Game 2: Arc Length & Voltage Dynamics

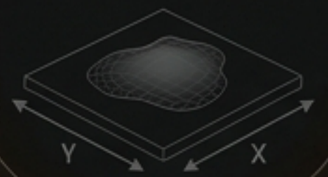
The Vertical Aim Lab: Translating 3mm Standoff Control into Muscle Memory.



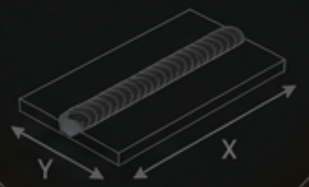
Gemini Notebook

Season 1 Core Competency: Spatial Awareness

Game 0:
Puddle Control
(X/Y Axis Expansion)



Game 1:
Bead Line
(X/Y Axis Travel)



Game 2:
Arc Length
(Z-Axis Standoff)

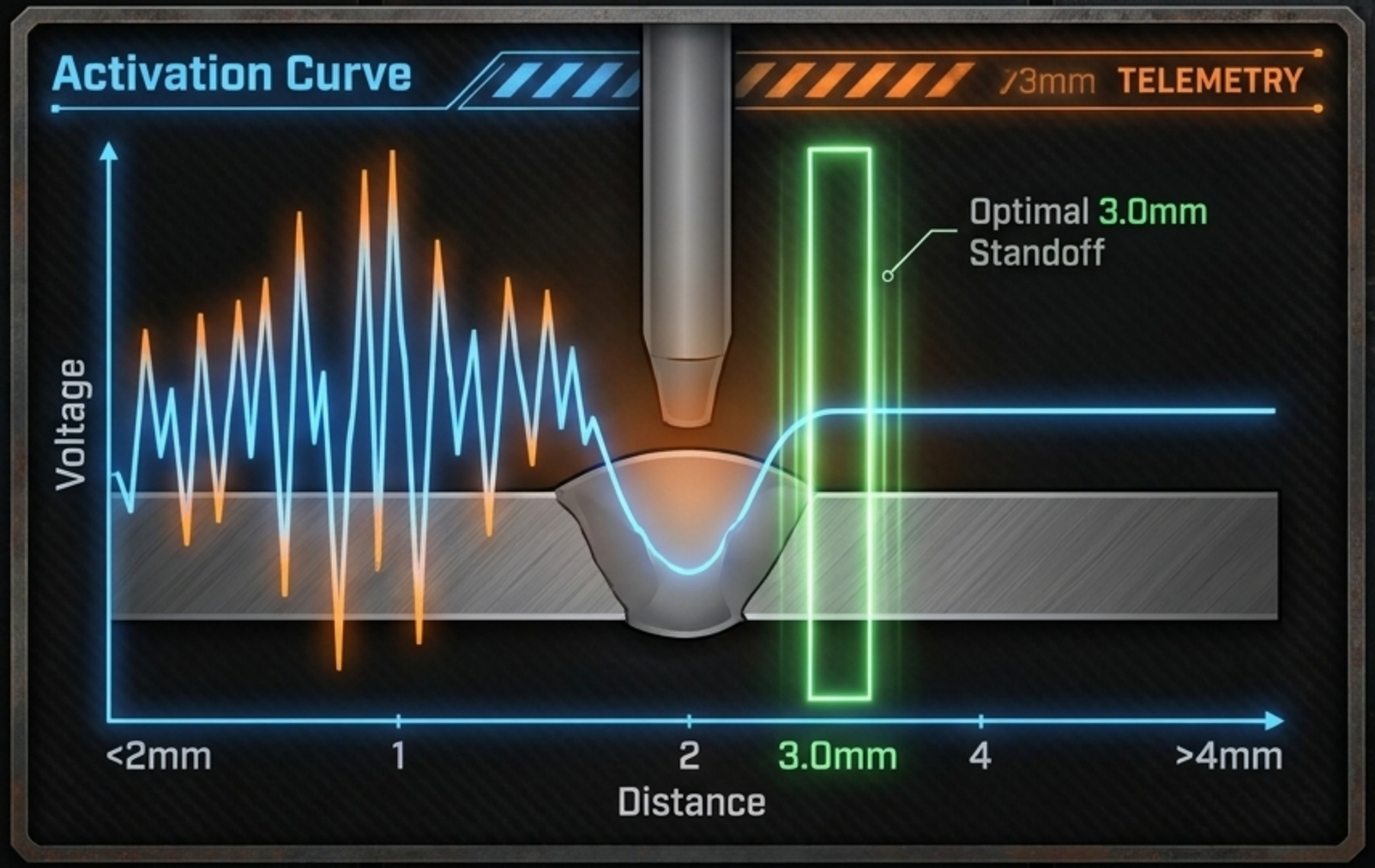


ARC GAP: 3.0mm +/- 0.1
STANDOFF: OKAY

Key Takeaway: Game 2 strips away horizontal travel to isolate a single, critical variable: the Z-axis depth control required by **OSHA 29 CFR 1910.252 and AWS D1.1 standards.**

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The Physics of the 3mm Standoff



Distance = Voltage

The arc length dictates the operating voltage of the weld.

3mm

The Threat

Fluctuating distance causes erratic voltage, triggering AWS D1.1 visual defect failures (poor penetration, undercut, porosity).

3mm

The Developer Reality

To the gamer, they are maintaining a physical hover distance; to the physics engine, they are managing a live, volatile electrical current.

