**Autonomous Driving Simulation Industry Chain Report, 2020-2021 (II)**

May 2021

# Abstract

In addition to simulation closed-loop platform and vehicle dynamics simulation mentioned in the Autonomous Driving Simulation Industry Chain Report, 2020-2021 (I), autonomous driving simulation also involves traffic flow simulation, scenario simulation and sensor simulation modules. The Autonomous Driving Simulation Industry Chain Report, 2020-2021 (II) sorts through companies in these areas.

| | Company | Simulation Products | | | |
|---|---|---|---|---|---|
| | | Sensor | Vehicle Dynamics | Traffic Flow | Scenario |
| Integrated Platform Companies | ANSYS 1970, the US | Closed-loop platform: VRXPERIENCE (co-developed with AVSimulation in 2019, supported by SCANeR) | | | |
| | | Optics (acquired in 2018) | Ansys Motion | SCANeR Studio | SCANeR Studio |
| | Siemens 1847, Germany | Closed-loop platform: TASS Prescan (acquired in 2017) | | | |
| | | Prescan | AMESim | Aimsun (acquired in 2019) | Prescan |
| | NVIDIA 1993, the US | Closed-loop platform: DRIVE Constellation | | | |
| | | DRIVE Sim (supported by NVIDIA Omniverse) | | | |
| | AVSimulation 2017, France | Closed-loop platform: SCANeR Studio | | | |
| | | Physics Based Sensors Pack | CALLAS VEHICLE DYNAMICS MODEL | Foundation Pack | Foundation Pack |
| | Spectris plc 1915, the UK | Closed-loop platform: VI-grade VI-DiM (acquired in 2018) | | | |
| | | RightHook (acquired in 2019) | VI-grade VI-CarRealTime | VI-grade STATIC Simulator | VI-grade WorldSim |
| | MathWorks 1984, the US | Closed-loop platform: Automated Driving Toolbox | | | |
| | | Automated Driving Toolbox | Vehicle Dynamics Blockset | Automated Driving Toolbox | RoadRunner (acquired VectorZero in 2020) |
| | | | | | Driving Scenario Designer |
| | PanoSim 2014, China | Closed-loop platform: PanoSim | | | |
| | | SensorBuilder | VehicleBuilder | WorldBuilder | WorldBuilder |
| | 51WORLD 2015, China | Closed-loop platform: 51Sim-One | | | |
| | | Sensor simulation model | 51Sim-One | OpenSCENARIO Editor | WorldEditor |

## Product Distribution of Some Autonomous Driving Simulation Companies

| Company | Self-developed (Orange) | Acquired (Blue) | Other | Co-developed (Green) |
|---|---|---|---|---|
| NI 1976, the US | ADAS Sensor Fusion HIL | monoDrive | | |
| Foretellix 2017, Israel | | Metamoto | | Foretify Platform |
| IPG Automotive 1984, Germany | CarMaker | | | |
| Mechanical Simulation 1996, the US | CarSim | | | |
| Vector 1988, Germany | | TESIS DYNAware (acquired in 2019) | | |
| PTV Group 1979, Germany | | | PTV VISSIM | |
| Systra 1957, France | | PARAMICS (acquired in 2005) | | |
| Caliper 1983, the US | Transmodeler | | | |
| MSC Software 1863, the US | | v-TRAFFIC v-SCENARIO (acquired VIRES VTD in 2017) | | Road Designer (acquired VIRES VTD in 2017) |
| Cognata 2016, Israel | | | | Cognata Simulation Platform |
| ESI Group 1973, France | | | | ESI Pro-SiVIC (merged and acquired CIVITEC in 2015) |
| AB Dynamics 1982, the UK | | | | rFpro (acquired in 2019) |
| Applied Intuition 2017, the US | | | | Simulate |
| Parallel Domain 2017, the US | | | | Batch, Step, Stream |

Note: the listed above are not the full range of products of these simulation companies

Orange background—self-developed products  Blue background—acquired products  Green background—co-developed products

# Abstract

Acquisitions (or mergers and acquisitions) are, beyond doubt, a shortcut for companies to better technology layout. Autonomous driving simulation is no exception. Ansys' acquisition of the optical simulation software provider OPTIS and Siemens' purchase of TASS have been milestones in their development histories of autonomous driving simulation technology.

