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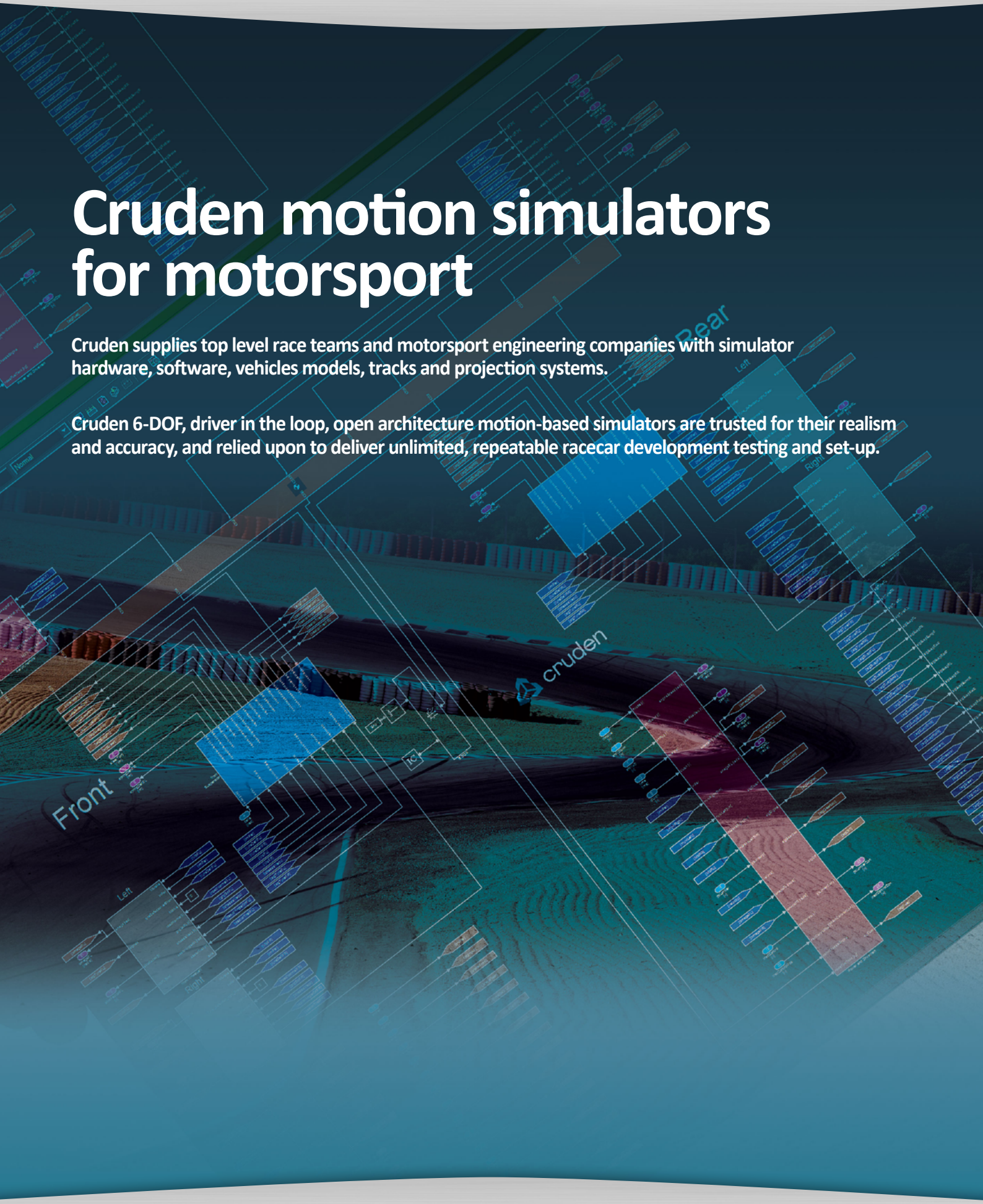
Cruden motion simulators for motorsport

Cruden supplies top level race teams and motorsport engineering companies with simulator hardware, software, vehicles models, tracks and projection systems.

Cruden 6-DOF, driver in the loop, open architecture motion-based simulators are trusted for their realism and accuracy, and relied upon to deliver unlimited, repeatable racecar development testing and set-up.



