# The Development of a Low Cost Driver Licensing Simulator

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***Abstract –*** *This paper describes the development of a low cost simulator for the licensing assessment of car and truck drivers. The simulator cabs were set up to be consistent with the ergonomics of either cars or trucks. The simulator was prepared for the Transit Commission in the state of Guyas, Ecuador, so all of the user interfaces were appropriate to Spanish speakers. Furthermore, the driving scenarios and hazard situations were set up to be consistent with the look and feel of the city of Guayaquil, Ecuador where the simulators are located. The assessment criteria were set up to present the licensing examiner with feedback on the occurrence of what were termed minor and fatal errors. The examiner would then base his decision for granting a license on the occurrence of the minor and fatal errors. The paper will describe the development of the simulator and user interface and discuss issues associated with driver assessment for licensing.*

***Résumé –*** *Cet article décrit le développement d'un simulateur de faible coût pour l'évaluation de licence de la voiture et de camion. Les cabines de simulation ont été mis en place pour être compatible avec l'ergonomie de l'une des voitures ou des camions. Le simulateur a été préparé pour la Commission de transport en commun dans l'état de Guyas, l'Équateur, de sorte que toutes les interfaces utilisateur ont été appropriées pour haut-parleurs en espagnol. En outre, les scénarios de conduite et de situations de risque ont été mis en place pour être compatible avec l'aspect et la convivialité de la ville de Guayaquil, en Équateur, où les simulateurs sont situés. Les critères d'évaluation ont été créés pour présenter à l'examinateur de licence avec les informations sur l'apparition de ce qu'on a appelé mineures et des erreurs fatales. L'examinateur alors fonder sa décision d'octroi d'une licence sur la survenue des erreurs mineures et fatale. Le document décrit le développement du simulateur et l'interface utilisateur et de discuter de questions liées à l'évaluation des conducteurs pour les licences.*

# Introduction

Driving simulation has been applied in many areas including research, assessment and training [1]. Assessment involves testing the capability of drivers to handle vehicles in a safe manner. Simulator assessment has been used in a wide variety of applications including patients who's medical condition may impact their driving safety [2], [3], older driver proficiency [4], commercial vehicle driver licensing [5], driver training [6], drug and alcohol impairment [7], [8] and fatigue [9]. This paper describes a simulator developed for a less familiar application, car and truck driver licensing assessment for a transit commission in the state of Guayas, Ecuador. Previously, the commission had used closed course testing to assess drivers for licensing. The use of the simulator is intended to produce a more objective test that includes controlled hazards (vehicles, pedestrians, road profile, etc.).

The closed course testing in Ecuador required not only using available land space but also providing a standardized testing vehicle for a high volume of license applicants. As such, secondary goals of the simulation system included: increased testing efficiency to accommodate the high volume, lowering of licensing costs required of testing vehicles (e.g., gas, vehicle maintenance), and integrating simulator data with existing data infrastructure. Because little work has been done on use of simulator assessment for driver licensing the licensing authority must still work out procedures and protocols for this application to meet the needs of the state of Guayas in Ecuador.

# Background

The simulator components included all of the software and hardware features in Figure 1 except that it was fixed base (no motion) and did not include a head mounted graphics display. The basic software platform has previously been validated for novice driver training [4] and has been applied to a range of other assessment applications (e.g. [2-9]). Assessment of drivers for the purpose of licensing is a relatively new application that has mainly been pursued for commercial truck drivers (e.g. [5]). The hardware was specifically designed to meet the requirements of this application and to accommodate shipping and installation in a distant foreign country as discussed below.

# Design

*Seating Console* - Ergonomics considerations for car and truck versions of the simulator console were addressed as portrayed in Figure 2. The design of the simulator console as illustrated in Figure 3 was governed by ergonomics, cost and shipping requirements (i.e. compact, light weight and rugged). All of the components were common to the car and truck configurations, but the seating and control orientation were dictated by the ergonomic requirements of cabin layout (e.g. truck drivers sit more erect and have a more upright steering angle).