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The Enemy of Consistency: Spatter



The Threat: Chaotic Arc 3.5mm 0.2,8



The Standard: Focused Current 5mm

The Trigger

3mm

Extending the arc length past 3.5mm (Long Arc) causes massive voltage spikes. The arc loses focus and acts like a spray can.

Real-World Consequence

3mm

Requires post-weld grinding, ruins the finish, fails AWS D1.1 visual inspection.

Game Engine Consequence

3mm

Immediate point deduction (-50 XP), aggressive screen-shake, and temporary visibility reduction due to particle overload on screen.

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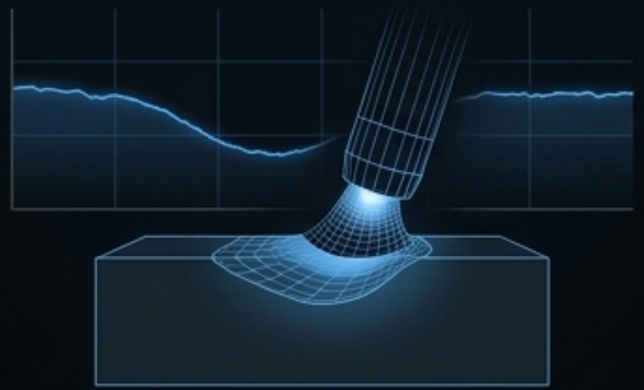
The Arc State Diagnostic Profile

< 2.5mm (Short Arc)

Physics: Voltage drops. Puddle goes cold. Risk of electrode fusing to base metal.

Audio Cue: Muffled, choking audio.

Haptic Cue: Heavy, grinding controller resistance.

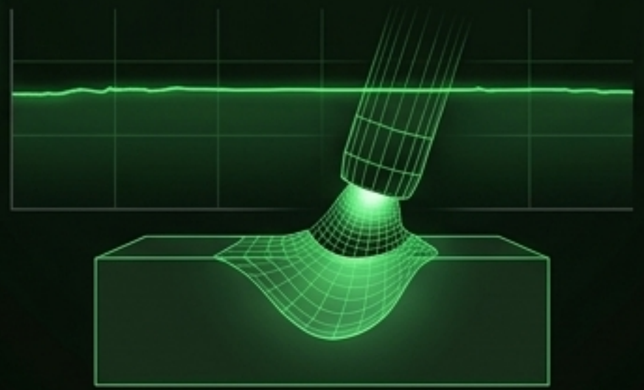


3.0mm +/- 0.5mm (The Sweet Spot)

Physics: Voltage perfectly stable. Flawless puddle penetration. Zero defects.