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Simulators for motorsport applications

Traditionally, the use of professional motion-based simulators has been limited to Formula 1 teams and a few motorsport engineering companies. Extremely powerful PC hardware has driven the development of accessible software tools for simulation to new levels. Now, simulators play a significant role in motorsport engineering in single seater as well as in sports car and touring car racing.

Cruden has recognized the potential of racing simulators since the late 1990s and has developed an extensive software suite that either integrates with existing engineering environments or serves as a starting point for newcomers. Simulators by Cruden are well known for their flexibility, durability and performance. Over 100 motion based simulators have been installed and many are being used for various motorsport applications:

- Driver training
- Race preparation and strategy
- Car set-up
- Car and component development

What to buy?

When acquiring a simulator, there are many questions. While there is no "one size fits all" solution, the engineering application will decide the configuration, motion system, top platform and other fundamental components. Next, the budget, timing, facility and the level of customer experience with DIL simulators are important factors to consider.

Cruden technology is open, meaning an array of different simulators can be put together for different applications. Our experts will help you choose the right solution for your situation.

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 contracts.

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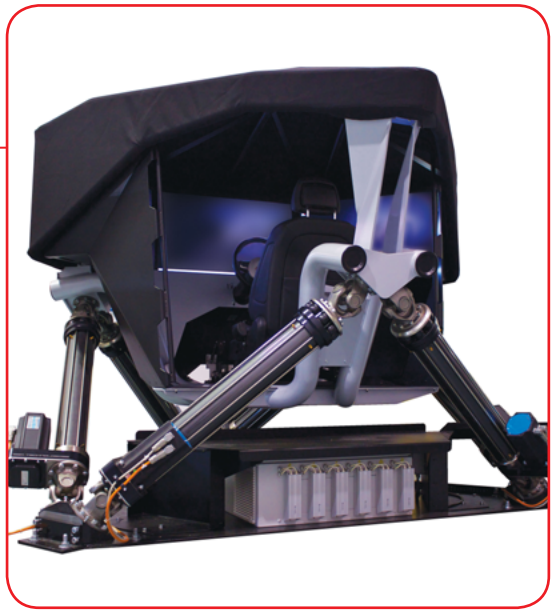
Products: standard or customized

Cruden makes standard as well as bespoke simulators to customer specification. Below are three standard simulators that are commonly specified for the motorsport market.



M646-D3C

Base product for motorsport applications

Compact, affordable and flexible, it ships in one piece and fits in a space of 5.5 m x 5 m x 3.5 m. Customers can be up and running within three to four months.

Hardware

- 6-DOF, 640 motion base
- Control loading / force feedback steering system
- 3x 42" displays
- Recessed top frame with race seat, steering wheel and pedals
- Canopy

Software

- Panthera Master
- Panthera ePhyse (external vehicle model integration)
- Panthera Set-Up Tool
- Panthera Telemetry Analyzer Pro
- Panthera Spectator view
- Panthera GPS Tracker
- Panthera CSVM detailed in-house vehicle model available as an option
- Content: circuits and test tracks

M646-N3

Simulator with on-board projection and screen

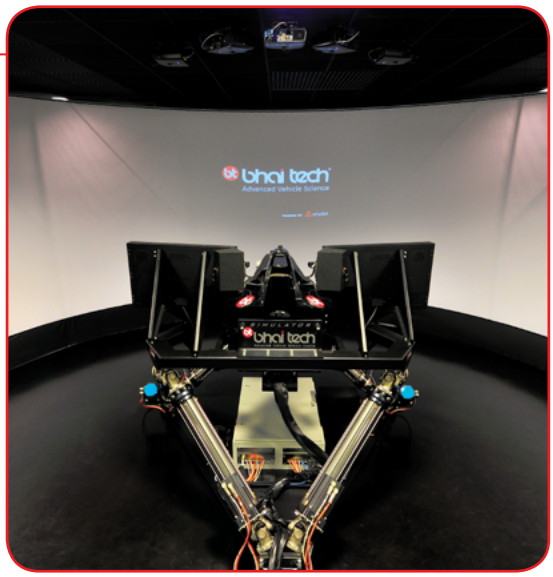
A compact solution for when a mock-up or partial vehicle is required and more advanced visuals. Fits into a space of 8 m x 7 m x 5.5 m.

