DriveRight VR Software Design Document (Paragraph Format, Section 7 Bulleted)

1. Introduction

DriveRight VR is a first-person virtual reality driver education simulator designed to teach, test, and validate real-world driving behaviors through immersive interaction, continuous behavioral tracking, and consequence-based learning. The system transforms driver education into an active skill-building experience by requiring users to physically perform the same behaviors demanded in real driving contexts—scanning intersections, executing full stops, signaling correctly, and managing right-of-way—rather than relying primarily on multiple-choice answers or passive video instruction. This document is intended to be implementation-ready: it specifies the functional requirements, interactions, content, and system responsibilities at a level of detail sufficient for an independent developer to build the intended experience.

2. Target Platform & Engine Choice

DriveRight VR will be implemented using the Unity Game Engine with XR Interaction Toolkit and OpenXR support. Unity is selected due to its robust VR ecosystem, strong physics and vehicle simulation tooling, cross-platform deployment options, mature asset pipeline, and straightforward integration with head-tracking and controller inputs. The visual direction prioritizes realism over stylization, using physically based rendering (PBR) materials, lighting that reflects real-world conditions (day/night, glare, fog, rain), and vehicle handling that feels plausible for novice training. These choices are made to maximize skill transfer: behaviors learned in DriveRight VR should map cleanly onto behind-the-wheel driving.

3. Intended Users

DriveRight VR is designed primarily for teen and first-time drivers (approximately ages 15–18), permit holders preparing for written and behind-the-wheel tests, and driving schools seeking a repeatable, safe training environment. Secondary users include instructors and parents who want objective performance data on a learner’s habits. In future deployments, the system is intended to be extensible for use by agencies evaluating standardized VR practice modules. The product supports both solo practice and supervised evaluation workflows, with reporting features that translate gameplay behavior into understandable rule-based feedback.

4. Design Goals

DriveRight VR is built around a small set of non-negotiable design goals: (1) validate real-world driving behavior rather than abstract memorization; (2) emphasize habit formation through repetition and consequence; (3) reduce cognitive overload for novice drivers by keeping the interface minimal and expectations consistent; (4) provide immediate, explainable feedback tied to specific rules; (5) support competitive motivation via gamification without rewarding unsafe speed; and (6) maintain modular extensibility so new scenarios, rule sets, and difficulty tiers can be added over time.

5. Core Gameplay Systems

The player drives from a first-person perspective using realistic vehicle controls. The experience is not designed as an arcade racer; instead, it evaluates observation, timing, judgment, and decision-making.

Core systems include continuous vehicle control (steering, acceleration, braking), real-time telemetry capture (speed, braking, signals), and an event-driven scenario system that introduces traffic situations at appropriate times. Where critical judgment is required, the system uses structured decision prompts to slow time, collect an explicit choice, and then simulate the consequence in a way that reinforces the rule and the habit.

6. Mirror Adjustment System

Before driving begins, the user must properly adjust the rearview and side mirrors. DriveRight VR includes a mirror-adjustment phase where the player physically grabs and rotates mirrors using VR controllers. Validation logic checks mirror positioning against acceptable angular ranges. This stage is not cosmetic: improper mirror setup reduces the effective field-of-view available to the player during driving, increasing blind-spot risk, triggering more frequent near-miss outcomes, and lowering the performance score. This design teaches that safe driving begins with correct vehicle setup and that poor setup has predictable downstream consequences.

7. Expanded Scenario Library (Bulleted)

DriveRight VR includes a large set of testable scenarios. Each scenario is rule-driven, logged, repeatable, and scored. The baseline scenario set includes:

- Unprotected left turns with oncoming traffic
- Four-way stop deadlocks
- Emergency vehicle approach
- Sudden pedestrian crossings
- School zone timing enforcement
- Highway merging
- Lane closures
- Adverse weather conditions
- Distracted drivers
- Construction flagger commands
- Railroad crossings
- Roundabout yielding
- Sudden braking of lead vehicles
- Bicycle lane interactions
- Night driving glare
- Fog-limited visibility
- Illegal passing traps
- Aggressive driver tailgating
- Tire blowout simulation
- Hydroplaning events

8. Decision Prompts & Outcome Simulation

High-risk moments trigger a structured decision prompt. When a prompt appears, gameplay pauses and the player is presented with three realistic options. The options are designed to reflect common mistakes and near-correct misunderstandings, with only one option fully satisfying the applicable driving rule. After the player selects an option, the system simulates the outcome immediately. Outcomes include safe continuation, citations, near-misses, or collisions depending on severity. To prevent false mastery, partial compliance is tracked separately (for example, signaling without completing a shoulder check). Each outcome is paired with a short rule explanation that states exactly what was done correctly or incorrectly.

9. User Interface & Aesthetics

The user interface is intentionally minimal to reinforce real-world driving perception. The in-car HUD shows only essential information: current speed, posted speed limit, turn signal indicators, and critical alerts. Decision prompts appear as clear VR overlays with large, readable text and simple selection mechanisms. Visual realism supports immersion, while color contrast and lighting are tuned for accessibility and legibility under varied conditions (night driving, glare, fog). The design avoids game-like UI elements such as minimaps, arrows, or score pop-ups during active driving to prevent training reliance on artificial aids.

10. Leaderboard & Gamification System

DriveRight VR includes a leaderboard system to motivate improvement and engagement. Players earn scores based on safe-driving performance rather than speed. Score inputs include rule compliance, reaction timing to hazards, smoothness of driving (e.g., avoidance of harsh braking and unsafe lane weaving), consistency over time, and mirror usage accuracy. Leaderboards can be configured as local (classroom-based) or global, depending on deployment. The scoring model is explicitly designed to avoid exploitation: reckless speed, aggressive maneuvers, or intentional collisions cannot produce higher scores. Where appropriate, the system can show category breakdowns (e.g., ‘Intersection Safety’, ‘Lane Change Safety’) to make competition educational rather than purely numerical.

11. Data Tracking & Scoring

The system logs player behavior continuously using two primary sources: (1) head/gaze tracking signals, and (2) vehicle telemetry. Logged fields include head orientation history, speed over time, braking events, turn signal state changes, stop duration at controlled intersections, proximity to hazards, decision prompt selections, and resulting outcomes. Scoring metrics include compliance percentage, average reaction time, mirror usage accuracy, violation frequency, and scenario difficulty weighting. Scores are normalized to prevent ‘easy scenario farming’ and to make performance comparable across sessions and users.

12. Scalability & Future Expansion

DriveRight VR is designed for modular expansion. New scenarios can be added through data configuration and scene composition without rewriting core validation logic. Rule sets can be localized by jurisdiction (e.g., California vs. other states) by swapping configuration tables and signage packs. Planned future capabilities include instructor dashboards, multiplayer observation modes (an instructor observing a learner’s session in real time), exportable analytics for schools, and pathways for integration into certified training pipelines pending regulatory approval.

13. Conclusion

DriveRight VR blends immersive simulation, behavioral validation, rule-based decision logic, and ethical gamification to create a rigorous and engaging driver education platform. By focusing on physically enacted habits—scanning, signaling, stopping, yielding, and hazard response—the system shifts learning from memorization into repeatable skill development. This document defines the project at a level of detail sufficient for direct implementation by an independent developer.