Problem Solving in Software Development

A Case Study

Design Studio Guest Lecture

Derrick Stolee
Feb 11, 2010

Are you a programmer?

Are you *just* a programmer?

Requirements of Development

- **Intellect**
- **Creativity**
- **Teamwork**
- **Verification**

- Use existing knowledge
- Add NEW techniques
- Use talents of others
- Prove it works!

What's the *coolest thing*
you've ever coded?

Enjoyment in Development

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Agile Sports Technology

our favorite startup

Started by three alumni:

David Graff, Brian Kaiser, and John Wirtz

Two main products:

- Hudl Pro
  - Playbook and video management software
  - Client/Server application
  - For Division I or Professional teams
  - Main sport: Football
- Hudl
  - Similar purpose
  - Web interface
  - "The Facebook of Football"
  - Also, other sports!

Outline of the Experience

- The Need
- Some Requirements
- The First Design
- The Second Design
- Construction
- The Future?

The Need

Bo Pelini needs to make a quarterback out of Cody Green and needs to do it quickly. Cody seems to forget his plays in high-pressure situations, so Bo thinks Cody could use some study time with the playbook. Bo wants to make sure Cody is getting the plays memorized, so he gives Cody some play quizzes.

However, NCAA limits the amount of time Bo and Cody can interact in person, and Bo thinks that time is better spent on the field.

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However, NCAA limits the amount of time Bo and Cody can interact in person, and Bo thinks that time is better spent on the field.

Play Quizzes: Existing System

A paper-and-pen play quiz system already exists

- Lots of manual labor checking the answers
- No immediate feedback
- Security issues for paper copies

A Need into a Feature: Hudl Pro

- Huskers already use Hudl Pro to manage their playbook
- Players already have access to the plays

A new feature is needed for Hudl Pro:

Automatic play quizzes

Some Requirements: a Use Case

1. Coach selects a play from the playbook.
2. Coach removes routes, labels, or players.
   This creates a "quiz"
3. Coach sends quiz to a Player.
4. Player receives notification of quiz.
5. Player fills in missing routes, labels, and players.
6. Player selects "Grade Quiz"
7. Quiz is graded, result posted to Player
8. Player sees grade, may repeat quiz

Test Driven Design: Check the Feature

Does this feature diagnose the problems?

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- Provides immediate feedback to player
- Security!

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Can this feature integrate with existing solutions?

- Playbook already in Hudl
- Tasks within Hudl allows quiz assignment

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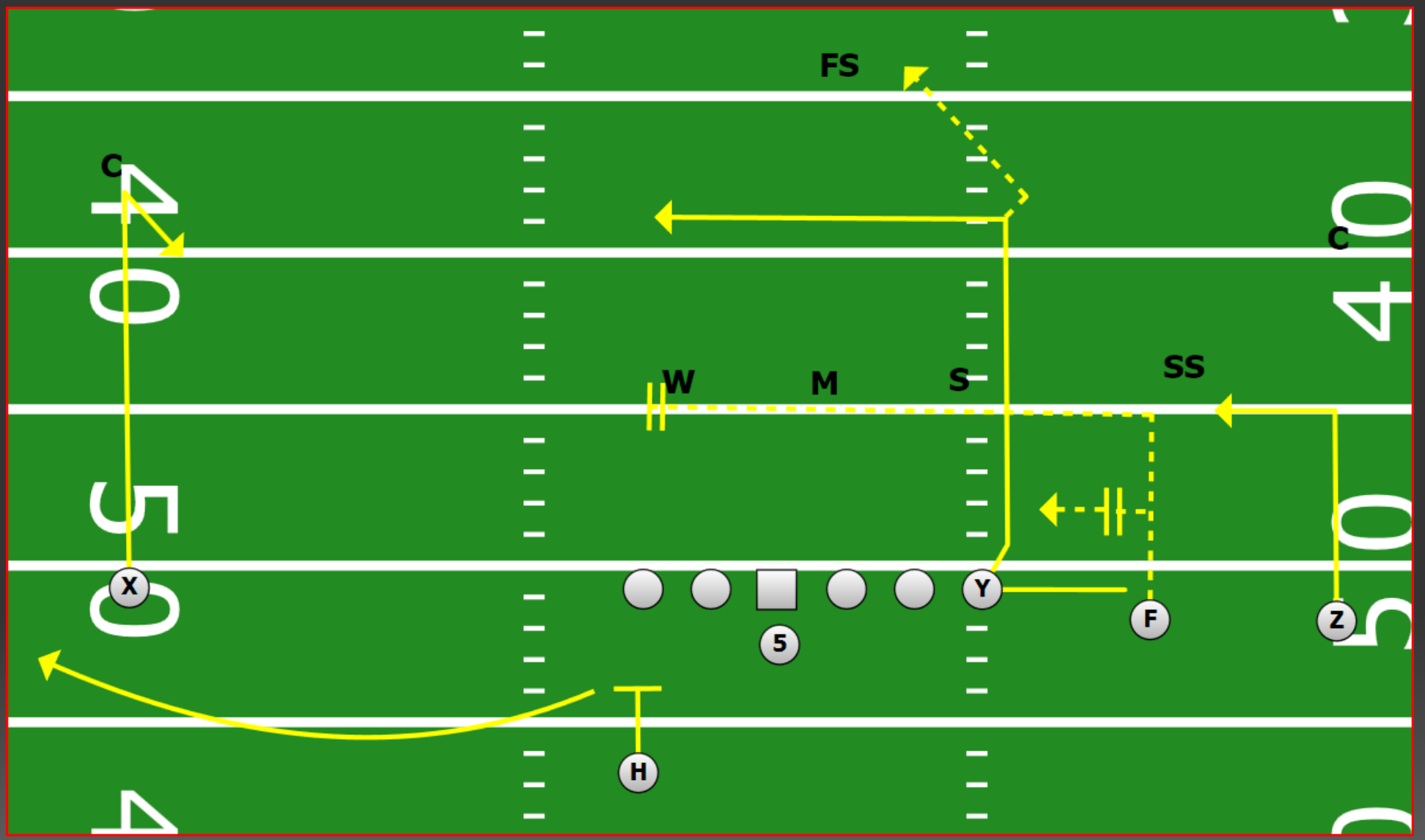
What do we mean by remove?



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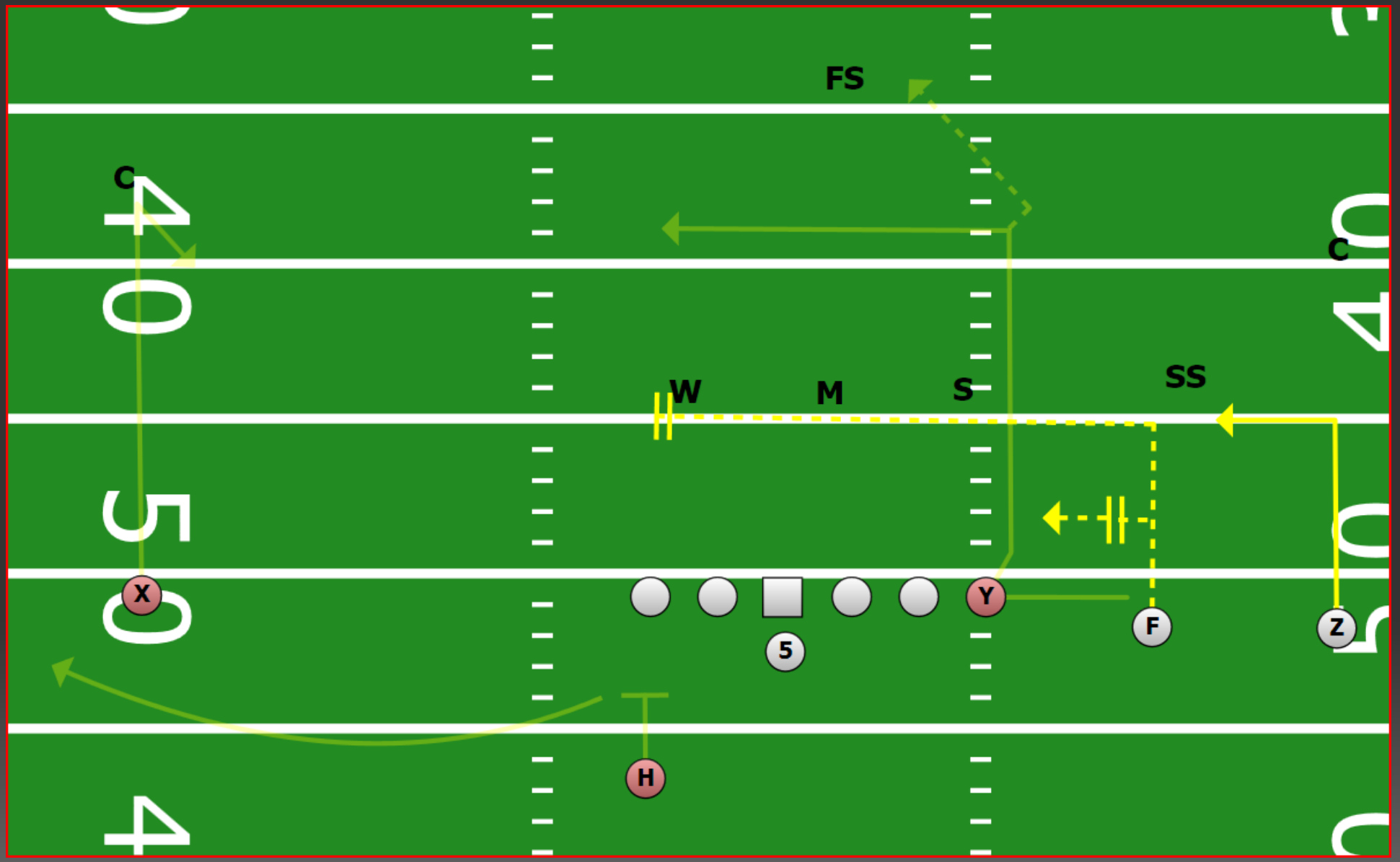