Hardware

- 6-DOF, 640 motion base
- Control loading / force feedback steering system
- On-board carbon fibre screen with a viewing angle of 180°
- 3 Barco F50 projectors (120 Hz @ 2560 x 1600 resolution)
- Top frame with interface on which a mock up or partial vehicle can be mounted
- Interchangeable Driver Cell (IDC) optional (see page 4).

Software

- Panthera Master
- Panthera ePhyse (external vehicle model integration)
- Panthera Set-Up Tool
- Panthera Telemetry Analyzer Pro
- Panthera Spectator view
- Panthera GPS Tracker
- Panthera CSVM detailed in-house vehicle model available as an option
- Content: circuits and test tracks



M646-F5

High immersion simulator with off-board projection and screen

This system requires a 9 m x 6.5 m x 5 m simulator room.

Hardware

- 6-DOF, 640 motion base
- Control loading / force feedback steering system
- Off-board, 8 m diameter, 210° viewing angle screen
- 5 Barco F50 projectors (120 Hz @ 2560 x 1600 resolution)
- Top frame with interface on which a mock up, partial or full vehicle can be mounted
- Interchangeable Driver Cell (IDC) optional (see page 4).

Software

- Panthera software suite incl:
  - •Panthera ePhyse (external vehicle model integration)
  - •Panthera Set-Up Tool
  - •Panthera Telemetry Analyzer Pro
  - •Panthera Spectator view
  - •Panthera GPS Tracker
- CSVM detailed in-house vehicle model available as an option.
- Content: circuits and test tracks

Hardware

Cruden's racing simulators are built around motion systems and direct drive force feedback steering systems. From there, a choice of standard top platforms is available, but custom configurations can also be specified by the customer using Cruden's technology building blocks.

Motion base

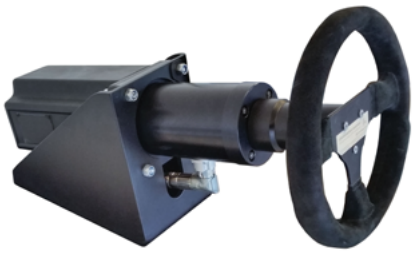
Cruden uses various motion bases for its simulators. Its standard industrial 6-DOF systems – with either 400 or 640 mm actuator stroke – are used in professional automotive, motorsport and military applications around the world.

The hexapod platform is a renowned and excellent solution for motion systems:

- The parallel kinematic structure and closed-loop system make it very stiff.
- Excellent high dynamic behaviour.
- No accumulation of positions errors, as with cascaded structures.
- Small package with a simple mechanical design, using six identical actuators.
- No moving cables and cable chains.

Control loading / Force feedback

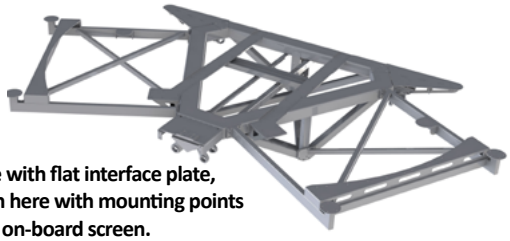
Cruden uses direct drive force feedback systems. These are purposely designed, single or multi-turn actuators for high-fidelity steering wheel applications, featuring double loop control. The tunable inner loop controls the servomotor and the outer loop uses a load cell, to optimally recreate the torque demanded by the vehicle model. This also allows the user to request features such as friction, damping and soft-stops. At a bandwidth exceeding 50 Hz, the maximum peak torque is 30 Nm, the nominal maximum torque is 20 Nm and the maximum velocity is 4500 deg/s.



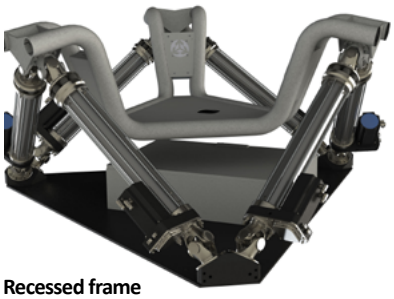
Top platform

Cruden standard simulators come with either a recessed-seating frame or interface frame on which a mock-up, cockpit or partial/complete vehicle can be mounted.

