

Driver-in-the-loop simulators for vehicle development & driver research



Safe, unlimited,
repeatable testing
that saves time
and cost



The case for obtaining driver feedback through virtual testing

For drivers of vehicles to feel comfortable and safe they need to be and feel in control of the situation. With ADAS and autonomous vehicles this has never been more important. To engineer a car that feels safe, it is critical that engineers and researchers understand how to make the driver and passengers feel comfortable while traveling in a highly automated vehicle. Feedback from different types of people in multiple scenarios, throughout the development process, is key. There are simply no models for this and sufficient real-life testing is impossible – driving simulators are the only way to develop the cars and systems of the future both safely

and efficiently and at the rate required to build or maintain a competitive advantage.

By adding a driver in the loop at the earliest possible stage of the development process, engineers can validate and make design choices sooner and with greater confidence, resulting in better designs, shorter development time, less cost building prototypes and reduced environmental impact. Moreover, the use of DIL simulators helps close the gap between subjective assessment using real vehicle prototypes and objective assessment using offline simulations.

Leading the way

Cruden has been transforming the role of the driver-in-the-loop or DIL simulators for many years. Simulators are no longer a standalone development tool, reserved for use by a few specialists. Instead they are a flexible and accessible gateway for the whole organisation that connects human beings with new and adapted vehicle systems and designs. We guarantee a relevant and representative driver experience that generates the most realistic human behaviour.

The ePhyse open-architecture interface enables users of a Cruden simulator to work with their organisation's existing CAE tools, including vehicle models, traffic simulation and sensor simulation, as well as with hardware test rigs. Engineers are not tied to one direction. With transport policy and mobility technology advancing by the day, it's good to know the engineering tool chain is future-proof and adaptable.

Applications

Our range of simulators is used in various applications (as listed to the right), for vehicle development by OEMs, Tier 1 suppliers, and increasingly as part of driver observation studies by both engineers and researchers – for example, for the monitoring of attention, testing signals and reactions to AV handover moments. A Cruden simulator adds value throughout the complete development process; from early concept designs and rapid prototyping to the calibration of controllers on HIL test rigs.

-  *Vehicle dynamics*
-  *ADAS and autonomous driving*
-  *Ride & comfort*
-  *Driver training*
-  *HMI*



Important factors when considering a new simulator

There are many choices to be made when acquiring a DIL simulator, related to hardware, software and integration. Simulator packages should be evaluated on their ability to provide a completely synchronised system, with the lowest possible latency, that manages four key machine-to-driver feedback channels: visuals, control-loading, motion and audio. This is with aim of ensuring the most natural and relevant driver behaviour.

Cruden takes an open and integrated approach, developing, integrating and commissioning the entire complex simulator architecture and its interfaces in-house, guaranteeing industry-leading system latency and frequency response. A top of the line DIL simulator is more than the sum of its parts and undertaking this integration is far from a trivial task. Customers assigning the integration work to Cruden can focus on their core business.

1. Visual



Eyes are the most important sense for situational awareness. Therefore, a good visual system is key to achieve the necessary, high level of immersion. Cruden supplies optimized visual systems (one coherent system of projectors, screen and signal distribution), content (tracks & roads, cars, scenery) and professional image generation, software, including warping, blending and motion platform tracking.

3. Motion



To achieve realistic driver behavior, it is important that proportional motion cues are presented to the driver without latency. Cruden has developed special motion cueing algorithms that provide the best possible motion cues for any size of motion workspace. Different cueing modes are available, optimized for specific driving scenarios (city, highway, circuit etc.) each optimized for a driving scenario (city, circuit).

2. Control Loading



It is essential to get the right force feedback on the steering wheel, to give the driver good feel and control of the car. All Cruden driving simulators use our direct drive force feedback steering system, a purposely designed, direct drive, multi-turn actuator for high fidelity steering feel reproduction.

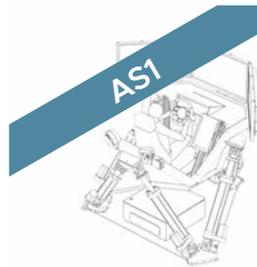
4. Audio



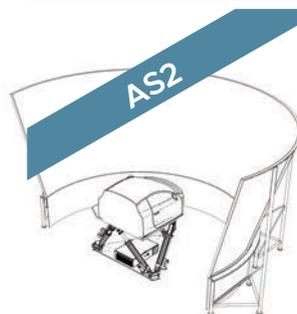
Sound is an often-underestimated sensory channel, possibly because most drivers are not aware how much sounds influence their behavior. Cruden simulators are supplied with high-end multi-channel audio systems that use top-class DA conversion, low latency signal processing, balanced signal distribution and high-end audio components. This is combined with a professional audio engine and a wealth of experience in recording and reproducing every audible sound.