What do we mean by fills in?

This is a vague requirement, let's fill in the details:

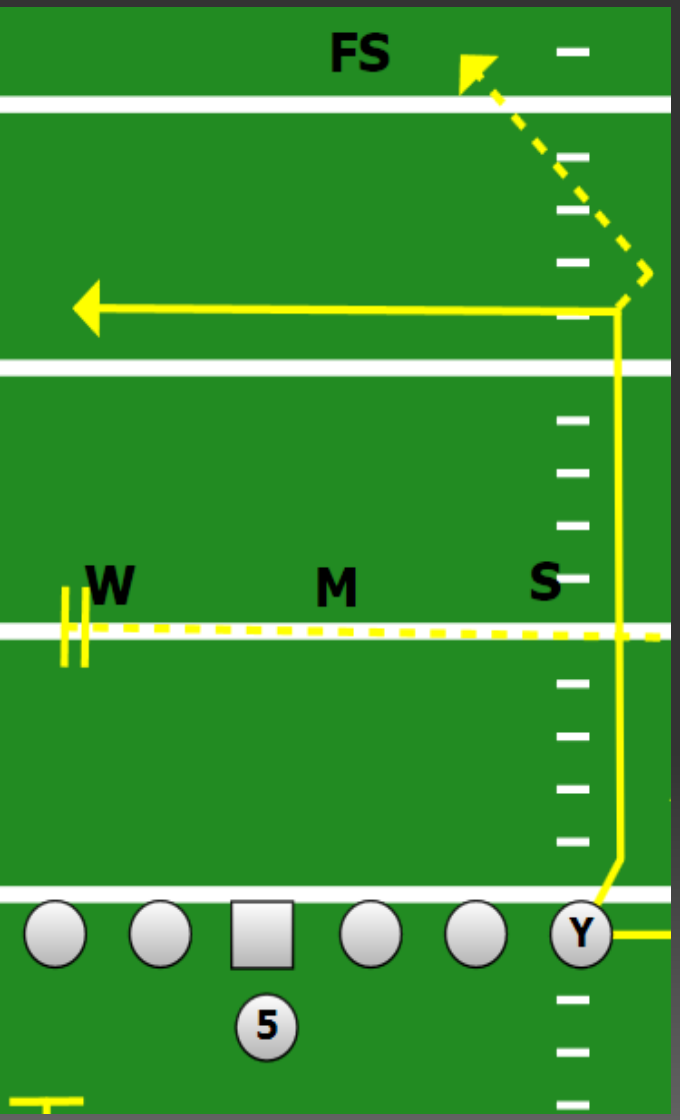
- The player uses the mouse or tablet input to draw a route
- Routes contain straight lines, angles, and "junctions"

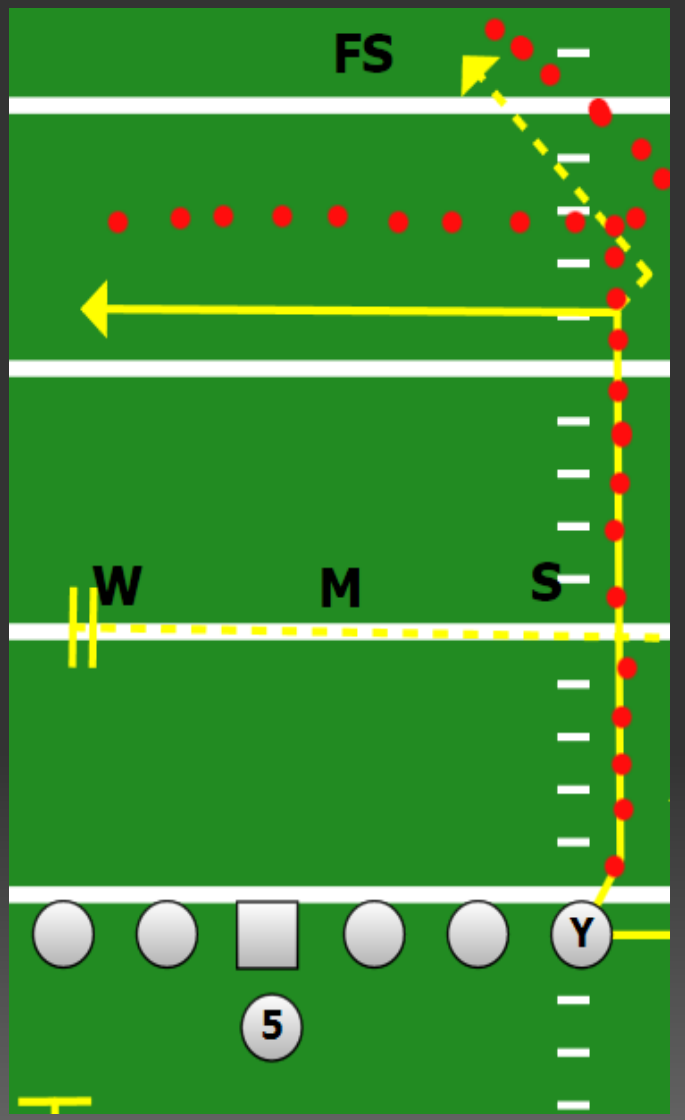
What do we mean by Quiz is graded?

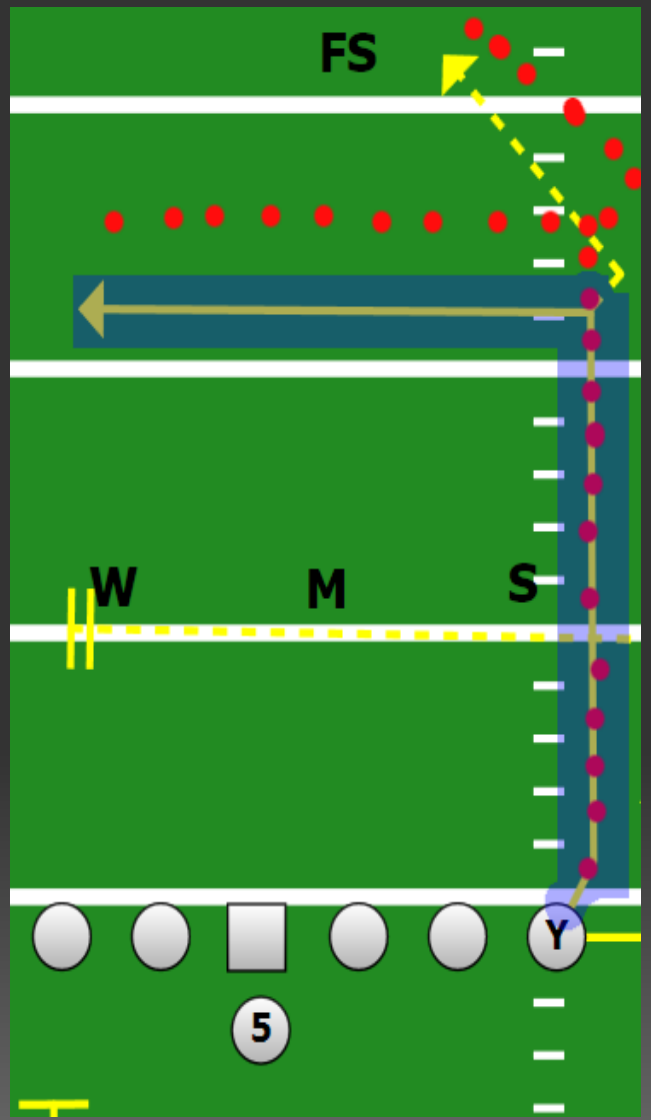
That's a very good question.