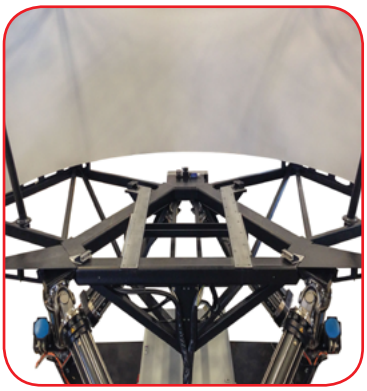
The Interchangeable Driver Cell (IDC) option allows for different mock-ups to be fixed to the top platform, with a cha



Frame with flat interface plate, shown here with mounting points for an on-board screen.



Recessed frame



Interchangeable Driver Cell (IDC) platform

FREQUENCY RESPONSE

The bandwidth (-3 dB point) of Cruden's motion bases exceeds 20 Hz in all 6-DOF. The bandwidth for heave and rotational degrees of freedom goes beyond 40 Hz.

The control loader bandwidth exceeds 50 Hz.

LATENCY

Visual full round-trip latency (from driver input to visual change from full white to full black) is just below 30 ms of which 19 ms is due to the projectors.

For motion (heave, roll, pitch and yaw) latency is 10 ms. Surge and sway are below 20 ms.

The end-to-end latency from the driver generating an input to the driver receiving feedback on the control loading is only 7 ms. Audio latency is as low as 8 ms.

Racecar components

Cruden has many years' experience integrating complete or partial tubs, mock-ups, cockpits and original vehicle components e.g. shifting devices, pedal boxes and steering wheels.

Add-ons such as an active brake pedal, seat belt loaders and vibration devices create a fit-for-purpose engineering tool.

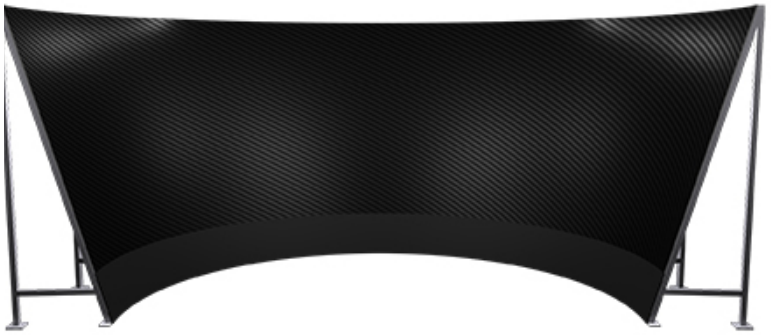
Display and audio

Cruden makes systems with integrated TFT displays as well as on- and off-board projection systems with both mono and stereo projection using various technologies available on the market (Infitec, active shutter glasses and more). All simulators come with digital audio, with extremely low latency (see box on page 4).

TFT displays

Cruden produces its own 42" vibration isolated, industrial displays.

Projection systems



Off-board, conical screen with a diameter of 6-8 m that facilitates the use of only 3 projectors for more than 180° horizontal field of view.

PC hardware

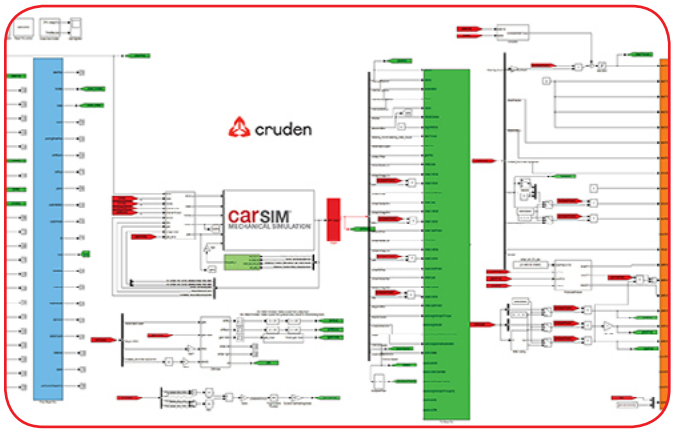
The rendering engine and peripheral software run on high-end COTS Windows PCs. RT Linux is used to control the hardware whereas the vehicle model may reside on a variety of Real Time platforms as well as on a soft real time Windows machine.