Audio Cue: Smooth, rapid frying bacon crackle.

Haptic Cue: Zero friction; fluid joystick glide.

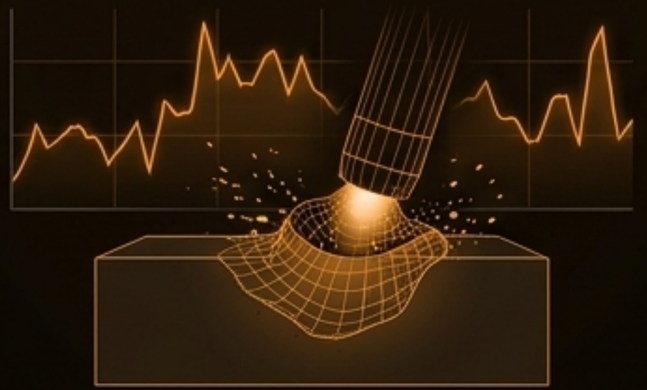


> 3.5mm (Long Arc)

Physics: Voltage spikes. Chaotic, unfocused arc. High porosity and spatter risk.

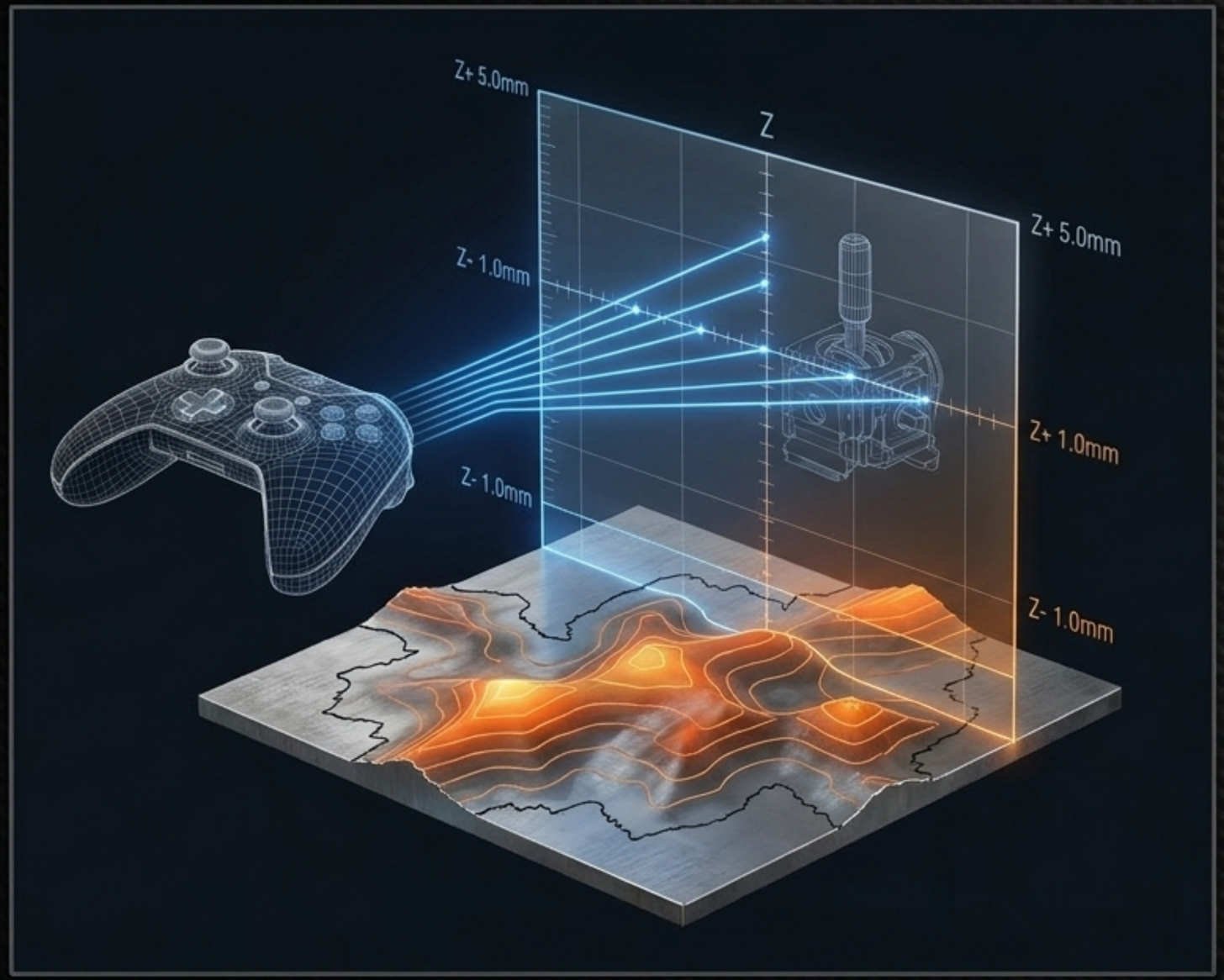
Audio Cue: Loud, erratic popping and harsh buzzer.