HOW DO WE DO THIS?

The First Design: Grade by tracing







Bringing in an Independent Contractor

- Team presented the situation so far
- Requirements, Design, Faults

- Proposed a new technique

- Acquired a prototype environment
  - Very close to Hudl
  - Same object model for routes
  - The prototype should be "plug-n-play"

The New Design

- The mouse/tablet input is inherently noisy.
- That is, even if the player knew the play exactly, drawing is difficult.
- To consistently evaluate a noisy input, modify the input to a less noisy, structured form.
- Decrease the number of variables in the equation.

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Machine Learning!

The New Design: Two Parts

Ink-to-Play Converter

- Convert the mouse input into routes using gestures
- Create a "guess" of the route that the player was attempting to draw
- Allow wiggle room: give the player the benefit of the doubt

Play Comparison/Grader

- Compare any two plays
- Match corresponding routes
- Focus on the big picture
- Give a multi-dimensional rating that can be adapted to grading styles

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Does it mimic the existing sytem?

1. Ask coaches and staff how they grade
2. Get example completed quizzes

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Does it exhibit good software design?

1. Modularity
2. Uses existing technology to the fullest

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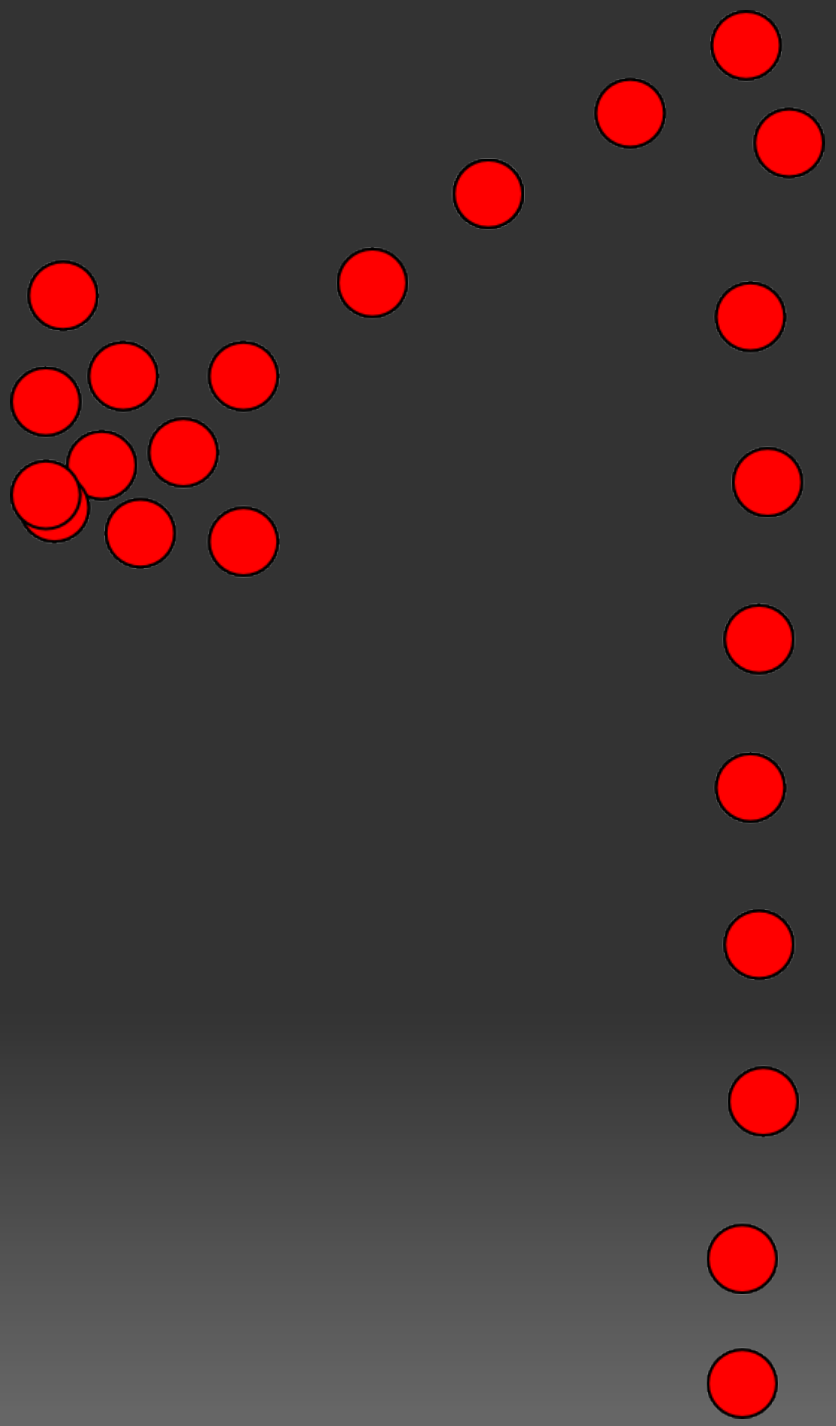
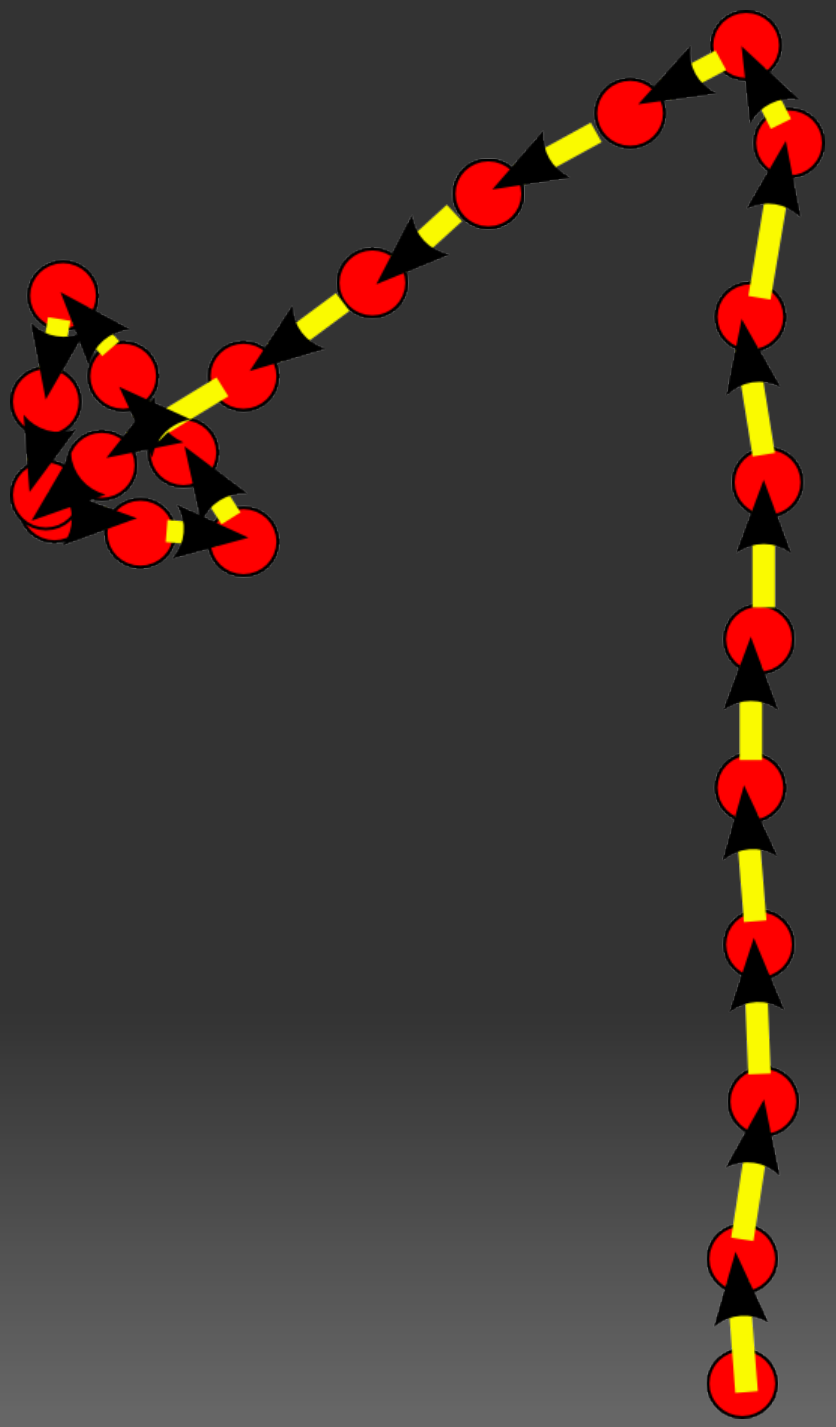
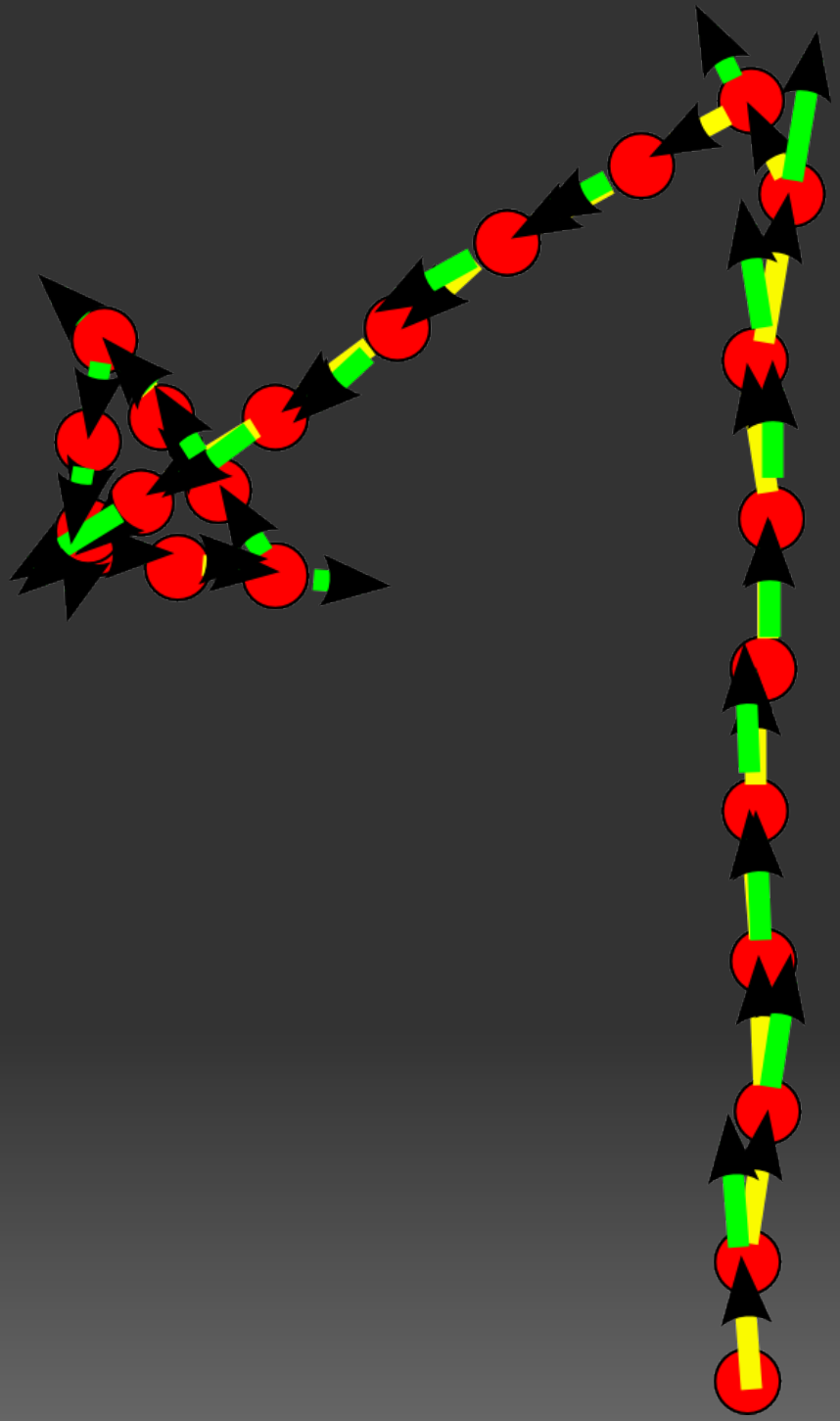
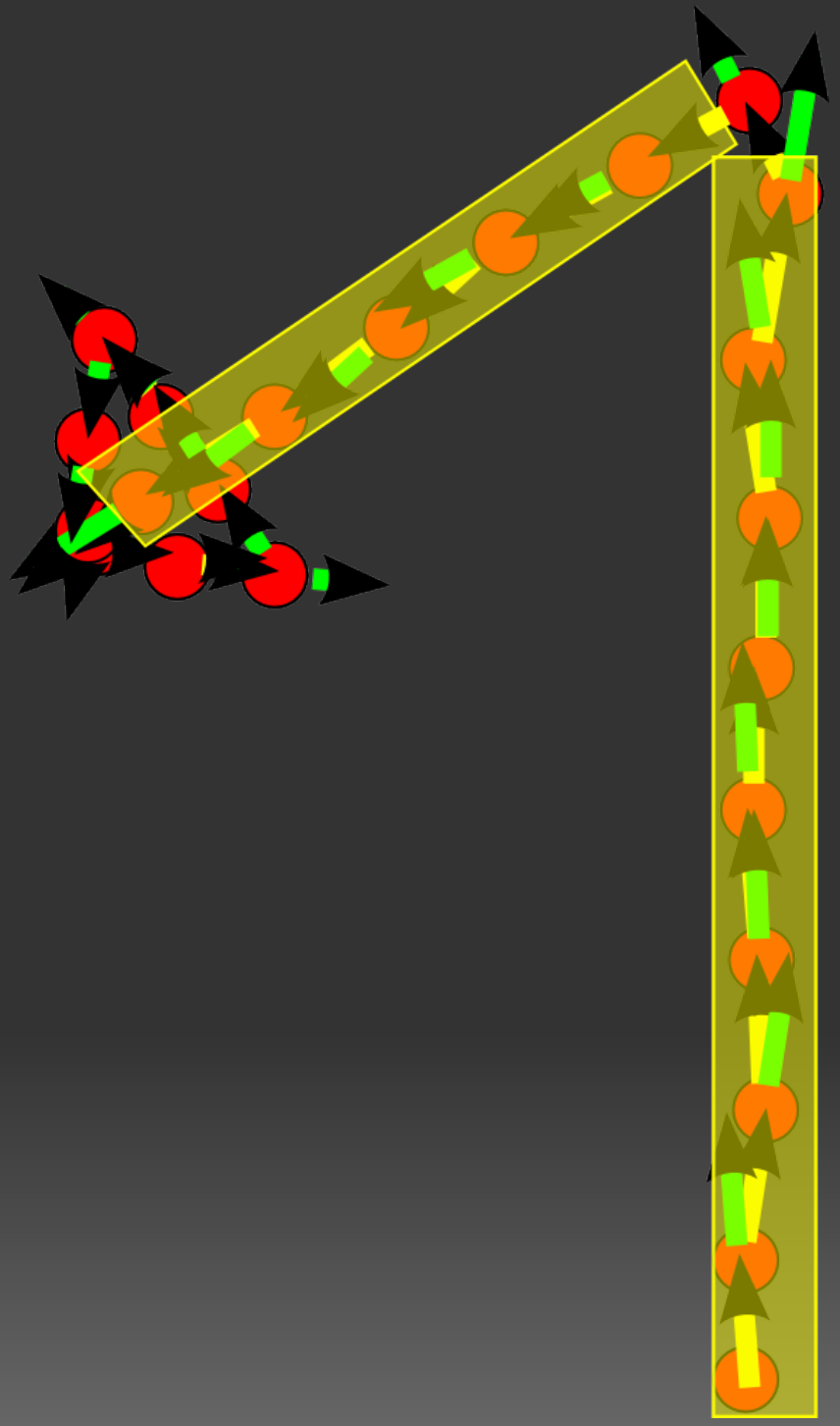
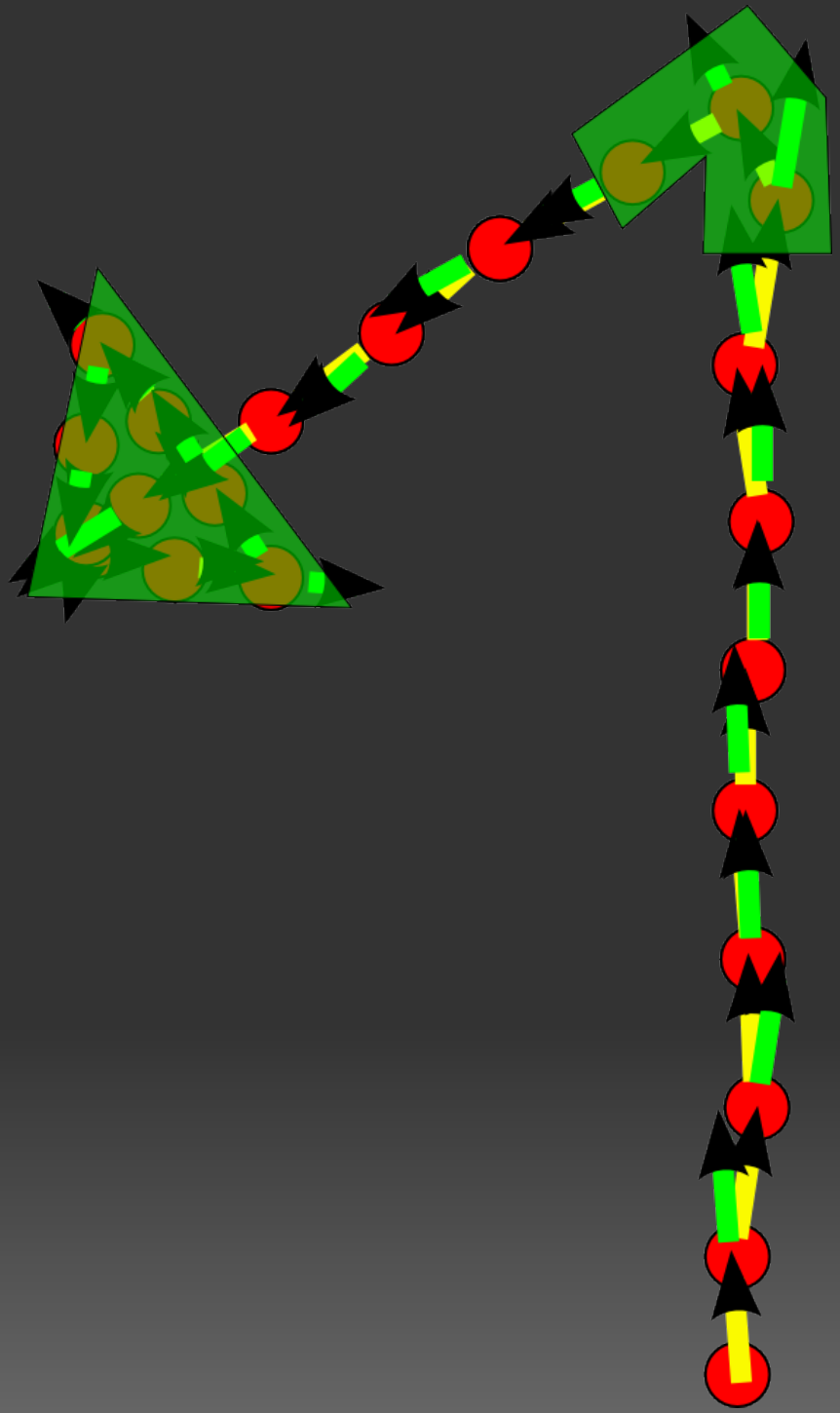
We need more information on
the algorithm...