Software

All Cruden simulators run on the Cruden Panthera software suite, which includes various modules, depending on the application. Panthera integrates perfectly with existing simulator hardware and is also available as a stand-alone desktop application.

Panthera

Panthera Master is the main simulation controller.
It uses high-end physics and an excellent rendering engine. It contains controllers for different types of hardware, e.g. motion platforms, steering feedback, pedals, dashboard and a scripting engine to define and customize the simulation. Panthera easily integrates with HIL or SIL configurations.



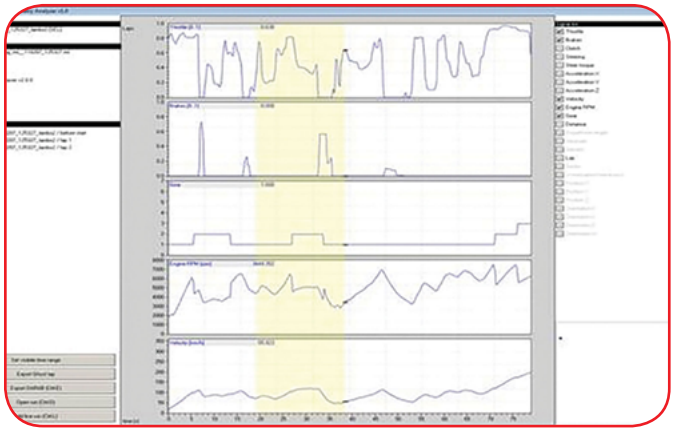
Vehicle modeling

Vehicle modelling / ePhyse

Either an internal or external vehicle model can be used with Cruden simulators. Panthera has a 16-DOF internal vehicle model.

Through Panthera ePhyse, external vehicle model packages such as Vi-Grade, IPG CarMaker, veDYNA, CarSim, Dymola, dSPACE ASM or SIMPACK can be integrated into a Cruden simulator. The models run natively, in co-simulation, through their Simulink S-functions or are compiled through Simulink Coder and then run on the Master PC.

Alternatively, Cruden has developed its own highly detailed Simulink Vehicle Model, Panthera CSVM, which is an option on every simulator. For start-up, Panthera CSVM-Lite is available.



Panthera Telemetry Analyzer Pro

Set-up Tool

With Panthera Set-up Tool and a Cruden vehicle model, engineers can change almost all vehicle settings from a GUI, most of which at runtime. Customers with a Simulink-compatible vehicle model can also interface to Panthera Set-up Tool.

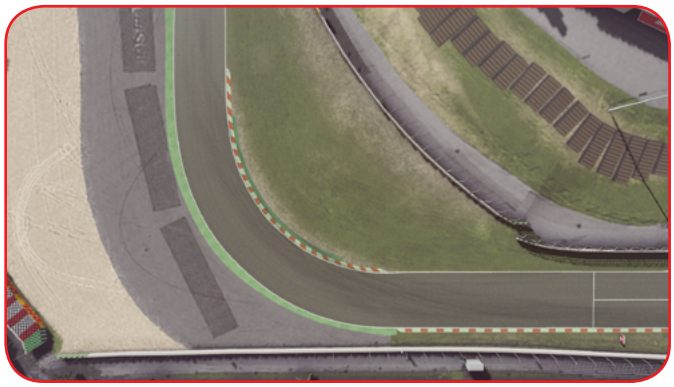
Telemetry

When running a Cruden vehicle model, vehicle performance can be evaluated as the simulator runs. After the session, the data can be exported in a variety of formats. Customers can also integrate this tool in their own vehicle modeling environment.