The more mature the autonomous driving simulation industry becomes, the higher barriers the industry poses. Technology and capital walls put up by simulation giants have been a big hindrance to the growth of start-ups. Players that just specialize in their own field may end up with being acquired or introducing external support. They cannot escape from tycoons at last.

**Acquiring these specialized leaders has been an easy way for giants to perfect their layout**

*1. VectorZero, the owner of the scenario editor RoadRunner, was acquired by MathWorks, an integrated simulation platform, and its simulation tools were included in MATLAB/Simulink product system.*

RoadRunner owned by VectorZero is a scene editor. It can create environments and roads, generate complex road networks composed of roundabouts, intersections and bridges, and custom traffic signs and markings.

Benefits of RoadRunner:

①A variety of editing tools: road tools, junction tools, lane tools, marking tools, prop tools, etc.;

②Quick 3D scene modeling: RoadRunner Asset Library lets users quickly populate their 3D scenes with 3D models.

MathWorks just settles on RoadRunner's 3D scene capabilities.
In April 2020, the integrated simulation platform MathWorks acquired VectorZero, and brought RoadRunner tools for designing 3D scenes for automated driving simulation, into its MATLAB/Simulink product system.

# Abstract
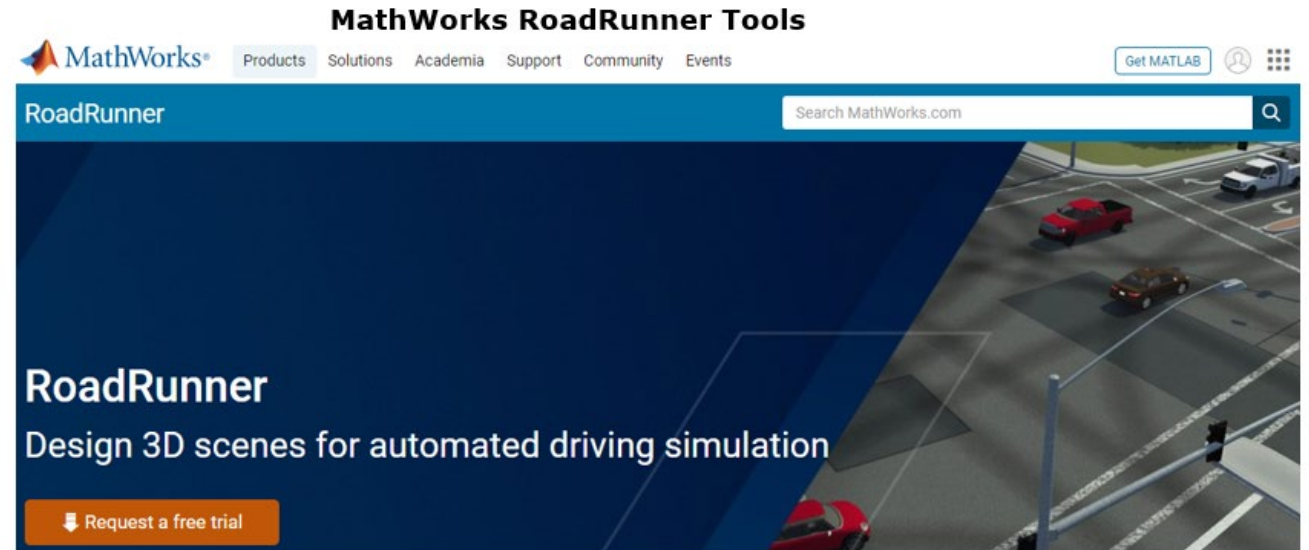
In May 2020, MATLAB R2020a Version added RoadRunner tools to Automated Driving Toolbox.

