

Sprinter Data



Team Introductions



Dylan Cedeno
Project Manager
Presenter



Marc Griffiths
Design Engineer
Presenter



Jordan Noyes
Quality Engineer



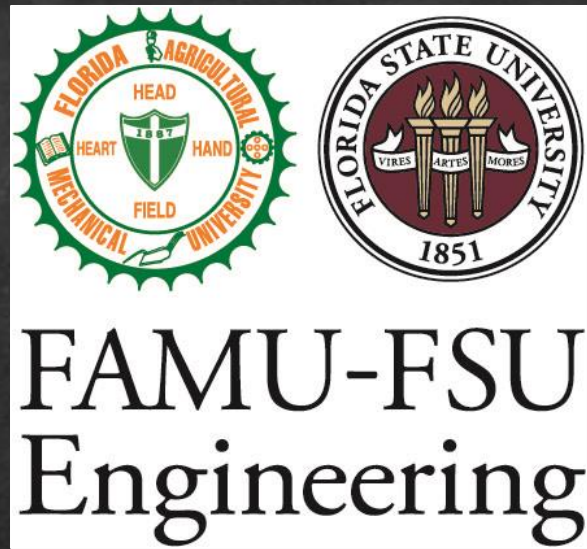
Handy A Pierre
Research Engineer



Edwin Ulysse
Data Engineer
Presenter

Dylan Cedeno

Sponsor and Advisor



Sponsor

FAMU-FSU College of Engineering
Academic Institution



Academic Advisor

Jonathon Clark, Ph.D.
Associate Professor

Dylan Cedeno

Summarizing VDR1

Dylan Cedenno



Objective



The objective of this project is to objectively measure and predict a sprinter's performance.

Dylan Cedeno

Assumptions

- ✦ Range of Sprinter heights from 5'6" to 6'4"
- ✦ User has prior experience with sprinting
- ✦ Starting with a standard starting block
- ✦ Used in fair weather
- ✦ Will not have access to a power outlet
- ✦ Used on a collegiate approved track
- ✦ Consumer is more concerned about accuracy than price

Dylan Cedeno



Markets

Collegiate Track Teams

Highschool Track Teams

Fans/Parents

Professional Running
Teams

Masters Sprinters

Other Sports

Dylan Cedeno

Key Goals

A product that will be desirable for purchase

- ✎ Cost effective
- ✎ Self-contained
- ✎ Minimal hinderance to performance

Predict a sprinter's performance

- ✎ Personalized inputs
- ✎ Creating trends based on inputs

Objectively measure a sprinter's performance

- ✎ Takeoff form
- ✎ Instantaneous velocity

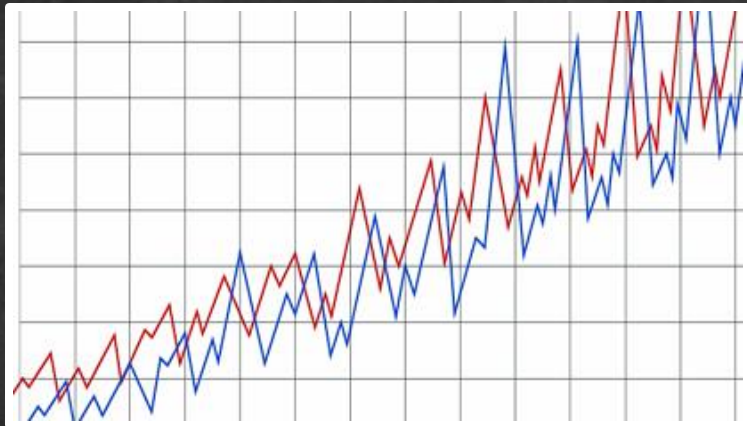
Dylan Cedeno

Targets and Metrics

Edwin Ulysse



Create Trends



Metric: Time it takes to output relationships between measurements

Target: Within 15 seconds of request time

Edwin Ulysse

Store Data

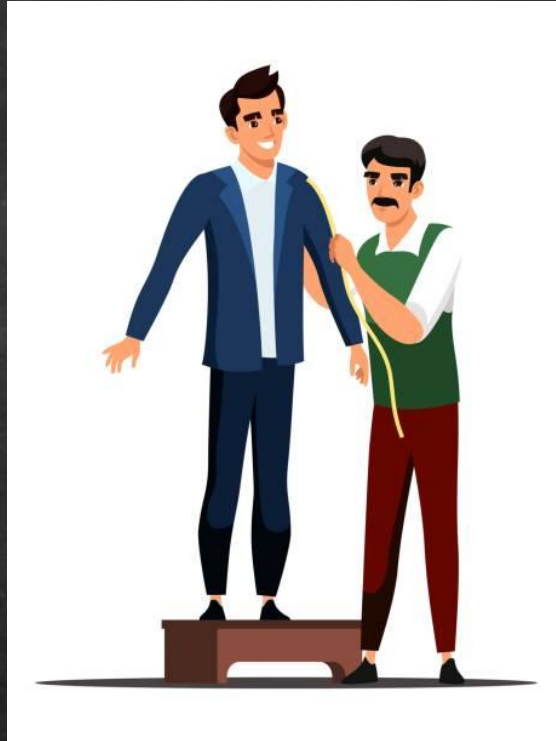


Metric: Compression and frame rate of videos recorded & Amount of storage taken by data collected

Target: 720 pixels at 60 frames per second & Maximum of 10 megabytes per trial

Edwin Ulysse

Retrieve Personalized Inputs



Metric: Time it takes to store the inputs of the athlete being measured, given by the athlete

Target: Inputs stored in under 5 seconds

Edwin Ulysse

Make Product Cost Effective



Metric: Desired purchase price

Target:

Keep purchase price under \$15,000

Edwin Ulysse

Product has Low Hinderance on Performance



Metric: If a wearable is used, the weight it must stay under

Target: Wearable must weigh less than 1 kilogram (~2 pounds)

Edwin Ulysse

Product Exposes User's Weaknesses



Metric: Percent difference between measurements of the user and the compared professional that is pointed out as a potential weakness

Target: A measurement greater than 5% difference from professional is a potential weakness

Edwin Ulysse

Tool Incorporates Professional Sprinters



Metric: Number of professional athletes the technology needs to store statistics for

Target: At least 5 different professionals

Edwin Ulysse

Technology Needs to Be Able to Be Used Daily for About Two Hours at a Time



Metric: The battery life needed for the technology to hold between charges

Target: A battery life of at least 3 hours

Take Measurements



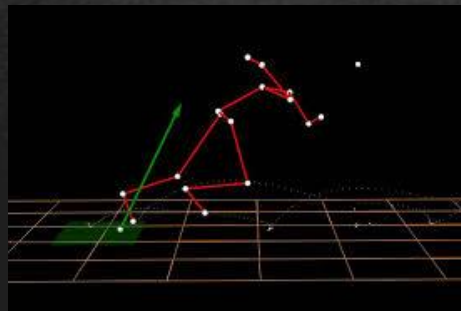
Gauge Line of Attack



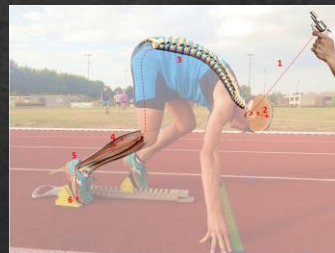
Measure Stride Length



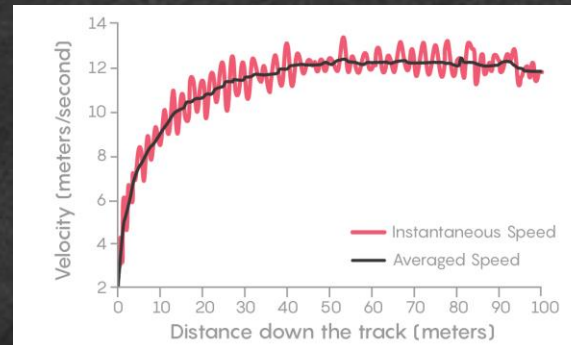
Observe Second Step



Calculate Impulse from the Block



Record Starter Gun Reaction Time



Track Instantaneous Velocity

Metric: Accuracy of measurement

Target: Accurate within 2%

Edwin Ulysse

Concept Generation

Marc Griffiths



Tension Cord Training Mechanism

Functions

☞ Gauge the line of attack

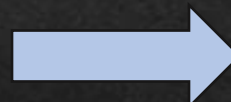
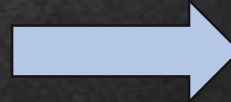
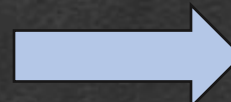
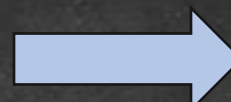
☞ Instantaneous velocity

☞ Product has low hinderance on performance

☞ Collect data

☞ Create trends

☞ Make the product cost effective



Solutions

☞ Take a video

☞ Tension cord and encoder

☞ Lightweight tension cord

☞ Server

☞ Line graphs

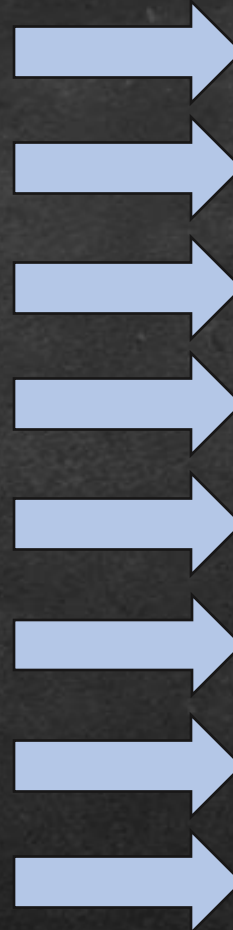
☞ Compare to other markets & lay-away

Marc Griffiths

All Inclusive Technology

Functions

- ✎ Instantaneous velocity
- ✎ Gauge line of attack
- ✎ Starter gun reaction time & kickoff force from the blocks
- ✎ Collect data & create trends
- ✎ Store data
- ✎ Make the product cost effective
- ✎ Product is self-contained
- ✎ Product has low hinderance on performance