Haptic Cue: Sharp, jarring vibration bursts.



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The Vertical Aim Lab



The Setup

3mm

Game 2 strips away the complexity of horizontal travel speed. The player focuses entirely on holding the torch joystick exactly at the 3mm hover point.

The Challenge Variable

3mm

The virtual steel plate introduces randomized micro-undulations, mathematically simulating warped real-world metal.

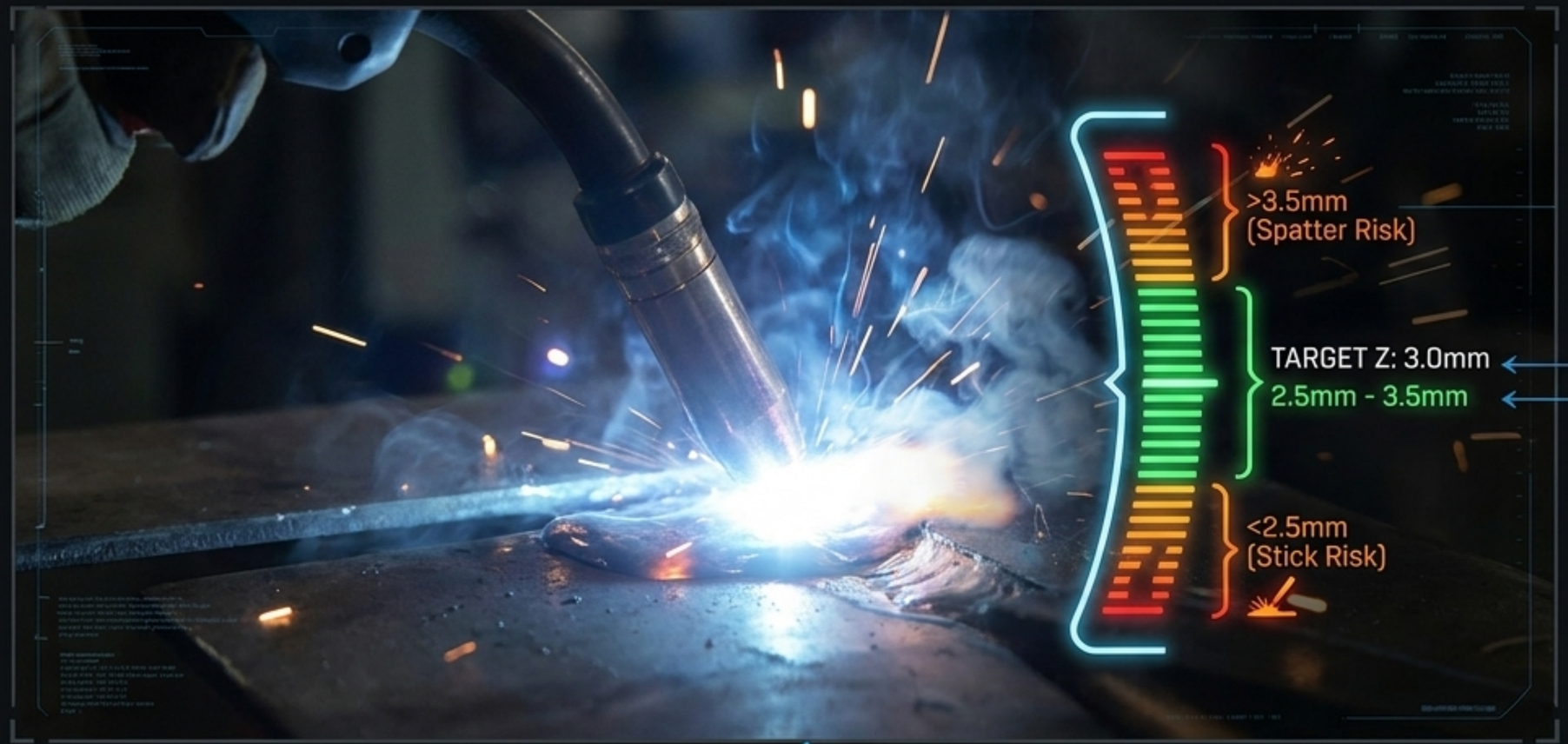
The Loop

3mm

As the metal subtly rises and falls, the player must execute constant Z-axis micro-movements to maintain the 3mm gap, demanding the exact tracking precision of an FPS competitive shooter.

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Visualizing the Invisible: HUD Telemetry



Green Zone: 2.5mm - 3.5mm
Sustaining this zone builds a visual combo multiplier.

Warning Zones:
Flashing Red/Orange for >3.5mm (Spatter risk) or <2.5mm (Stick risk).

The Fading Crutch



BOOTCAMP
(Day 0-30)