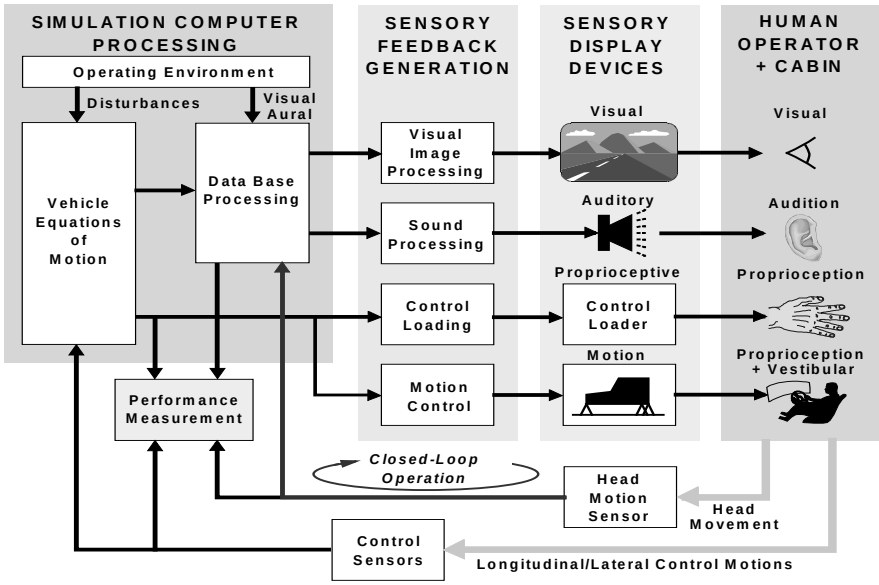
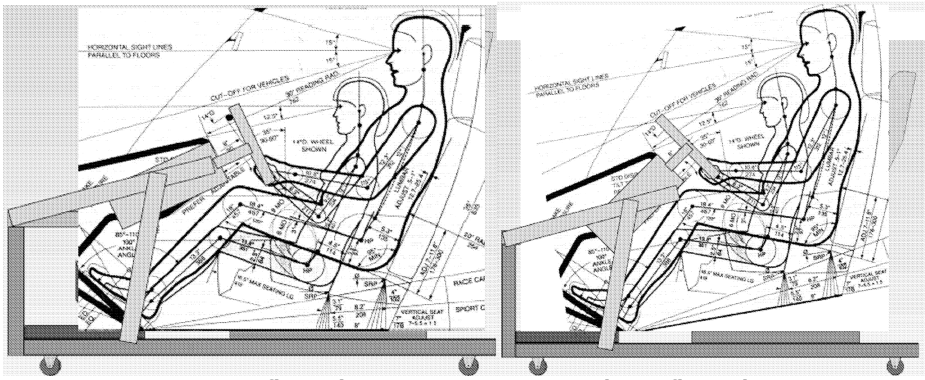



**Figure 1. Simulator Components**



**Car Configuration** **Truck Configuration**

**Figure 2. Ergonomic considerations for Simulator Consoles**

*Dynamics and Cueing* – The vehicle dynamics and cueing computations were performed on a Dell Vostro Tower computer with a dual core processor running commercially available simulation software (e.g. [1], [10]). The lateral/directional dynamics provided for basic understeer response plus cornering limits of 0.8 g lateral acceleration. The longitudinal dynamics provided for gear shifting based on clutch and shifter inputs and engine torque limits, and also included braking deceleration limits of 0.8 g. Scene graphics were provided by a commercial renderer (Open GVS) that presented the road and environs and specific models that were added at run time from a display list. The display list is used for vehicles, pedestrians and signal timing that are presented relative to the driver's position and speed, and also for various road environment objects such as buildings, flora, and traffic control devices (signs, road markings and delineation) [1], [10].

**a) Installation**

**b) Facility**


**c) Console Frame**

**d) Controls**

**Figure 3. Licensing Simulator Configuration and Installation**

**Figure 4. The Roadway Environment of Guayaquil, Ecuador**

*Driver Cueing Displays* – Visual cueing was provided by a large 42 inch flat panel display with 1080i resolution as illustrated in Figure 3. The auditory cueing was provided by the Dell Vostro Tower sound system that included a low frequency woofer and higher frequency crossover plus tweeters. Sounds included engine, tire road noise and tire squeal at high g's, crash, and wave file commands spoken in Spanish. Steering feel was provided by a torque motor responding to lateral g's.