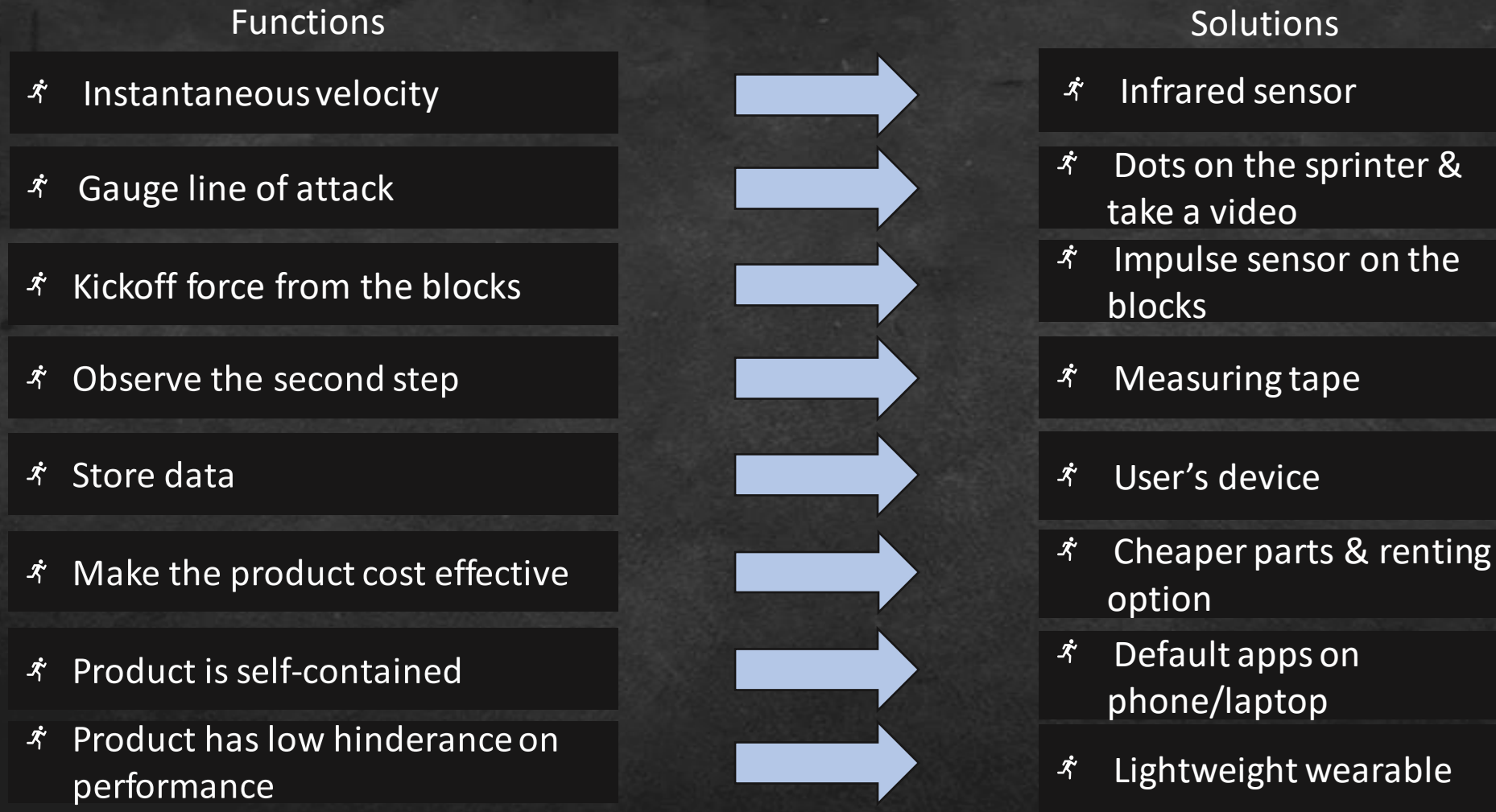


Solutions

- ✎ Laser sensor
- ✎ Dots on the sprinter
- ✎ Force sensor on the blocks
- ✎ Personalized inputs & line graphs
- ✎ Compressed folder
- ✎ Cheaper parts & renting option
- ✎ All parts included
- ✎ No wearable