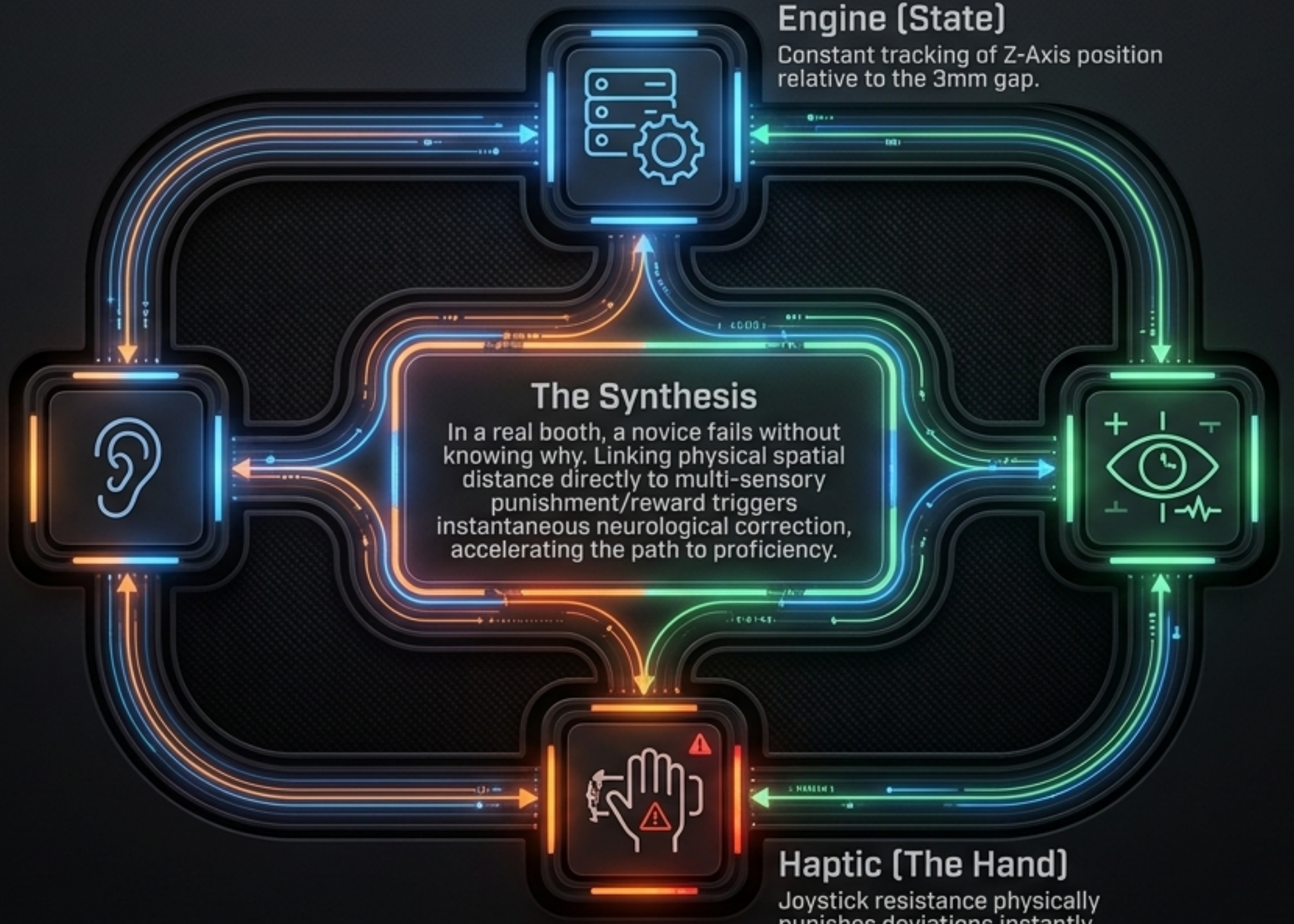
MID-SEASON
(Day 60-90)

SEASON 2
(Day 120+)

As the player progresses through the 120-day Bootcamp, this HUD element progressively fades opacity. By Season 2, it vanishes entirely, forcing reliance strictly on the physical look of the puddle and the sound of the arc.

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Wiring Muscle Memory



Engine (State)

Constant tracking of Z-Axis position relative to the 3mm gap.

Audio (The Ear)

Translates distance into pitch and distortion. Frying bacon vs. Buzzing.

The Synthesis

In a real booth, a novice fails without knowing why. Linking physical spatial distance directly to multi-sensory punishment/reward triggers instantaneous neurological correction, accelerating the path to proficiency.

Visual (The Eye)

Real-time HUD telemetry and physical puddle diameter.

Haptic (The Hand)

Joystick resistance physically punishes deviations instantly.

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Defining the Platinum Standard

Accuracy (40%)

38.5%



Time spent exactly within the 3.0mm +/- 0.5mm HUD window.

Consistency (30%)

29.1%



Lack of drastic Z-axis spikes; smooth, deliberate micro-corrections.

Safety (30%)

30.0%



Zero arc strikes outside the designated weld zone (Strict OSHA/AWS D1.1 compliance trigger).

Penalty Mechanics

-50 XP



-50 XP for prolonged spatter events (distance > 4mm sustained for > 2 seconds).

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Calculation Engine: Final Base XP = (Accuracy * 10) + (Consistency * 5) - (Defects * 50)
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From High Score to Certification





3mm

Game 2 is not a mini-game; it is the absolute prerequisite for Season 3 and Season 4 (Multi-pass, 6G pipe, Remote operations).

Mastering the physical 3mm arc length eliminates 70% of beginner visual defects (porosity, spatter, lack of fusion).

3mm

Perfecting this HUD and scoring engine creates a player who, on Day 120, possesses the muscle memory required to pass a live AWS D1.1 Limited Thickness 3/8in qualification and step into a high-paying robotic operator role.

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