What new requirements are needed?

Loose Requirements:

- What types of gestures give what type of segments?
- How can we combine all gestures into a route?

Stronger Requirements:

- What angle range is allowed in a straight segment?
- How many "large" angles are required to make a joint?
- How do we differentiate between an arrow endpoint and a hook back?

How to find the requirements

The way I did it: **Guess and check**

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The way I should have done it: **Collect data!**

- Attempt to draw routes and record movements
- Predict manually the segments, joints, and junctions.
- Record statistics on the variables:
  - Length of difference vector
  - Angles
  - Number of points
  - Shape

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  - BEST: Get users to provide data!
- Predict manually the segments, joints, and junctions.
  - BEST: Get coaches/staff to predict this!
- Record statistics on the variables:
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Development Process

Stage 1: Proof of concept

- Code was not integrated with Hudl
- Independent application
- Did use the Hudl object model

Stage 2: Integration with Hudl

- Stage 1 inserted into Hudl
- Problems! Coordinate system reversed
- Also, bugs found!

Development Process

A side benefit:
The ink-to-play portion could be inserted into the play editor!

This allows coaches to write plays in a more natural way, just like the whiteboard.

Specifics of Implementation

Organize the algorithm into pieces:

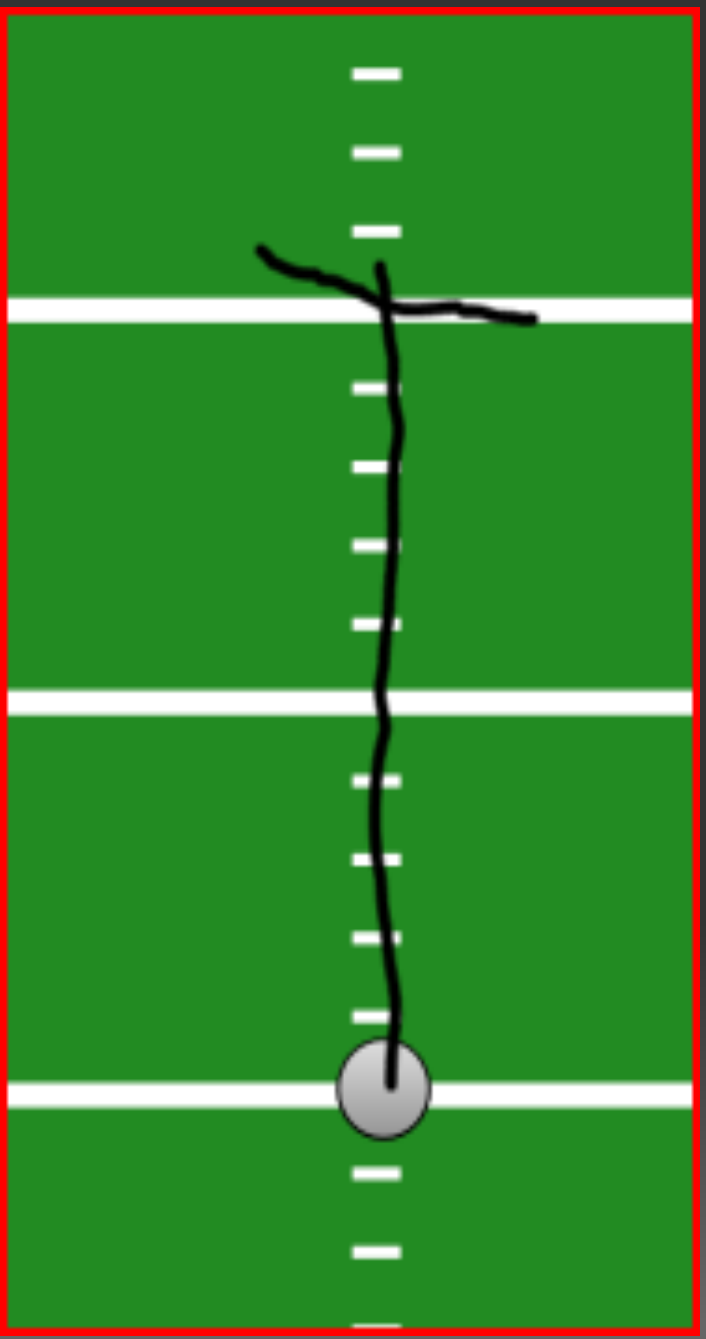
An interface created for a "Pattern Recognizer" was created.

