Real-World Drive Cycle Simulation

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INTRODUCTION

Future transport trends are quickly accelerating towards increasing levels of electrification and automation. Vehicle manufactures are faced with in increasing number of challenges related to the design and analysis of such complex vehicles. With this comes an increasing need for more sophisticated approaches to real-world drive cycle simulation.

Historically, vehicle drive cycle simulation primarily consisted of building high-level vehicle systems models and simulating over legislatively mandated drive cycles.

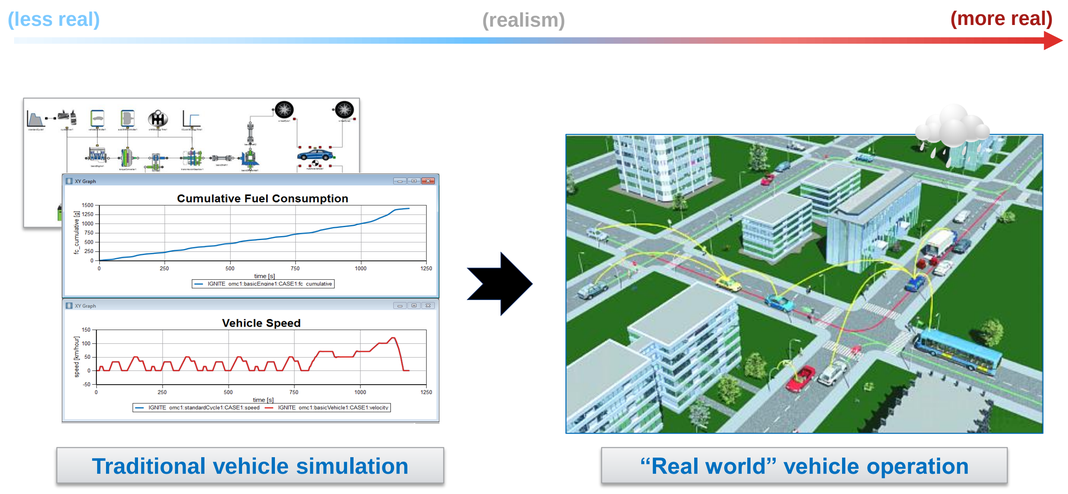
These simple drive cycles were intended to represent a mix of real-world driving behaviors, but in practice, they rarely produced results that are representative of 'real-world' vehicle performance and efficiency.

Looking to the future, transport system simulation is going to require more advanced approaches that can provide 'real-world' operational conditions and actions. To address this need, Ricardo Software has been developing a configurable software platform for real-world vehicle drive cycle assessments.

THE NEED FOR REALISM

Traditionally, vehicle system simulation involves drawing a box around the vehicle and optimizing it for standardized and legislative drive cycles. These drive cycles are represented by simple speed vs. time traces, resulting in a very "controlled" approach to predicting vehicle behavior and efficiency.

Compare this to a high-level look at how a vehicle operates in the real-world and all of the environmental factors that it interfaces with and reacts to on a constant basis.



Traditional simulation vs. real world operation

Factors such as driver behavior, road condition and route, other cars and drivers on the road, traffic signals, weather, terrain, etc.

All of these factors have a significant effect on the operation of an individual vehicle, and therefore a significant impact on the resulting "real-world" behavior. Examples include:

- The difference between a calm and aggressive driver.
- The impact of catching every red light on a specific route.
- The effect of running the air conditioning on HIGH because of outside temperatures.
- The difference in fuel consumption from driving in heavy traffic vs. cruising at highway speeds, based on time of day and traffic patterns.

With these examples in mind, it is easy to envision the various benefits that would be provided by the ability to simulate a vehicle model within a framework that can incorporate representations of these various environmental factors.