Marc Griffiths

Launch Monitor Pro



Marc Griffiths

Concept Selection



House of Quality



Marc Griffiths

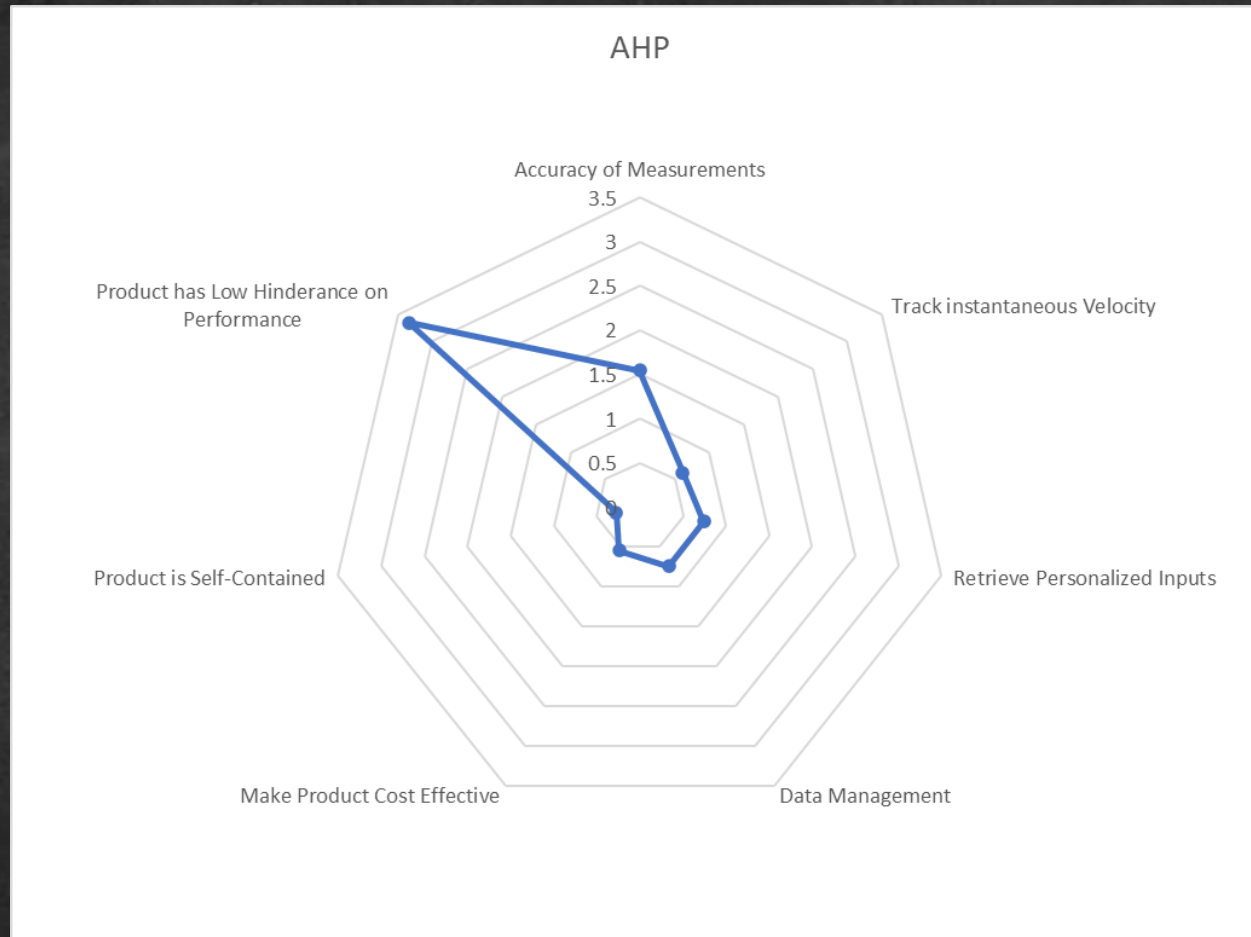
Pugh Chart

Pugh Chart 3				
Selection Criteria	4	6	7	8
Gauge Line of Attack	DATUM	-	S	S
Observe Second Step		S	S	S
Calculate Kickoff Force from the Block		S	S	S
Record Starter Gun Reaction Time		S	+	+
Track Instantaneous Velocity		-	S	S
Retrieve Personalized Inputs		+	S	S
Collect Data		S	S	S
Store Data		S	-	-
Create Trends		-	S	-
Make Product Cost Effective		+	+	-
Product is Self-Contained		S	S	S
Product has Low Hinderance on Performance		-	S	S
# of pluses		2	2	1
# of Minuses		4	1	3

Marc Griffiths



AHP



Marc Griffiths

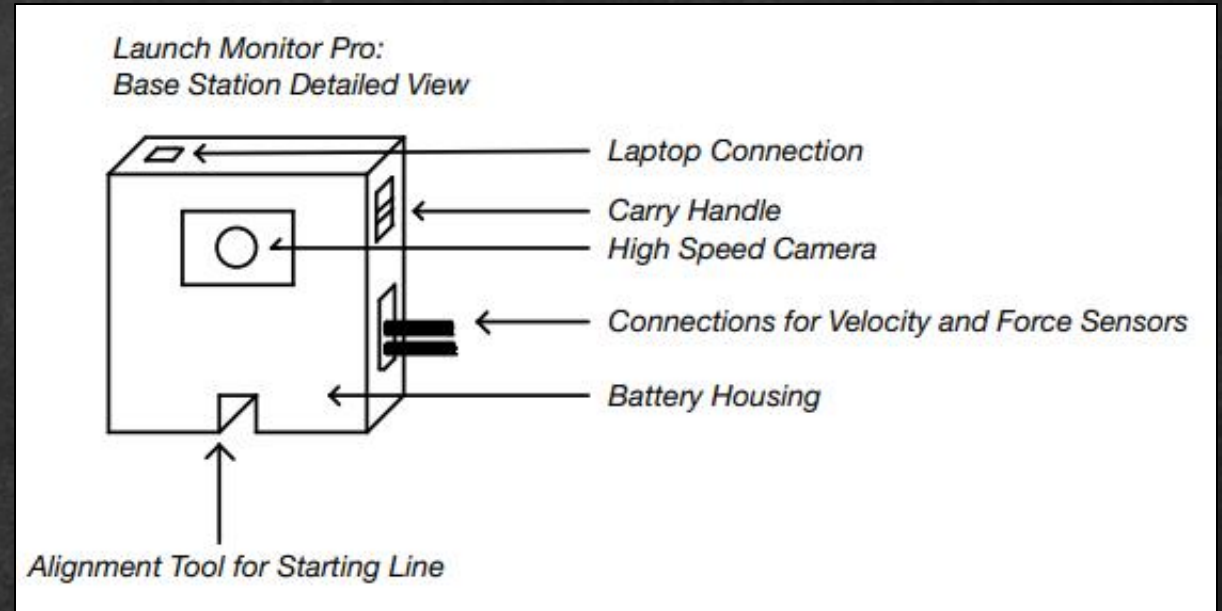
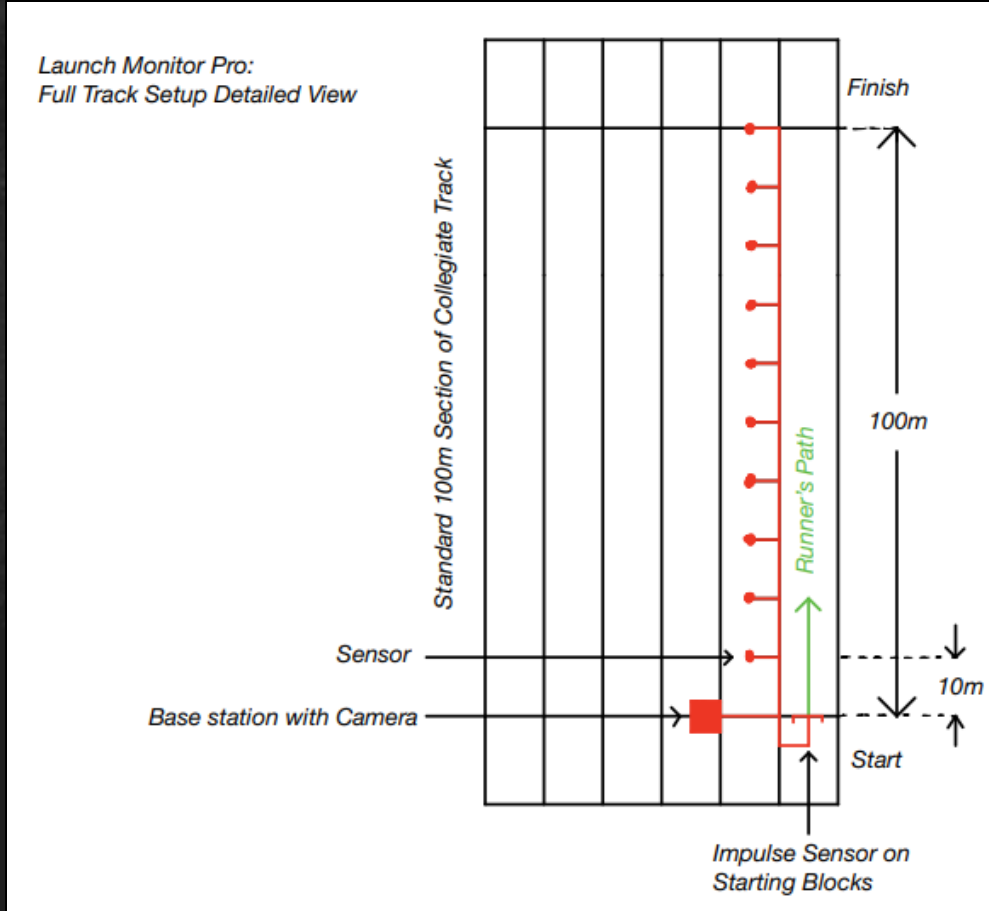
Final Concept