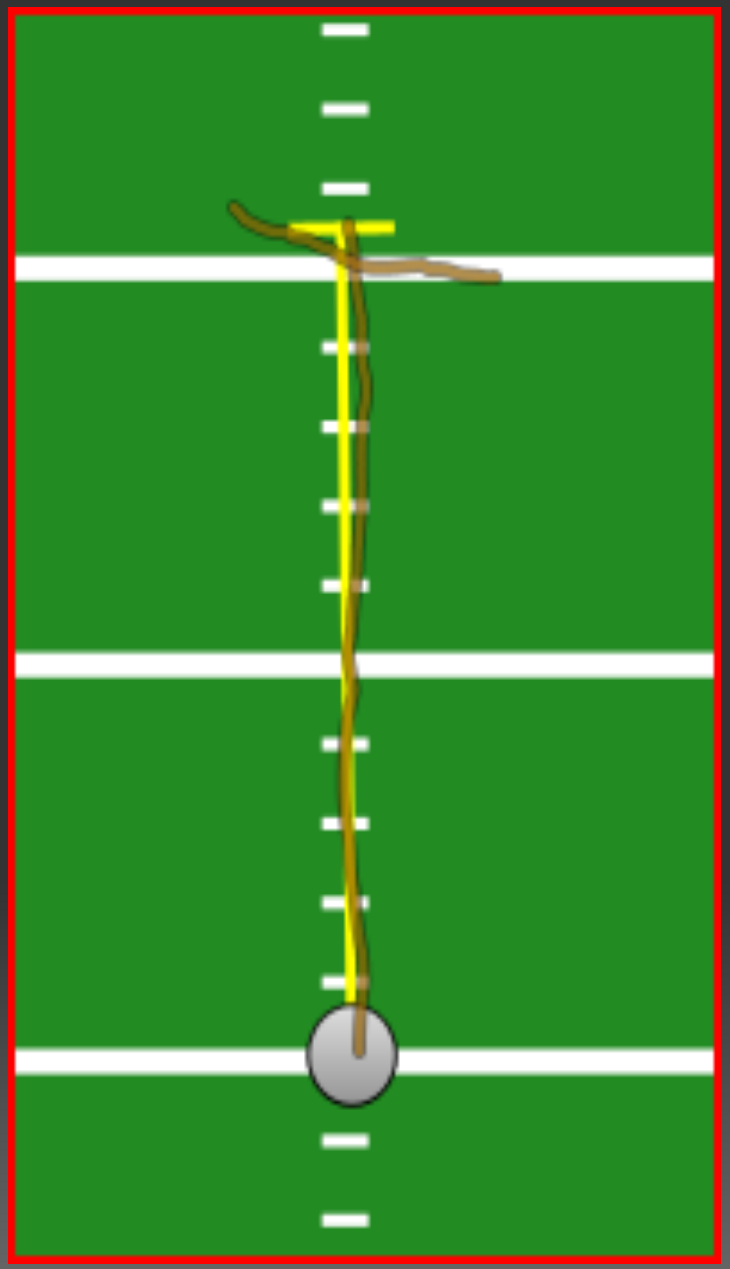
Different implementations competed for segments of the path:

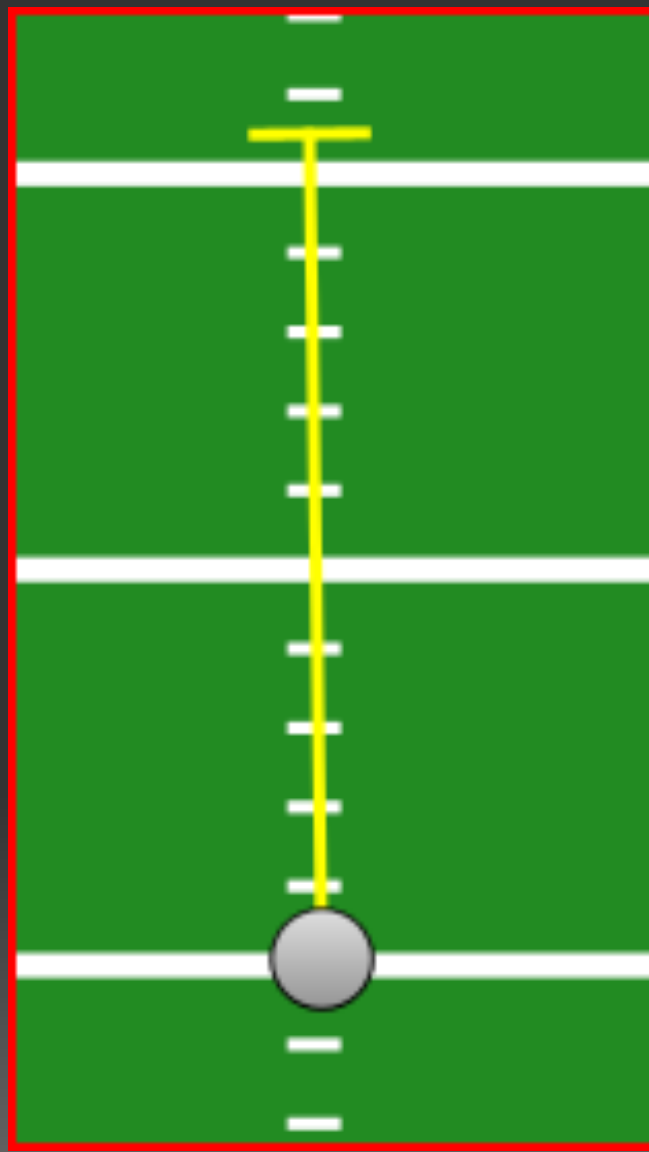
- Straight segments
- Joints
- Arrows
- Blocks
- Stops

New types of route segments only need a new recognizer!

Results







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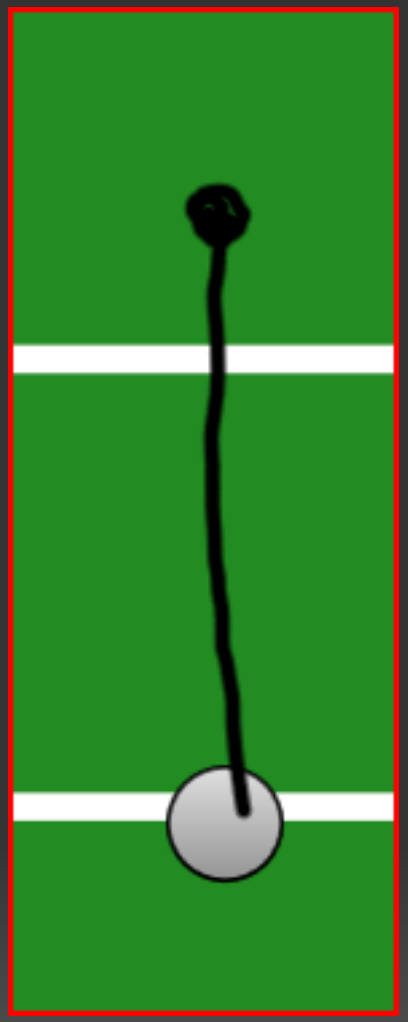