*Drivng Scenarios* - Driving scenarios and models were developed to give the look and feel of the Ecuador capital city of Guayaquil as portrayed in the Figure 4 photographs. These photographs were taken during a drive throughout Guayaquil and environs specifically to capture the essence of the driving environment. Screen shots of the resulting scenarios with different hazard events are shown in Figure 5. The scenarios were prepared using previously published procedures [1], [10]. All traffic control devices (signs, signals and markings) were simulated according to conventions adopted in Ecuador as illustrated in Figure 5. Verbal driving instructions were provided as part of the scenarios (e.g. turn left at the next intersection) and were recorded by a native Ecuadorian speaker in Spanish using local vocabulary and idioms.


**a) Car Cabin Configuration**


**b) Truck Cabin Configuration**

**Figure 5. Driving Scenario Scenes with Hazard Situations**

A total of four customized scenarios based on vehicle speed environment were provided. These included:

1) Orientation Drive: Designed to familiarize the driver with simulator displays, controls, and virtual environment. Audio warnings were provided for any speed and traffic violations. White fog was provided to help adapt drivers to the simulation environment. Runtime: 5 min.

2) Rural Drive: High speeds in a moderate to light traffic environment. Events included: three lane freeway, speed reduction for two signal lights, left turn intersection with oncoming traffic, oncoming head collision, mountain curves, and truck passing task. Runtime: 8 min.

3) Suburban Drive: Heavy pedestrian and road obstacle environment with minimal road markings at slow vehicle speeds. Events include: one way streets, stop signs, pedestrian walk outs, vehicle pullouts, vehicles backing into driver's path, oncoming traffic in narrow streets, right/left turn intersections and a construction zone obstacle course. Runtime: 5 min.

4) Metro Drive: Heavy pedestrian and traffic in multi-lane urban environment with traffic signals at moderate vehicle speeds. Events include: bridge overpass, vehicle merges, pedestrian walkouts, vehicle pullouts, and right turn intersection. Runtime: 5 min.

*User Interface* - A Graphical User Interface (GUI) illustrated in Figure 6 was designed to allow a licensing examiner to select driving scenarios, and to give feedback on driver performance. The performance feedback includes major errors (accidents and tickets) and minor errors (crossing centerlines and edge lines, turn indicator usage, etc.) as summarized in Table 1. Examiners interpret the performance scores in terms of granting or denying a license (e.g. no fatal errors, a few minor errors).