Cruden products

Cruden has three standard automotive simulators, each with extensive upgrade options to suit specific customer needs and budget. More details can be found in our product information sheets. Our experts will help you choose the right solution for your situation.



A compact 6-DOF simulator with 3 x 42" onboard screens for departmental use where footprint and budget are limited, either with or without motion. Cruden supplies the driver interface hardware and vehicle model. Ideal for driver observation work in HMI, ADAS & AV concept development.



A vehicle dynamics-focused 6-DOF simulator, with 210 deg conical projection screen and three projectors, for vehicle dynamics testing. Designed to be integrated with the customer's own hardware and CAE modelling tools.



The ultimate complete vehicle simulator offering the highest possible level of immersion thanks to its high contrast and high resolution visual system with additional 360-degree yaw motion. Extra stiff dynamic platform, suitable for multiple applications such as vehicle dynamics, ADAS and HMI testing.

Cruden's products and services include:

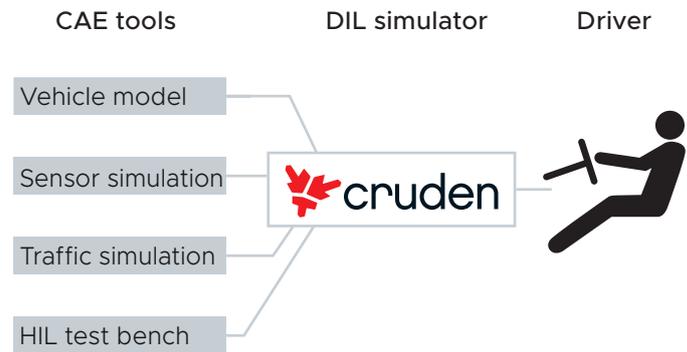
Hardware	Software	Integration services
Direct drive force feedback steering systems	Cruden Panthera simulator software suite	Tuning of customers' vehicle dynamics model for use in a driving simulator
Static to 9-DOF motion systems	ADAS development toolkit	Integration of customers' ADAS/AD development tools
Top platforms, into which mock-up or partial/complete vehicles can be mounted. Interchangeable options available.	Data logging	Traffic integration
Professional automotive driver interface equipment e.g. shifting devices, pedal boxes, steering wheels, complete dashboards, seat belt loaders	Panthera SISTER (Server for Interaction with Surfaces & Terrains).	Interfacing with common or customer-specific data exchange protocols like FEP
Visual systems with on- and off-board projection systems as well as integrated TFT displays.	Platform tracking and warping & blending – for setting up flawless projection systems.	
Digital audio systems	3D content – roads, cars, tracks, environment, scenarios.	

Cruden backs up its installations with maintenance, support and consultancy contracts. This can vary from responding to occasional phone and email queries, to

providing remote online support, maintenance visits and full support and consultancy.

Driving the vehicle model; integrating with your CAE tools

Through our ePhyse generic interface architecture, Cruden simulators integrate with engineers' own CAE tools in sensor simulation, traffic simulation, HIL testing and dedicated vehicle dynamics packages such as VI-CarRealTime, IPG Carmaker, CarSim, SIMPACK, VeDYNA, dSPACE ASM, AVL VSM and Dymola-based models. ePhyse interface can link any Real-Time code to the simulator environment, supporting platforms such as dSPACE, CCUR iHawk, ETAS and Speedgoat.



Customers

Our customers range from engineers progressing from running desktop vehicle simulation, to first tier suppliers and small automotive departments up to OEMs specifying large R&D capital investment simulator projects requiring significant customization. We have partnered with Audi, AVL, BMW, Bridgestone, Ferrari, Hyundai Mobis, Jaguar Land Rover, Lamborghini, Mercedes-Benz, Michelin and Porsche, as well as various universities and research institutes.

About Cruden

Cruden's founders have been developing professional driving simulators since the early 1990s. We were the first specialized company to supply motion-based simulators to the market and led the development of simulators in the motorsport automotive and marine industries. As a result, we have the world's leading experts in simulator hardware and software design, vehicle dynamics and modelling, content and design, professional image generation and motion-cueing. Cruden was born in 2005 and the company is based in Amsterdam, the Netherlands.

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