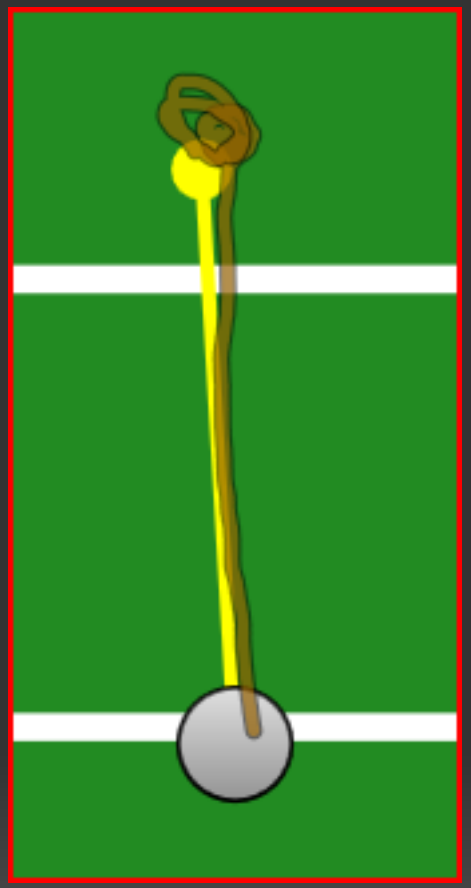

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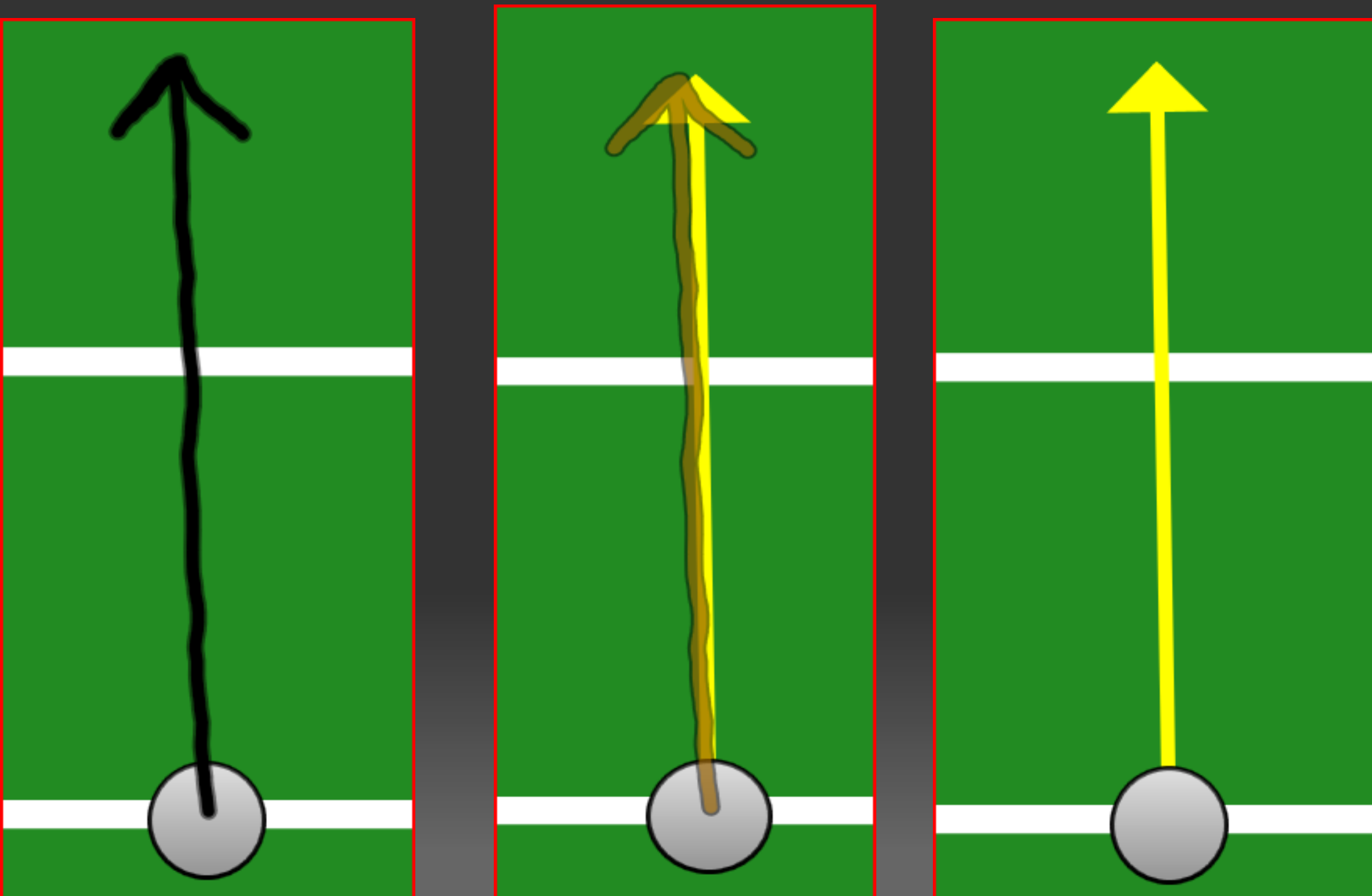

Demo!

Demo provided by **Kyle Deterding**.

TESTING??? WHAT TESTING???

By the end of the project, a proof-of-concept was present.

My job was "done"

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My job was "done"

...I think they hired an intern to work on it...

How to Test

- Assuming we collected proper data, we had test samples ready during development!
- While it would be nice to get to 100% tests completed, there may need to be some failed samples.
  - Certain samples may contradict each other
  - Attempt to get 99% accuracy

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- Add variety to data set
  - Use mouse vs. tablet
  - Different zoom levels (editor only)
  - Include BAD input and WRONG answers
  - If grading is more than P/F include all possible grades

What would a *researcher* do?

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Existing Resources

+

New Technology

=

Innovation

What would a *researcher* do?

Existing Resources

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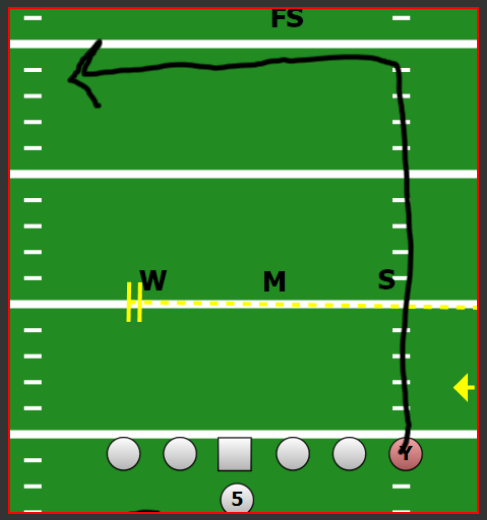
New Technology

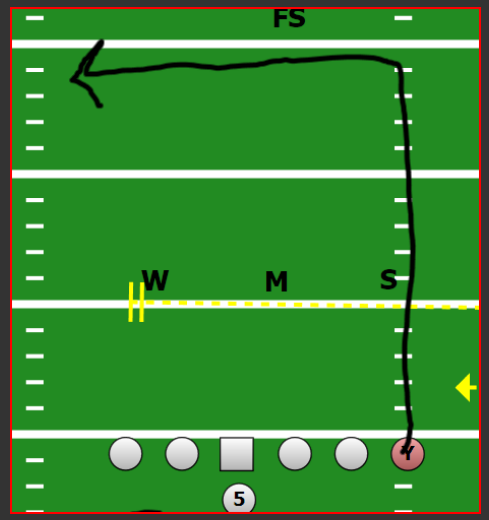
=

Innovation

(Is there a market?)



Ink-to-Play



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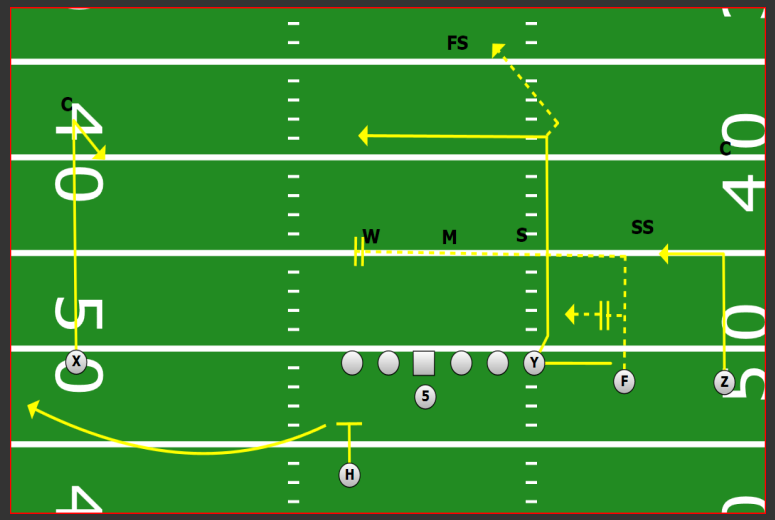
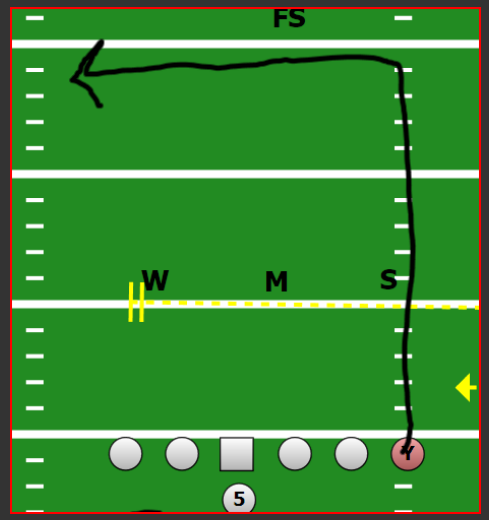