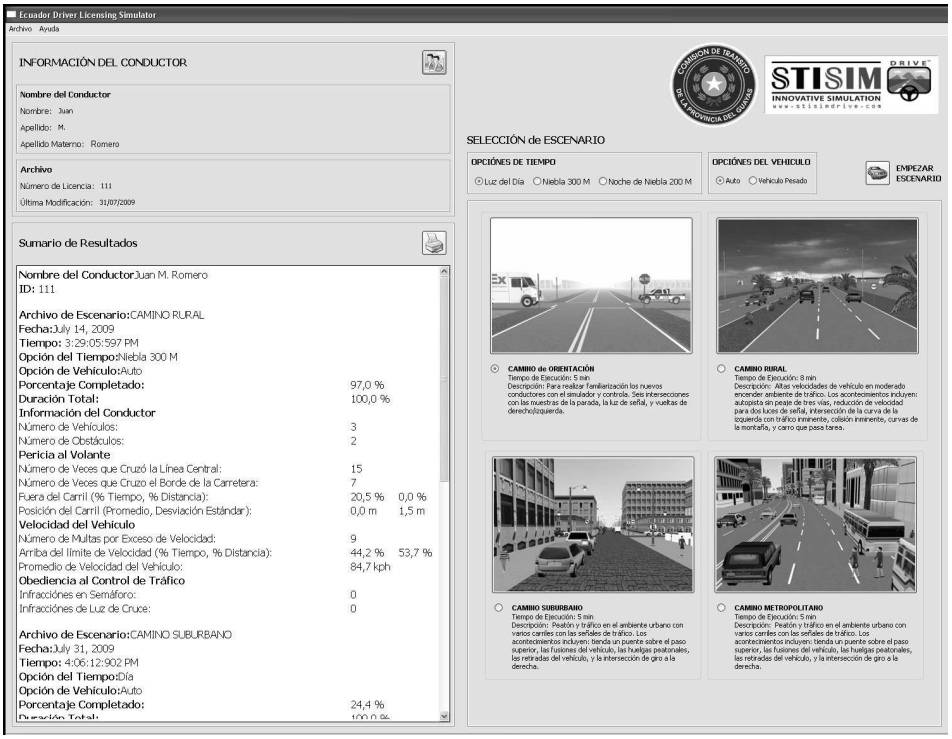



**Figure 6. Licensing Simulator GUI**

**Table 1. Drive Summary Provided to License Examiner**

| English | Spanish |
|---|---|
| **RESULTS SUMMARY** | **RESUME DE RESULTADOS** |
| **Driver Name:** | **Nombre del Conductor:** |
| **ID:** | **Número de Licencia:** |
| **Scenario File:** | **Archivo de Escenario:** |
| **Weather Options:** | **Opción del Tiempo:** |
| **Run Completion:** | **Porcentaje Completado:** |
| **Vehicle Options:** | **Opción de Vehículo:** |
| **Total Runtime:** | **Duración Total:** |
| **Date: Time:** | **Fecha: Tiempo:** |
| | |
| **Driver Collisions:** | **Colisiones del Conductor:** |
| Number of Vehicles: 10 | Número de Vehículos: 10 |
| Number of Pedestrians: 10 | Número de Peatones: 10 |
| Number of Road Obstacles: 10 | Número de Obstáculos: 10 |
| | |
| **Steering & Handling:** | **Volante y Manipulación:** |
| Number of Centerline Crossings: 10 | Número de Veces que Cruzó la Línea Central: 10 |
| Number of Road Edge Excursions: 10 | Número de Veces que Cruzo el Borde de la Carretera: 10 |
| Out of Lane (% Time, % Distance): 10.0 % 10.0 % | Fuera del Carril (% Tiempo, % Distancia): 10.0 % 10.0 % |
| Lane Position (Average, Standard Deviation): 10.0 m 10.0 m | Posición del Carril (Promedio, Desviación Estándar): 10.0 m 10.0 m |
| | |
| **Vehicle Speed:** | **Velocidad del Vehículo** |
| Number of Speeding Tickets: 10 | Número de Multas por Exceso de Velocidad: 10 |
| Over Speed Limit (% Time, % Distance): 10.0 % 10.0 % | Superaciones de la Velocidad (% Tiempo, % Distancia): 10.0 % 10.0 % |
| Average Vehicle Speed: 10.0 kph | Promedil de la Velocidad del Vehículo: 10.0 kph |
| | |
| **Traffic Control Compliance:** | **Cumplimiento de Control de Tráfico:** |
| Number of Traffic Light Tickets: 10 | Número de Billetes INFRACCIONES en Semáforo: 10 |
| Number of Stop Sign Tickets: 10 | Número de Billetes INFRACCIONES en Señal de Pare: 10 |
| Number of Turn Signal Tickets: 10 | Número de Multas INFRACCIONES de Luz de Cruce: 10 |

# Concluding Remarks

The arrival and installation of the simulators was greeted with interest (Figure 3) and they have been officially implemented for driver licensing assessment. As of this writing two applicants have been granted their license, and two applicants have been rejected and cautioned to return prepared to take the simulation assessment. The plan is to use the simulators as a replacement to the current closed course testing in order to present drivers with critical and realistic traffic and road environment situations. Fairly detailed performance feedback is provided to the examiners, but assessment criteria for licensing must still be worked out by examiners and commission authorities. The procedures and passing criteria are still being refined by the Transit Commission as of this writing.

It can be argued that the driving simulator assessment system developed here is assessing completely different metrics of driving behavior and skill than an on-road test may be assessing. But is this really a problem? According to an international literature review by Senserrick and Haworth [11], the relationship between scores of on-road assessments and crash rates once licensed has shown little association. Ecuadorian drivers in addition are required to complete a basic vehicle skills class prior to examination, therefore assessments of vehicle handling and mirror checking may be redundant for licensing

In conclusion, general simulator validation issues for assessment have been extensively dealt with in the literature (e.g. [4], [12] and included references) for specialized driving populations but further work is needed for licensing assessment for the general population. There exists a growing need for cost-effective, reliable and valid driver licensing test procedures. The current system clearly provides some desirable attributes such as safety for the driver and examiner, and the ability to test the applicant in real world situations that are relevant to traffic safety.

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