***2. The integrated simulation platform Spectris plc acquired VI-grade (vehicle dynamics simulation) and RightHook (sensor simulation).***

In July 2018, Spectris plc acquired VI-grade, a vehicle dynamics and driving simulator player, for a foray into the vehicle testing and simulation field.
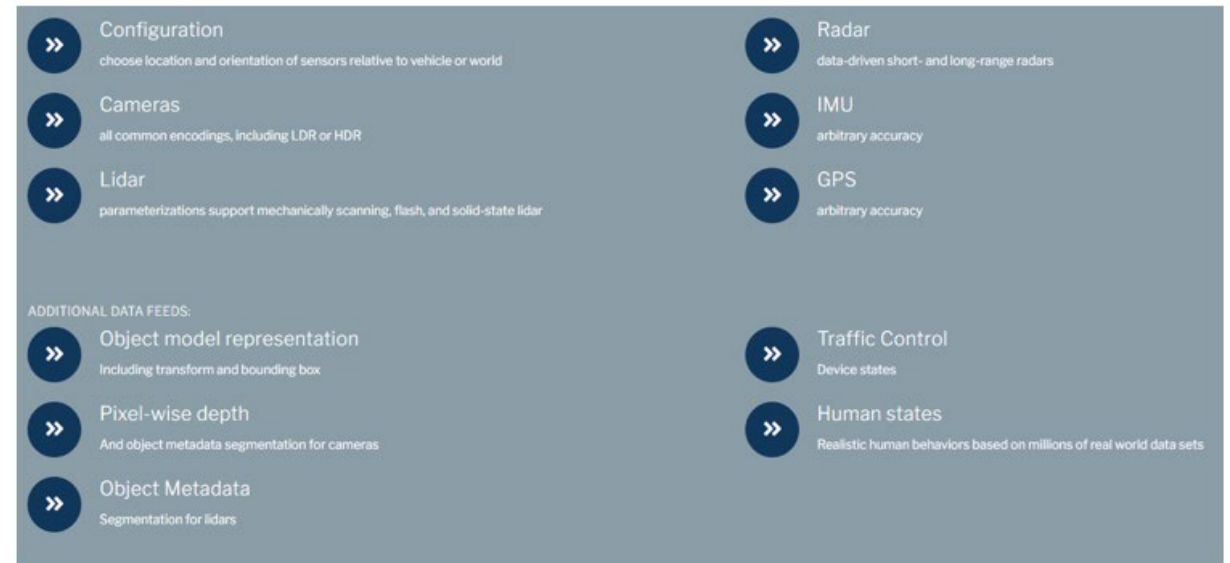
In February 2019, Spectris plc bought RightHook, a sensor simulation firm, and then merged it into VI-grade.

Benefits of RightHook:

①Provide a complete simulation tool chain including RightWorld and RightWorldHD, RightWorldHIL;

②Enable HD map-based simulation, and rebuild the whole simulation environment according to the HD maps used by autonomous driving companies. The test environment is real driving environment.

**Sensors Supported by RightHook**

» Configuration
choose location and orientation of sensors relative to vehicle or world

» Cameras
all common encodings, including LDR or HDR

» Lidar
parameterizations support mechanically scanning, flash, and solid-state lidar

ADDITIONAL DATA FEEDS:

» Object model representation
Including transform and bounding box

» Pixel-wise depth
And object metadata segmentation for cameras

» Object Metadata
Segmentation for lidars

» Radar
data-driven short- and long-range radars

» IMU
arbitrary accuracy

» GPS
arbitrary accuracy

» Traffic Control
Device states

» Human states
Realistic human behaviors based on millions of real world data sets

# Abstract

VI-CarRealTime, VI-grade's vehicle dynamics model, provides a set of dynamics simulation services such as hardware/software in the loop.

In November 2020, VI-grade introduced VI-WorldSim that provides urban and public road test environments for ADAS and autonomous vehicles. VI-WorldSim features include traffic, pedestrians, lighting, weather, and sensors to enable users to create and test scenarios for vehicle development programs through an intuitive and easy-to-use desktop editor.

Noticeably, for this product, RightHook provides integrated visual environment for driving simulators, which means the two companies have merged in terms of operation and products.