Playbook Library

+



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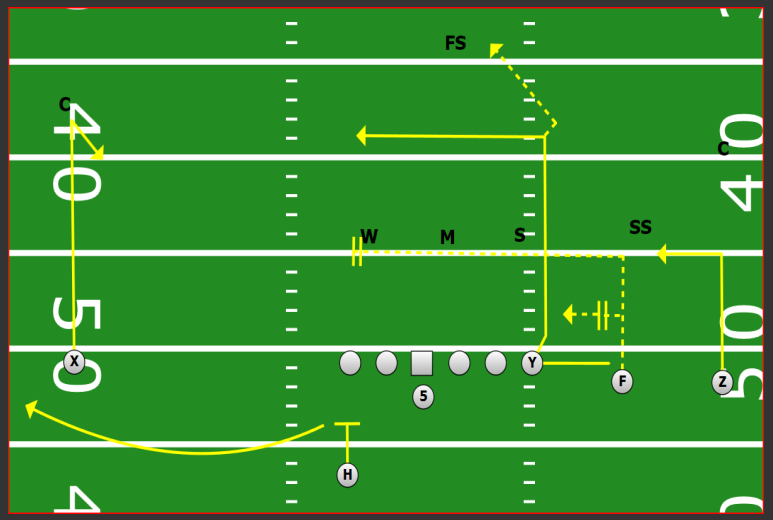

Playbook Library

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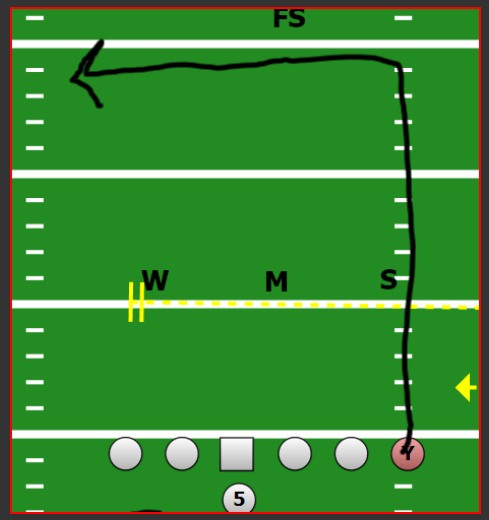
Video Library



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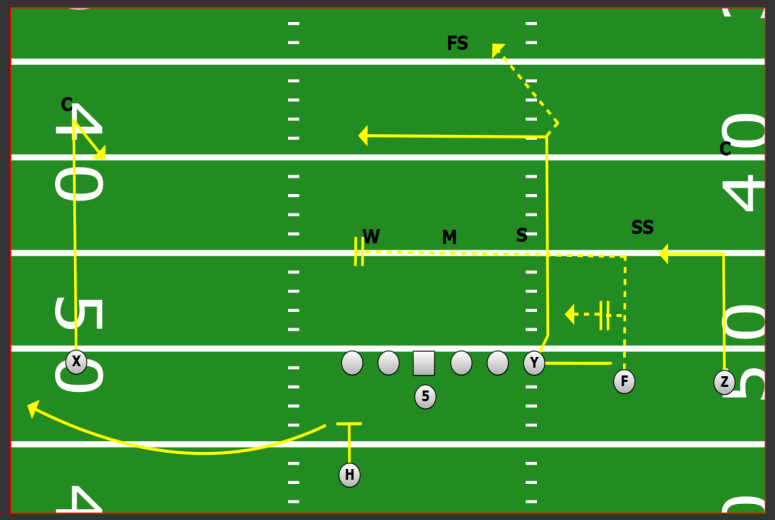

Playbook Library

Video Library

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Player Tracking

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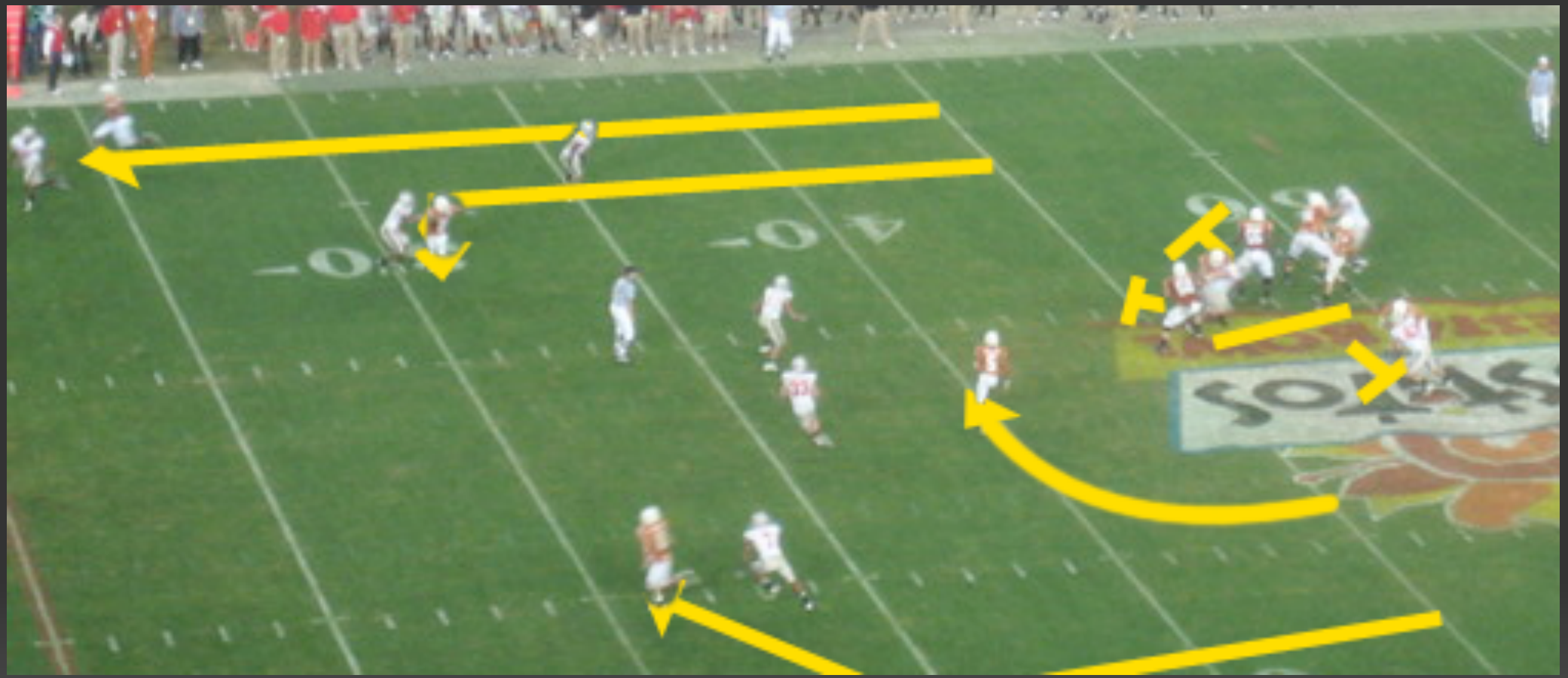
Video Play Recognition



Imagine a world where this existed.

How do you use it?

Imagine a world where this existed.

How do you test it?

Imagine a world where this existed.

How do you test it?

That's a good question!

Thanks

Big thanks to all who helped with this presentation:

The Agile Sports Crew
Especially: Kyle Deterding
Brian Kaiser

Design Studio Crew
Brian and Jeremy
for the opportunity
PCs/TCs for asking me
The Class for putting up with me for
one more slide...

Raikes Alumni Mentorship

- Are you an undergrad?
- Do you want more friends?
- Do you want more advice?
- Do you think alumni are TOTALLY AWESOME?

Sign up for an alumni mentor!

- We'll match you up if you give the following info:
  - Your major
  - Your career goals
  - Possible jobs/companies you want to give you a job
  - Hobbies, interests, etc.