Dylan Cedeno

Dylan Cedeno

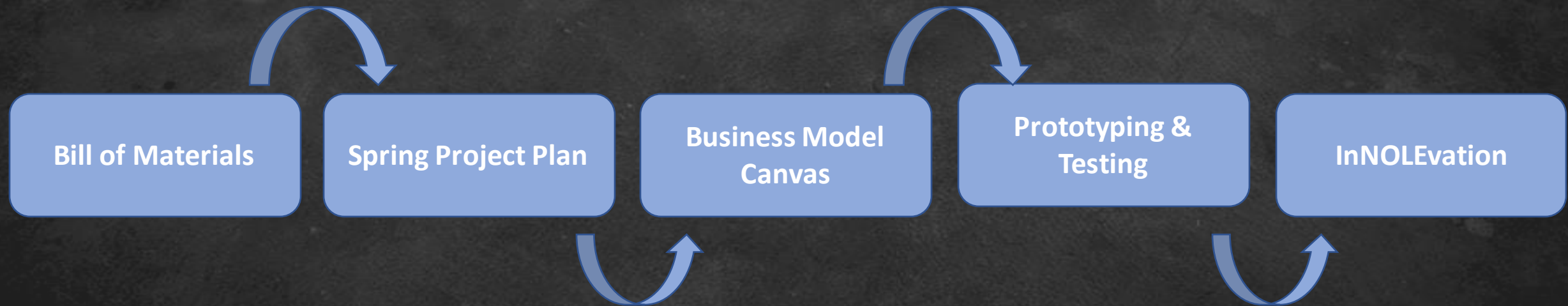


Launch Monitor Pro



Dylan Cedeno

Next Steps...



Dylan Cedeno

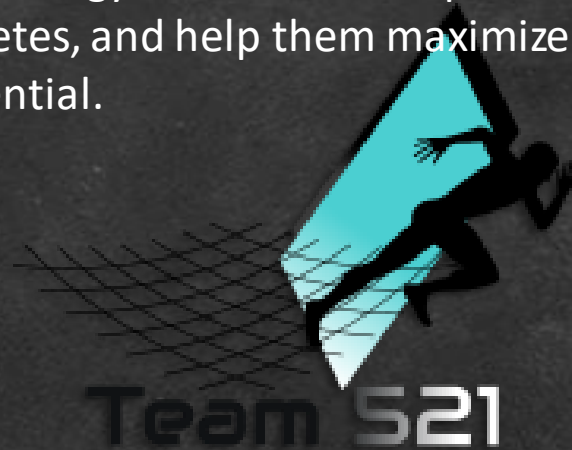
References

<https://simplifaster.com/articles/contact-length-sprinting-speed/>
<https://simplifaster.com/articles/sprinting-in-team-sport-the-butt-kicking-epidemic/>
<https://www.bbc.co.uk/sport/athletics/40779741>
<http://www.johk.pl/files/10078-56-2017-v56-2017-03.pdf>
<https://www.basvanhooren.com/is-it-possible-to-react-faster-than-100-ms-in-a-sprint-start/>
<https://www.investopedia.com/terms/t/trendanalysis.asp>
<https://www.quantamagazine.org/infinite-powers-usain-bolt-and-the-art-of-calculus-20190403/>
<https://uxdesign.cc/how-personalized-design-is-different-from-traditional-design-430e9f8df753?gi=764be137ce0f>
<https://www.dataversity.net/what-is-data-storage/>
<https://blog.edisonnation.com/2015/08/inventing-101-making-your-idea-cost-effective/>
<https://morioh.com/p/46a28dc89a97>
<https://mbe.group/what-are-your-strengths-and-weaknesses/>
<https://www.dailymail.co.uk/sciencetech/article-2885530/The-secret-world-s-greatest-sprinters-revealed-Researchers-Jamaican-athletes-symmetrical-KNEES.html>
<https://www.businessmobiles.com/dark-mode-damaging-eyes/battery-life/>



Thank You for Listening!