Remote simulator operation

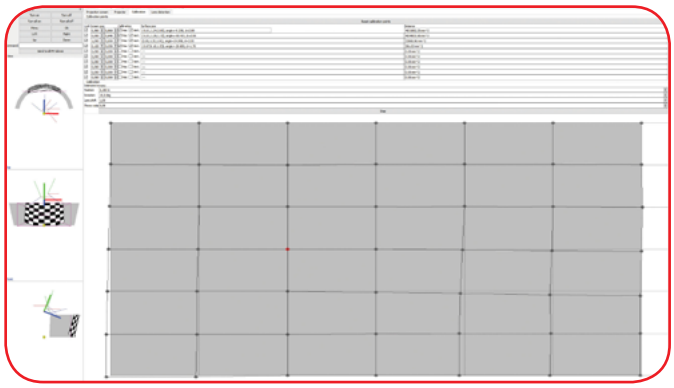
Content: circuits, test tracks, environment

Cruden creates content and has built up a library of race and test tracks from around the world. The use of full Lidar scanned data provides the most accurate circuit representation, from a reassuring bump in the track to the tree that signals a driver's braking point.



Edge blending & warping

The Panthera software has a built-in module, Projectionist, that compensates for the distortion when projecting on an arbitrary shape surface. The compensation takes into account the position of the projectors, the shape of the projection screen as well as the dynamic position and orientation of the motion base. It also smoothly blends the edges of each area where projections overlap.

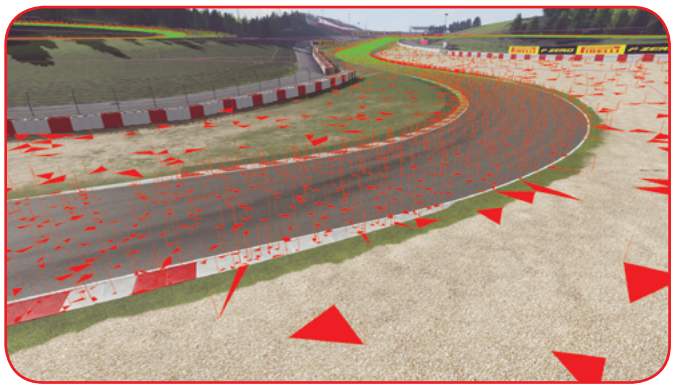


Platform tracking

For off-board projection, Panthera tracks the motion platform position and orientation and adjusts the projected images accordingly. This can also be combined with head and/or eye-tracking.

Panthera SISTer

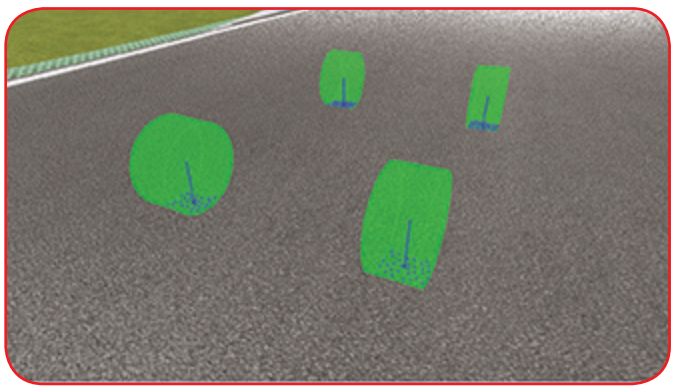
Panthera SISTer (Server for Interaction with Surfaces & Terrains) determines how the tire contact patch interacts with the road. This can be done either by multisampling with up to 49 intersection queries per wheel, or by driving directly on a dense point set with a spatial density down to 10 mm. This is done at a frequency of 1000 Hz or higher. This method provides highly improved input to the tire model, resulting in detailed and precise forces and moments plus road-normal calculations, without additional computational costs to the vehicle model. The interaction between the vehicle model and Panthera SISTer has a latency of less than 2 ms and uses a predictive algorithm to compensate for these delays.



INTEGRATION AND SYSTEM KNOW-HOW

Engineers value Cruden above all, because of its expertise in system integration and overall system know-how. A simulator is a complex mechatronics system, consisting of mechanical, electrical, electronic and sometimes hydraulic components, as well as several software packages. Cruden designs the complete simulator architecture, including all the components that are integrated into a simulator.

This integration, both in the design as well as manufacturing and commissioning phase, is one of the most important and often underestimated factors.



