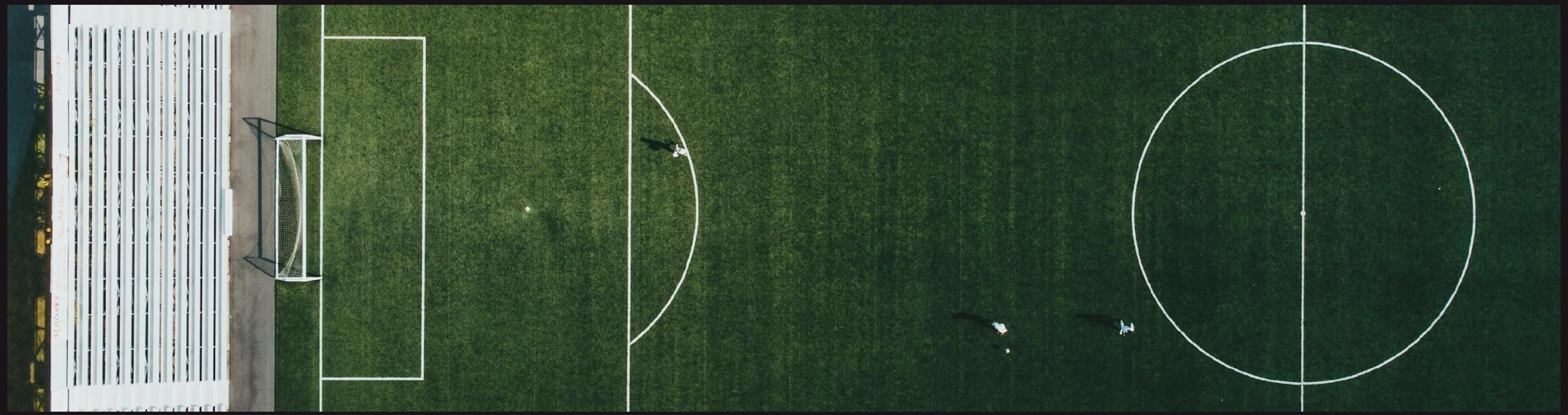
GROW IRISH WEEK WITH ULTRAX

Visualizing Most Demanding Periods Across Training Sessions

Patrick Bernius, Liam Egan, Isabelle Esler, Connor Toomey

THE TASK

Given three days, we were tasked with engineering any feature(s) to help us determine when and how athletes experience peak exertion and how these “Most Demanding Periods” (MDPs) affect subsequent performance.



GUIDING QUESTIONS

MDP Determination

How can we algorithmically identify MDPs using speed, acceleration, heart rate, and exertion metrics?

Session Variability

How stable are MDP patterns within a session vs. across sessions?

Mapping Player Uniqueness

Do players have unique “exertion signatures”?

Post MDP Effects

After a peak exertion event, how does performance change? (speed decay, inability to hit % max speed, etc.)

OUR SOLUTION

Using a metabolic-power-based metric, we developed intensity index directly from raw exertion signals, giving Ultrax a foundation for advancing fatigue and workload-modeling research.

01

Defining Metabolic Power (MP)

What is MP? Why MP?

02

MP Formula Derivation

Explanation of MP components

03

Formula Application (Intensity Index)

Expanding MP formula across sliding windows

04

Streamlit Application

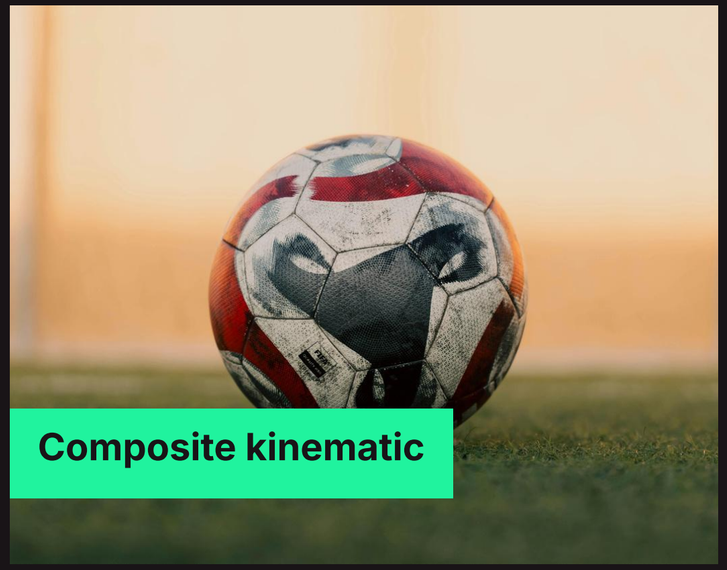
Prototype live demo, value add, & integration into current systems

WHAT IS MP?