Mission Statement: Our mission is to utilize technology to enhance the performance of athletes, and help them maximize their full potential.



Backup Slides



Functions Backup



Hierarchy Flow Chart



Targets and Metrics Backup



Target Catalog

Function/Need	Metric	Target
*Gauge Line of Attack	Accuracy of measuring the angle at the ankle, knee, hip, shoulder	Accurate within 2%
*Observe Second Step	Accuracy of measuring the height off the ground from the blocks	Accurate within 2%
*Measure Stride Length	Accuracy of measuring the length from the second step to the third step	Accurate within 2%
*Calculate Impulse from the Block	Accuracy of calculating the force off the block, with respect to time	Accurate within 2%
*Record Starter Gun Reaction Time	Accuracy of recording the time from the starter gun sound to impulse rise	Accurate within 2%
*Track Instantaneous Velocity	Accuracy of tracking the velocity at every 5 meters	Accurate within 2%
Create Trends	Time it takes to output relationships between measurements	Within 15 seconds of request time
Store Data	Compression and frame rate of videos recorded	720 pixels at 60 frames per second
	Amount of storage taken by data collected	Maximum of 10 megabytes per trial
Retrieve Personalized Inputs	Time it takes to store the inputs of the athlete being measured, given by the athlete	Inputs stored in under 5 seconds
Make Product Cost Effective	Desired cost to keep the purchase price under	Keep purchase price under \$15,000
Product Is Self-Contained	Additional purchase necessary outside of product	\$0.00 spent outside of product purchase
*Product has Low Hinderance on Performance	If a wearable is used, the weight it must stay under	Wearable must weigh less than 1 kilogram (~2 pounds)
The tool incorporates professional sprinters and eases the effort required for sprinter comparisons	Number of professional athletes the technology needs to store statistics for	At least 5 different professionals
The analysis from the product exposes users' fundamental weaknesses	Percent difference between measurements of the user and the compared professional that is pointed out as a potential weakness	A measurement greater than 5% difference from professional is a potential weakness
*The technology needs to be able to be used daily for about two hours at a time	The battery life needed for the technology to hold between charges	A battery life of at least 3 hours

Concept Generation Backup



Morphological Chart					
Functions	Potential Solutions				
Gauge Line of Attack	Record a video	Take a picture	Have dots on the sprinter as a reference	Have a line on the sprinter as a reference	
Observe Second Step	Sprinter has a tape measure on their foot	Recording a video	Sprinter runs next to a ruler	Having a laser sensor on the sprinter's foot	Having a string temporarily attached to the sprinter's foot
Calculate Kickoff Force from the Block	Place a force sensor on block	Incorporating a scale under blocks	Using a variation of the individual's body to determine the impulse	Using a spring that would retain compression form force	
Record Starter Gun Reaction Time	Using the starting of the gun with respect to the impulse	Record the audio of the starter gun	Using a high-speed camera to determine when the gun is fired	Using a timer	Slowing down video
Track instantaneous Velocity	Using a video	Having a laser sensor on the sprinter's foot	Using a string attached to a motor and encoder	Using a infrared sensor on the track	Using a radar gun
Retrieve Personalized Inputs	User input	Measured	Creation of a user interface		
Collect Data	Researching sprinter's record	Accepting user input			
Store Data	Placed in a compressed folder	Store in a spreadsheet	Writing the information down	Using a server	Placing in a third-party application?
Create Trends	Makes a line graph	Creates a pivot table	Uses error bars	Creates a bar graph	Make comparisons to other athletes
Make Product Cost Effective	Comparable to markets	Using cheaper parts	Has a lay-away system	Having a subscription option	Having a renting option
Product is Self-Contained	Within one app/ software	Comes with all parts included	Use of default applications	Able to fit in a trunk	
Product has Low Hinderance on Performance	Embedded in uniform	Does not use a wearable	Technology in the shoe(s)	Lightweight	

Crap Shoot

People	Common Activities	Potential Resources
Sprinters	Sprinting	Video
Coach	Competing	Sensors
Scout	Training	Stopwatch
Parents	Performing	Sprinter blocks
Fans	Exercising	Wearable
Athletes	Supporting	Software/ application



Concept 2: Dots and Infrared

Functions

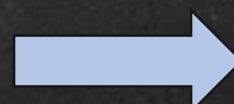
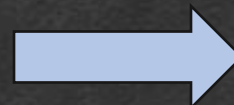
Instantaneous velocity