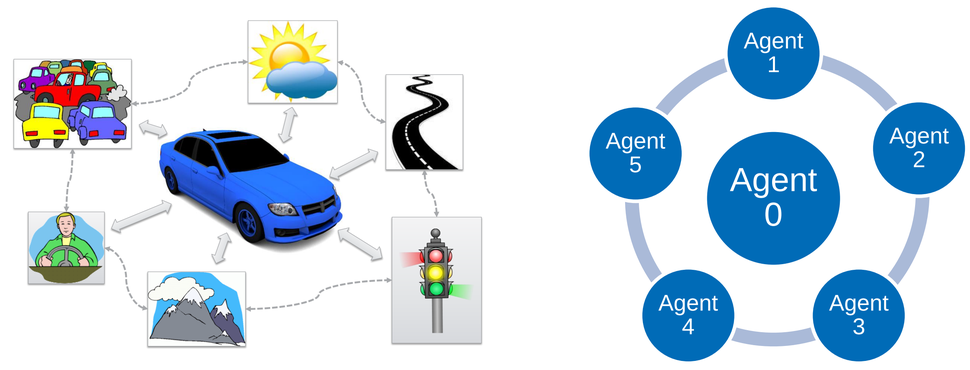
Now of course, herein lies the challenge…

How do you incorporate all of these interdependent factors into simulation-based prediction of vehicle performance and fuel economy?

BUILDING A VIRTUAL "REAL-WORLD"

Performing real-world drive cycle simulation starts with constructing a simulation framework that supports modeling a vehicle within a virtual "real-world"

In simple terms, constructing a complex physical vehicle model, and then simulating it within a virtual world that mimics the real-world environment in which it is expected to operate. A framework that incorporates the behavior, and therefore the impact of, the various key environmental factors mentioned previously. Behaviors such as: driver behavior, road condition and route, other cars and drivers on the road, traffic signals, weather, terrain, etc.



Agent Based Vehicle Simulation

This is accomplished by employing an Agent-Based Modelling approach to describe the actions and interactions of critical ground transportation participants.

Agent based modeling is a framework in which the various individual factors within a system are modelled (and represented) as "agents". Agents are self-directed entities bounded by simple rules. During simulation, agents simultaneously interact with both each other and the environment, producing a truly inter-dependent virtual eco-system. Additionally, as self-directed entities, agent behavior is inherently selfish and based on their specific rules, priorities and objectives… just as in the real-world.

Overall, agent based modeling simulations are constructed to mimic the real world by connecting multiple individual agents that are continuously interacting in an unscripted manner.

COMPARING CYCLE VS. REAL-WORLD

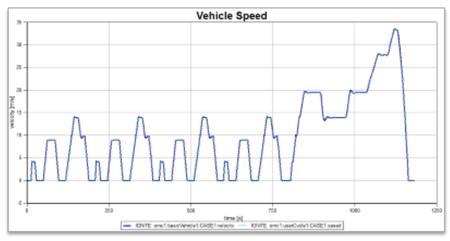
Vehicle design and analysis performed using the traditional cycle-based approach can only yield the best case fuel economy and performance for the very specific set of boundary conditions applied.

Alternatively, a real-world approach incorporates vehicle simulation that is distance and objective based. Objectives such as traveling from point A to point B on a real route. Detailed topology and terrain information, based on the route selected. Traffic and environmental factors modeled as a function of the route and time of day being analyzed.

This results in an unscripted and reactionary simulation of a vehicles duty cycle. As a result, any vehicle design and analysis performed with this approach will yield a much more "real-world" fuel economy and performance prediction.

Cycle-based vehicle simulation

- Speed vs. time based
- No gradient / terrain
- No other vehicles / objects
- Scripted operation

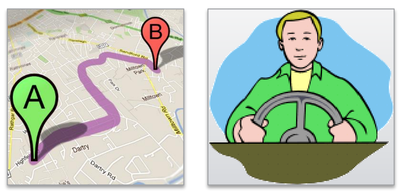


Yields best case FE & performance
(function of specific conditions)

vs.

Real-world vehicle simulation

- Distance and objective based
- Detailed topology / terrain
- Traffic
- Environment
- Un-scripted operation



Yields real-world FE & performance
(function of realistic interactions within an environment)

Cycle-based vs. Real-World Simulation