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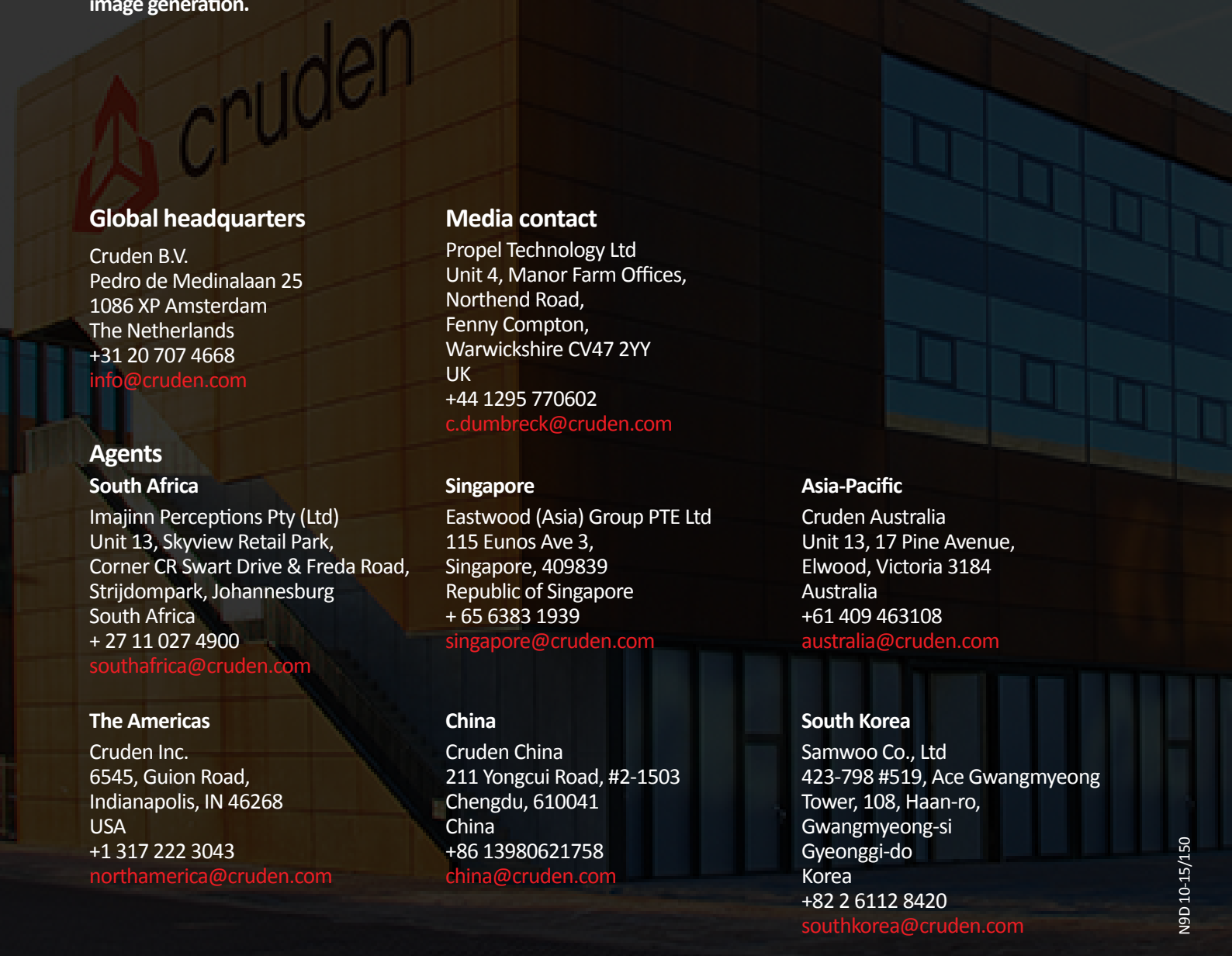
Cruden's founders have been developing professional motion simulators since the early 1990s. The company started developing products for the aerospace industry and helped lead the technology transfer into the marine, automotive and motorsport industries.

As a result, Cruden has the world's leading experts in the complete array of technologies required for a simulator.

Cruden's team of vehicle dynamicists, software developers, mechanical engineers and project managers is based at its global headquarters in Amsterdam. The building houses the functional teams that cover: mechanical design of all the company's components and systems; hardware assembly and integration; the content studio which makes all the content for the simulated environment e.g. tracks, roads, vehicles and scenery; and all associated software, from the design of motion-cueing algorithms, through vehicle modeling to the simulator operating software and professional image generation.



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