Starter Gun Reaction Time

Kickoff force from the blocks

Incorporate professionals for comparison

Make the product cost efficient



Solutions

Infrared Sensors

Take a video

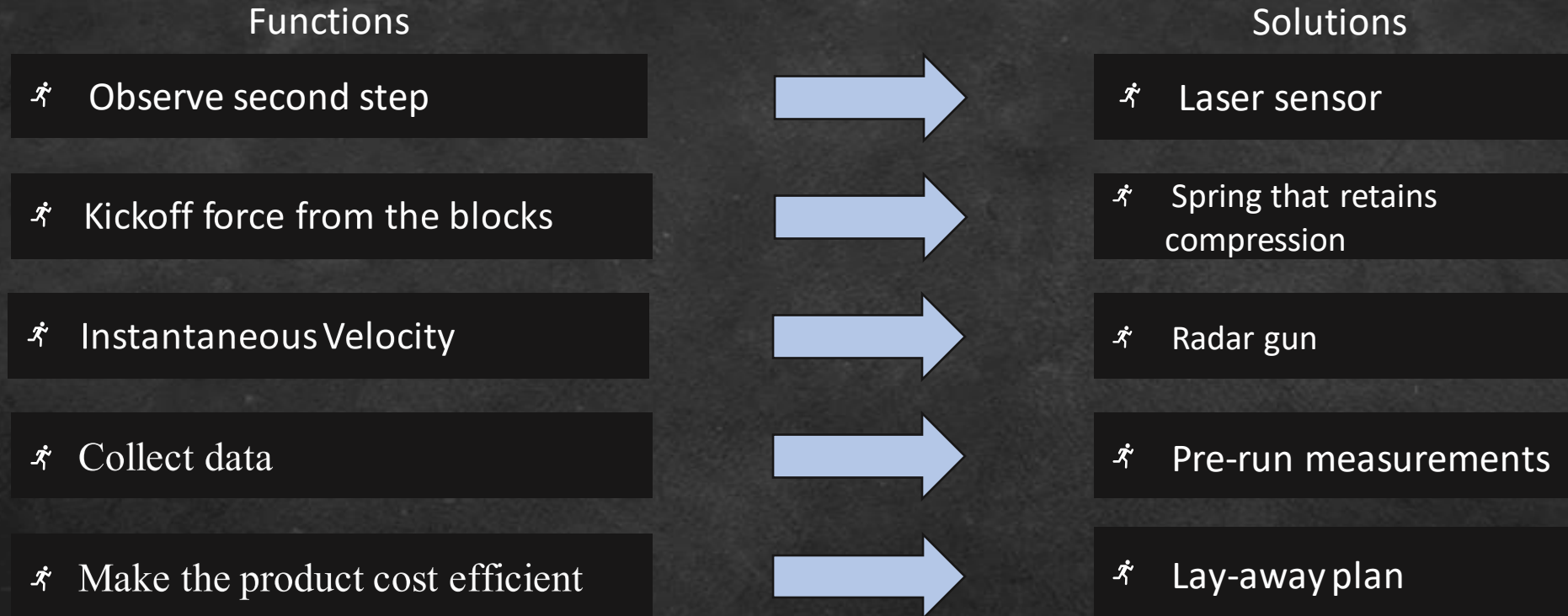
Impulse sensor

Store Data

Subscription plan

Marc Griffiths

Concept 3: Lasers, Springs, and Radar Guns



Marc Griffiths

Concept 4: Lasers, Dots, and Sensors with Professionals



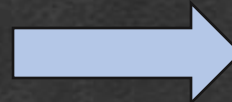
Marc Griffiths

Concept 5: Machine Learning Prediction

Functions

🏃 Create Trends

🏃 Collect Data



Solution

🏃 Machine Learning

🏃 Dots on the sprinter & take a video

Marc Griffiths

Concept Selection Backup



Table 1: House of Quality

Engineering Characteristics							
	Units	N/A	Seconds	Megabytes	\$	Pounds	
Customer Requirements	Importance	Weight Factor	Accurate within 2%	Processing Time	Data Size	Price	Low Weight
Gauge Line of Attack	3		5				
Observe Second Step	3		5				
Measure Stride Length	3		5				
Calculate Impulse from the block	3		5				
Record Starter Gun Reaction Time	3		5				
Track Instantaneous Velocity	3		5				
Create Trends	2			5			
Store Data	2			1	7		
Retrieve Personalized Inputs	2			5			
Cost Effective	3					9	
Self-Contained	1						
Low Hinderance on Performance	5						7
Daily use without external power	3						
Raw Score	222		90	22	14	27	35
Relative Weight			0.4054	0.0991	0.0631	0.1216	0.1577

Table 2: Pugh Chart 1

Selection Criteria	1080 Sprint	1	2	3	4	5	6	7	8	
Gauge Line of Attack	DATUM	+	+	+	+	+	S	+	+	
Observe Second Step		S	-	+	S	+	S	+	+	
Calculate Kickoff Force from the Block		S	+	+	+	+	S	+	S	
Record Starter Gun Reaction Time		+	+	+	+	+	+	+	+	
Track Instantaneous Velocity		S	-	S	+	-	S	+	-	
Retrieve Personalized Inputs		+	S	+	+	+	+	+	+	
Collect Data		S	-	-	-	+	S	+	+	
Store Data		+	+	+	+	+	S	+	+	
Create Trends		+	+	+	+	+	S	+	+	
Make Product Cost Effective		+	-	-	-	+	S	+	-	
Product is Self-Contained		+	-	-	-	+	S	-	-	
Product has Low Hinderance on Performance		+	+	+	+	+	S	+	-	
# of pluses			8	6	8	8	11	2	11	7
# of Minuses			0	5	3	3	2	0	1	4

Table 3: Pugh Chart 2

Selection Criteria	8	1	3	4	5	6	7
Gauge Line of Attack		S	-	S	S	-	S
Observe Second Step		S	-	-	S	-	S
Calculate Kickoff Force from the Block		S	-	S	-	-	S
Record Starter Gun Reaction Time		S	-	S	-	-	S
Track Instantaneous Velocity		-	-	-	-	-	-
Retrieve Personalized Inputs		S	-	-	-	+	S
Collect Data	DATUM	S	S	S	S	S	S
Store Data		S	-	+	S	+	S
Create Trends		-	-	+	S	S	+
Make Product Cost Effective		+	+	S	S	S	+
Product is Self-Contained		S	S	S	S	S	S
Product has Low Hinderance on Performance		-	-	S	S	-	S
# of pluses		1	1	2	0	2	2
# of Minuses		2	9	3	4	6	1