**Start-ups double down on financing, hoping to change the fate of "being acquired".**

*1. Applied Intuition raised USD125 million.*
Applied Intuition was founded by Qasar Younis and Peter Ludwig (former workers of Google) in 2017. The company recorded roughly USD26 million in revenue in 2020. The edge of Applied Intuition lies in the ability to use real/synthesized data to build complex scene interactions in a short time and generate thousands of permutations to cover edge scenarios. Meanwhile, in the simulation process, the dashboard of the virtual vehicle can display "the impact of virtual intersections and obstacles on vehicle acceleration and passenger comfort", and other information.

On October 22, 2020, Applied Intuition raised USD125 million in a Series C funding round led by Lux Capital, Andreessen Horowitz, and General Catalyst, which took its market capitalization to USD1.25 billion.

**Financing Course of Applied Intuition**

| Time | Round | Amount | Investors |
|------|-------|--------|-----------|
| Sept. 2018 | A | USD11.5 mln | Andreessen Horowitz, Lux Capital, Liquid2, Naval Ravikant, Haystack, Floodgate |
| Sept. 2019 | B | USD40 mln | Kleiner Perkins, Microsoft M12, Sozo Ventures and La Famiglia |
| Oct. 2020 | C | USD125 mln | Led by Lux Capital, Andreessen Horowitz and General Catalyst |

**Background of Applied Intuition's Team Members**

Automotive x Software

Our team has software and automotive experts from the top companies in the world

Google · The Moonshot Factory · WAYMO · Microsoft · amazon · NVIDIA · Apple

APTIV · BOSCH · GM · VOLVO · TOYOTA · Ford · Tesla

**2. The scenario simulation startup Parrallel Domain raised USD11 million in a Series A funding round where Toyota was a co-investor.**

Parallel Domain was founded by Kevin McNamara (with a background in Apple autonomous driving technology) in 2017. Parallel Domain can synthesize a variety of scenes (e.g., day, night, fog, rain and city) for sensors (including LiDAR and camera), and also can embed complex elements (e.g., traffic lights, vehicles, pedestrians and animals) in scenes. Its simulation platform provides abundant metadata for users to test various new sensors and technical configurations.

In October 2020, Parallel Domain raised USD11 million in a Series A funding round led by Foundry Group and co-invested by Calibrate Ventures, Costanoa Ventures, Ubiquity Ventures and Toyota AI Ventures.

### Financing Course of Parallel Domain

| Time | Round | Amount | Investors |
|------|-------|--------|-----------|
| Dec. 2018 | Seed | USD2.5 mln | Costanoa Ventures (leading investor), Ubiquity Ventures, etc. (co-investors) |
| Dec. 2020 | A | USD11 mln | Foundry Group (leading investor), Calibrate Ventures, Costanoa Ventures, Ubiquity Ventures and Toyota AI Ventures (co-investors) |

**3. The scenario simulation company Cognata added partners including Hyundai Mobis, Atlatec and Ouster between 2020 and 2021 for accelerating commercialization of products.**

Combining artificial intelligence, deep learning and computer vision, Cognata reproduces cities on its 3D simulation platform, providing customers with a range of test scenarios that simulate real-world test driving. In 2020, Cognata increased several partners, gathering pace in product application and variety.

①In November 2020, Cognata teamed up with Atlatec to support Atlatec's HD maps on the Cognata simulation platform, providing customers with the ability to extend the catalogs of accurate environments available for large-scale virtual validation;
②In January 2021, Cognata and Ouster partnered up in order to develop an accurate virtual LiDAR model in Cognata's simulation software.

According to the 2020 Blue Paper on Autonomous Driving Simulation of China, the current distribution of autonomous driving algorithm tests is as follows: around 90% tests are completed on simulation platforms, 9% in test fields and 1% on public roads. As simulation technology advances and becomes widespread, the industry aims at 99.9% tests carried out on simulation platforms, 0.09% in closed scenarios and 0.01% on real roads. In the second half of autonomous driving, the commercial use will bring soaring demand for testing, which may catalyze a new round of shuffle in the simulation industry.

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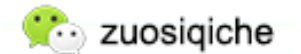TEL: 010-82601561, 82863481
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