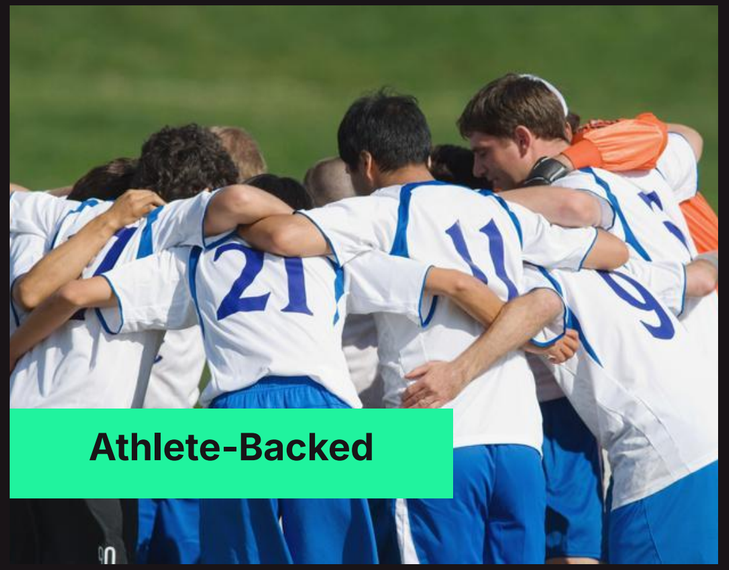
Metabolic Power is a measure of the rate at which the body expends energy during movement. It represents how quickly the body is using metabolic energy (from carbohydrates, fats, etc.) to perform work.

WHY MP?

Most objective



Composite kinematic



Athlete-Backed

MP combines multiple exertion metrics into a single, objective measure of an athlete's true energetic cost. Unlike raw speed or heart rate alone, MP reflects how demanding a movement feels physiologically, especially during accelerations, decelerations, and repeated high-intensity bursts. Because it aligns closely with athlete perception and fatigue, it provides a more accurate foundation for modeling workload and identifying MDP.

FORMULA DERIVATION

01

Speed

Instantaneous speed of the player (m/s)

02

Acceleration

Magnitude of increased/decreased acceleration (m/s^2)

03

Cadence

Step rate or stride frequency (steps/min)

APPLYING MP: INTENSITY INDEX

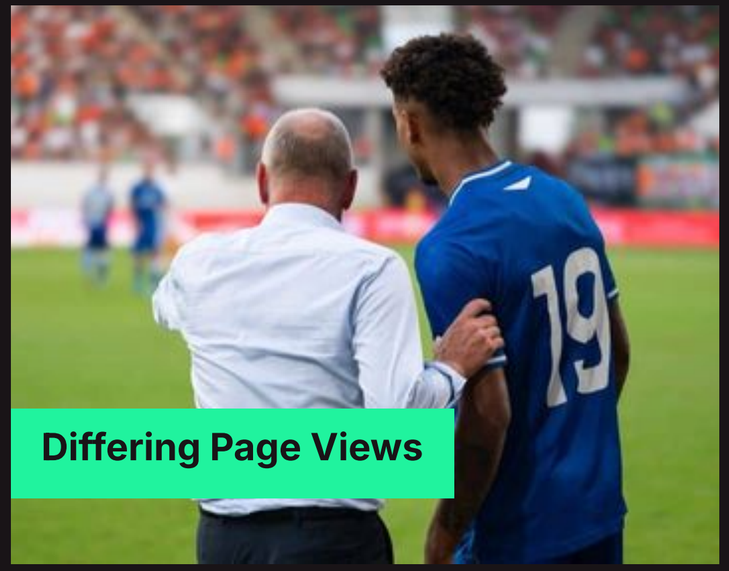
We applied MP over 10-, 20-, and 30-second sliding windows to identify the most demanding periods for each player and session. Windowed MP peaks were used to derive three components of intensity: explosiveness, repeatability, and volume. Together, these metrics form a unified Session Intensity Index.

This index provides a stable way to evaluate athletes who may be at risk of injury, overtraining, or increased fatigue.