Table 4: Pugh Chart 3

Selection Criteria	4	6	7	8
Gauge Line of Attack		-	S	S
Observe Second Step		S	S	S
Calculate Kickoff Force from the Block		S	S	S
Record Starter Gun Reaction Time		S	+	+
Track Instantaneous Velocity		-	S	S
Retrieve Personalized Inputs		+	S	S
Collect Data		S	S	S
Store Data		S	-	-
Create Trends		-	S	-
Make Product Cost Effective		+	+	-
Product is Self-Contained		S	S	S
Product has Low Hinderance on Performance		-	S	S
# of pluses		2	2	1
# of Minuses		4	1	3

DATUM



AHP Criteria								
	Accuracy of Measurements	Track instantaneous Velocity	Retrieve Personalized Inputs	Data Management	Make Product Cost Effective	Product is Self-Contained	Product has Low Hinderance on Performance	
Accuracy of Measurements	1	3	5	1	3	5		0.2
Track instantaneous Velocity	0.333333333	1	1	1	1	3		0.2
Retrieve Personalized Inputs	0.20	1.00	1	1	3	3		0.2
Data Management	1.00	1.00	1.00	1	1	3		0.2
Make Product Cost Effective	0.33	1.00	0.33	1.00	1	3		0.2
Product is Self-Contained	0.20	0.33	0.33	0.33	0.33	1		0.2
Product has Low Hinderance on Performance	5.00	5.00	5.00	5	5.00	5.00		1
SUM	8.066666667	12.33333333	13.66666667	10.33333333	14.33333333	23		2.2



Normalization

	Accuracy of Measurements	Track instantaneous Velocity	Retrieve Personalized Inputs	Data Management	Make Product Cost Effective	Product is Self-Contained	Product has Low Hinderance on Performance	Average	WeightedSum	Criteria	Consistency	λ	RI	CI	CR
Accuracy of Measurements	0.124	0.243	0.366	0.097	0.209	0.217	0.091	0.192	1.544	0.192	8.023	7.602	1.35	0.100	0.074
Track instantaneous Velocity	0.041	0.081	0.073	0.097	0.070	0.130	0.091	0.083	0.617	0.083	7.400				
Retrieve Personalized Inputs	0.025	0.081	0.073	0.097	0.209	0.130	0.091	0.101	0.744	0.101	7.371				
Data Management	0.124	0.081	0.073	0.097	0.070	0.130	0.091	0.095	0.745	0.095	7.830				
Make Product Cost Effective	0.041	0.081	0.024	0.097	0.070	0.130	0.091	0.076	0.549	0.076	7.194				
Product is Self-Contained	0.025	0.027	0.024	0.032	0.023	0.043	0.091	0.038	0.278	0.038	7.309				
Product has Low Hinderance on Performance	0.620	0.405	0.366	0.484	0.349	0.217	0.455	0.414	3.345	0.414	8.087				

[Normalization]

Accuracy Comparison

Concept 4: Lasers, Dots, and Sensors with Professionals

Concept 6: Tension Cord Training Mechanism

Concept 7: All Inclusive Technology

Concept 8: Launch Monitor Pro

Concept 4: Lasers, Dots, and Sensors with Professionals

1

0.333333333

1

3

Concept 6: Tension Cord Training Mechanism

3.00

1

0.333333333

3

Concept 7: All Inclusive Technology

1

3.00

1

0.333333333

Concept 8: Launch Monitor Pro

0.333333333

0.333333333

3

1

Sum

5.333333333

4.666666667

5.333333333

7.333333333



Normalized Accuracy Comparison

	Concept 4: Lasers, Dots, and Sensors with Professionals	Concept 6: Tension Cord Training Mechanism	Concept 7: All Inclusive Technology	Concept 8: Launch Monitor Pro	Average	Weighted Sum	Criteria	Consistency	Lambda	RI	CI	CR
Concept 4: Lasers, Dots, and Sensors with Professionals	0.188	0.071	0.188	0.409	0.214	1.208	0.214	5.650	5.563	0.890	0.521	0.585
Concept 6: Tension Cord Training Mechanism	0.563	0.214	0.063	0.409	0.312	1.667	0.312	5.341				
Concept 7: All Inclusive Technology	0.188	0.643	0.188	0.045	0.266	1.485	0.266	5.588				
Concept 8: Launch Monitor Pro	0.063	0.071	0.563	0.136	0.208	1.181	0.208	5.673				



Cost Comparison

	Concept 4: Lasers, Dots, and Sensors with Professionals	Concept 6: Tension Cord Training Mechanism	Concept 7: All Inclusive Technology	Concept 8: Launch Monitor Pro
Concept 4: Lasers, Dots, and Sensors with Professionals	1	0.33	0.33	3
Concept 6: Tension Cord Training Mechanism	3	1	3	1
Concept 7: All Inclusive Technology	1	0.33	1	3
Concept 8: Launch Monitor Pro	0.33	1	0.33	1
Sum	5.33	2.66	4.66	8

Normalized Cost Comparison

	Concept 4: Lasers, Dots, and Sensors with Professionals	Concept 6: Tension Cord Training Mechanism	Concept 7: All Inclusive Technology	Concept 8: Launch Monitor Pro	Average	Weighted Sum	Criteria	Consistency	Lambda	RI	CI	CR
Concept 4: Lasers, Dots, and Sensors with Professionals	0.188	0.124	0.071	0.375	0.189	0.880	0.189	4.646	4.516	0.890	0.172	0.193
Concept 6: Tension Cord Training Mechanism	0.563	0.376	0.644	0.125	0.427	1.829	0.427	4.285				
Concept 7: All Inclusive Technology	0.188	0.124	0.215	0.375	0.225	1.031	0.225	4.575				
Concept 8: Launch Monitor Pro	0.062	0.376	0.071	0.125	0.158	0.722	0.158	4.559				

