 5 – 4 – 3 – 2 – 1 - GO at which point the user knows to begin running.

This invention is an improvement on what currently exists. Currently, an athlete can only check if they are on pace once a lap by using a watch to check splits. However, watches cannot show if an athlete is falling behind or getting ahead during the lap. The TrackPacer provides a continuous indicator of pace during the entirety of the lap. Essentially, it provides continuous feedback, on every point of the track rather than once or twice a lap.

This LED light eliminates the trouble of mentally calculating splits, and gives the athlete a more reliable training method. Its convenient, easily viewed placement on the inner perimeter of a track provides instant feedback without a need for the athlete to make any mental calculations. Worn devices hinder performance due to their weight, added drag, and difficulty of reading whilst moving.

3. GOALS & OBJECTIVES

The goal of the TrackPacer is to enhance athletic training and performance for Cal Poly athletes. It is proven that athletes are best motivated when there is something tangible to chase and beat, such as another runner. It would be almost impossible for a runner to defeat a record on their own without competitors as in a race. However, the TrackPacer psychologically replaces opponents on the track and provides athletes with something to visibly chase during training, which makes workouts more effective.

Another goal of the TrackPacer is to improve the appeal of Track events to an audience. Track events lack the number of spectators of other sports such as football, basketball and soccer. Consequently track athletes do not have the availability of athletic scholarships enjoyed by athletes of more popular sports.

Orad Videographics revolutionized television viewership of Olympic sports such as Track and Field as well as swimming with its introduction of superimposed graphics. Prior to superimposed world record lines, these sports lacked a large following. The superimposed world record line engaged spectators in a captivating way that has spiked the popularity of these sports. The objective of the TrackPacer is to do the same, but for a live audience. The TrackPacer also aims to provide useful real-time feedback to the athletes themselves as well as psychological incentive to break intangible records when there are no live opponents challenging a leading runner.

Another goal of the TrackPacer is to draw people off the treadmill and outside onto the track. Many people are motivated by achieving very set goals, such as running for 30 minutes at 7 MPH. People use a treadmill instead of the track because it is difficult to maintain a specific speed because the track does not force you to run a particular speed in the way that a treadmill does. Various studies have shown that running outdoors is much healthier than on a treadmill. If the TrackPacer can offer the pacing precision of a treadmill, runners will be encouraged to get outside onto the track instead.

4. BUDGET

400 meters of LED strips	$2,620
Electrical Components & Microprocessors	$1,190
Aluminum Channeling	$3,560
Installation & Maintenance	$3,000
Total	$10,370

5. ABOUT THE STAFF

Alexandra Kline is a 5th year Liberal Arts & Engineering student at Cal Poly. She is responsible for networking and finding market opportunities, researching and purchasing components, programming the iOS application, navigating the patent process, programming the Arduino, and trouble shooting technical issues.