STREAMLIT APP LIVE DEMO:

Click Here

STREAMLIT VALUE ADD



Differing Page Views

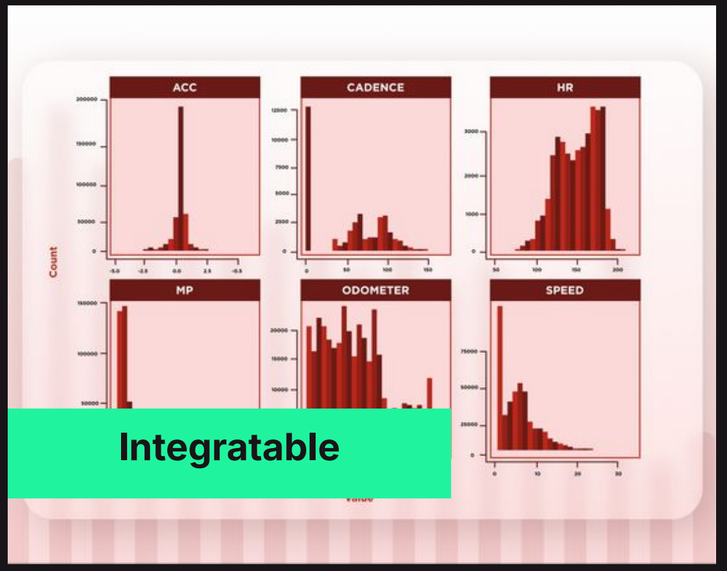
Coach's view - allows for stats to use for examining top performers and those at risk of overexertion or injury.

Analyst's view - allows for data to be observed at a deeper level to aid in decisions of players

MDP Fatigue Windows

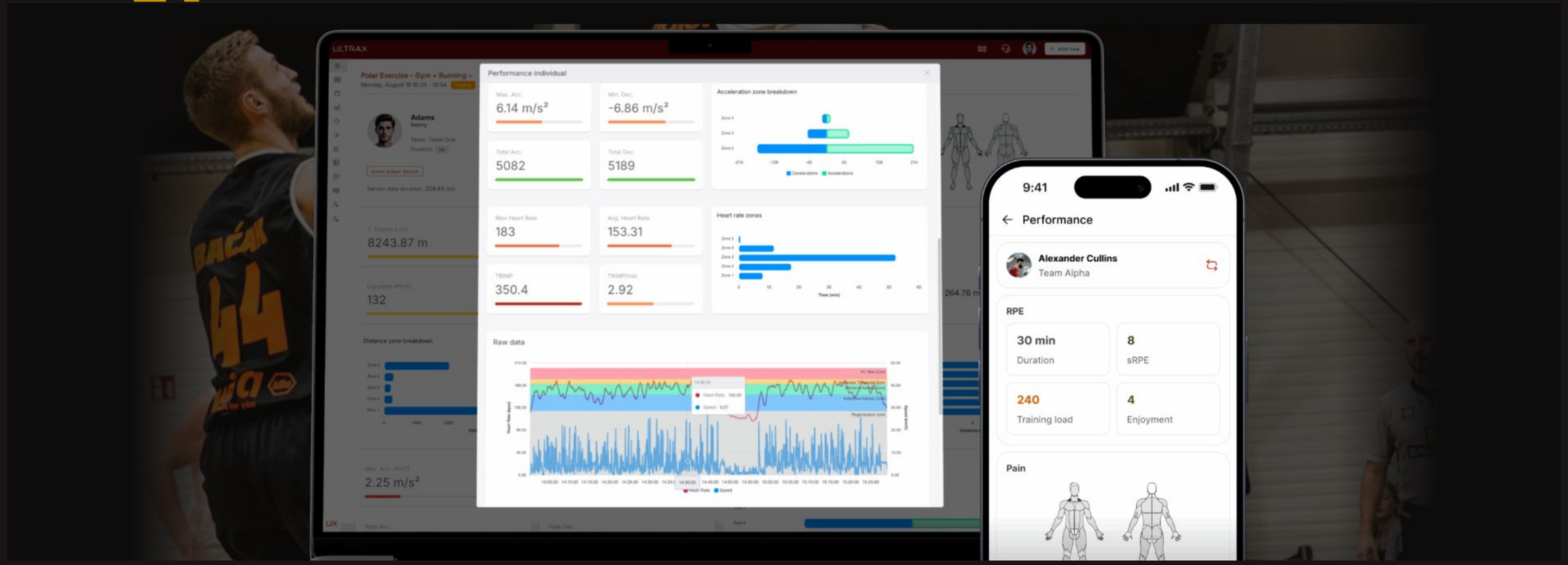
Viewing the MDP of players (individual and generalized) can help to determine fatigue and/or potential injury windows of athletes.

Fatigue + MDP level information can help to determine practice involvement and intensity



Integratable

Interface fits aesthetically and logically within preexisting Ultrax Software and Applications



INTEGRATING MDP, MP, & INTENSITY INTO CURRENT TOOLS

Our app features could be applied to Ultrax's existing platform, which tracks injuries currently.

Implementing our application software will also track athletes' MDP and MP based on session intensity to track and prevent injury.

THANK YOU!

Presented by

Patrick Bernius, Liam Egan,

Isabelle Esler, & Connor Toomey