

**Global Autonomous Driving Simulation and
Virtual Test Industry Chain Report,
2018-2019**

January 2019

STUDY GOAL AND OBJECTIVES

This report provides the industry executives with strategically significant competitor information, analysis, insight and projection on the competitive pattern and key companies in the industry, crucial to the development and implementation of effective business, marketing and R&D programs.

REPORT OBJECTIVES

- ◆ To establish a comprehensive, factual, annually updated and cost-effective information base on market size, competition patterns, market segments, goals and strategies of the leading players in the market, reviews and forecasts.
- ◆ To assist potential market entrants in evaluating prospective acquisition and joint venture candidates.
- ◆ To complement the organizations' internal competitor information gathering efforts with strategic analysis, data interpretation and insight.
- ◆ To suggest for concerned investors in line with the current development of this industry as well as the development tendency.
- ◆ To help company to succeed in a competitive market, and

METHODOLOGY

Both primary and secondary research methodologies were used in preparing this study. Initially, a comprehensive and exhaustive search of the literature on this industry was conducted. These sources included related books and journals, trade literature, marketing literature, other product/promotional literature, annual reports, security analyst reports, and other publications. Subsequently, telephone interviews or email correspondence was conducted with marketing executives etc. Other sources included related magazines, academics, and consulting companies.

INFORMATION SOURCES

The primary information sources include Company Reports, and National Bureau of Statistics of China etc.

Abstract

It is in this report that the autonomous driving simulation industry is analytically expounded, ranging from simulation platform, vehicle dynamics simulation, sensor simulation, scenario simulation to scenario library.

Simulation technologies seem afar to people's lives and are hard to understand for them, but it is a key domain in which breakthroughs are to be made for automotive sector, even intelligent manufacturing in China and it deserves heavy investments.

Simulation technology is the simulation model technology that reveals the system behaviors and process by way of simulation experiments and numerical computing with simulation hardware and software. Simulation technology found initial application in the early 20th century, taking example for the building of water conservancy model in laboratories for research of hydraulics. In 1940s-1950s, the burgeoning aviation & aerospace and atomic energy technologies conduced to advances in simulation technology. In 1960s, the computer technology flourished and the advanced simulation tools became available, which expedited evolution of simulation technology.

From 1990s on, simulation and digital virtualization technologies has been an integral crucial to the R&D of automobiles. The advanced idea to develop cars based on mathematical model and digital simulation has prevailed among the automakers worldwide.

The vehicle R&D becomes ever sophisticated as cars are going smarter and smarter, causing higher costs of vehicle development and a prolonged development cycle. Lots of new technologies about vehicle security are subject to external environment and test security restraints and are hard to be carried out effectively. Yet, the traditional means for R&D, tests and validation are out of date.

For adequate security validation, autonomous driving requires a great deal of scalable simulation testing service (billions of km and even to tens of billions of km). Actually, the real road test is featured with low efficiency, and many automakers favor selecting autonomous driving simulation tests.

It is pointed out by a guest speaker on an automobile forum that, 90 percent of autonomous driving tests will be done by simulation, 9 percent done in test fields, and 1 percent on real roads.



The so-called autonomous driving simulation tests are to test autonomous cars with technologies such as sensor simulation, vehicle dynamics simulation, advanced graphics processing, traffic flow simulation, numerical simulation and road modeling, and with algorithms to build the comparatively real driving scenarios.

Such processes must be undergone to develop an autonomous driving system, as software simulation, hardware in the loop (HiL), vehicle in the loop (ViL), indoors lab tests, outdoor test field, and to ultimately the massive tests on public roads.

The Vehicle Simulation Industry Dominated by German and American Companies

There are dozens of simulation test companies around the globe, among which America ranks first by the number of companies but Germany boast most simulation firms in the automotive sector.

It can be seen from the development course of simulation industry that new opportunities emerge all the time and the emerging companies have sprung up incessantly. Simulation tycoons have grown ever competitive through mergers and acquisitions and have developed dozens of and even hundreds of product categories which are applied in tens of industries.

Typical Companies in Autonomous Driving Simulation Worldwide

AD Simulation Test Company	Country
ANSYS	USA
Microsoft AirSim	USA
Mathworks	USA
National Instruments (NI)	USA
Applied Intuition	USA
Vector	Germany
VIRES	Germany
dSPACE	Germany
ETAS	Germany
VI-grade	Germany
Siemens & TASS	Germany
TESIS	Germany
rFpro	UK
Unity	UK
ESI	France
AVL	Austria
Cognata	Israel
Panosim	China
51VR/RealDrive	China

Product Portfolio (Partial) of dSPACE



ControlDesk

Universal experiment software for ECU development



INTEMPORA MULTISENSOR SOFTWARE SOLUTIONS



RTMaps

Intempora's development environment for multisensor applications (ADAS, robotics, multimodal HMI, etc.)



MotionDesk

3-D online animation of simulated mechanical systems in real time, e.g. for visualizing ADAS or vehicle dynamics scenarios



SCALEXIO Customized Rack Overview

Modular simulator system



V2X Solution

Development and test of V2X applications



Test Benches

Testing complex mechatronic systems in the fields of autonomous driving and vehicle dynamics



Automotive Simulation Models

Tool suite for simulating the engine, vehicle dynamics, electrical system, and traffic environment



ASM Traffic

Real-time model for traffic and environment simulation



ModelDesk

Graphical user interface for parameterization, management, and simulation



ASM Vehicle Dynamics

Real-time models for ground vehicle simulation



Road Generator

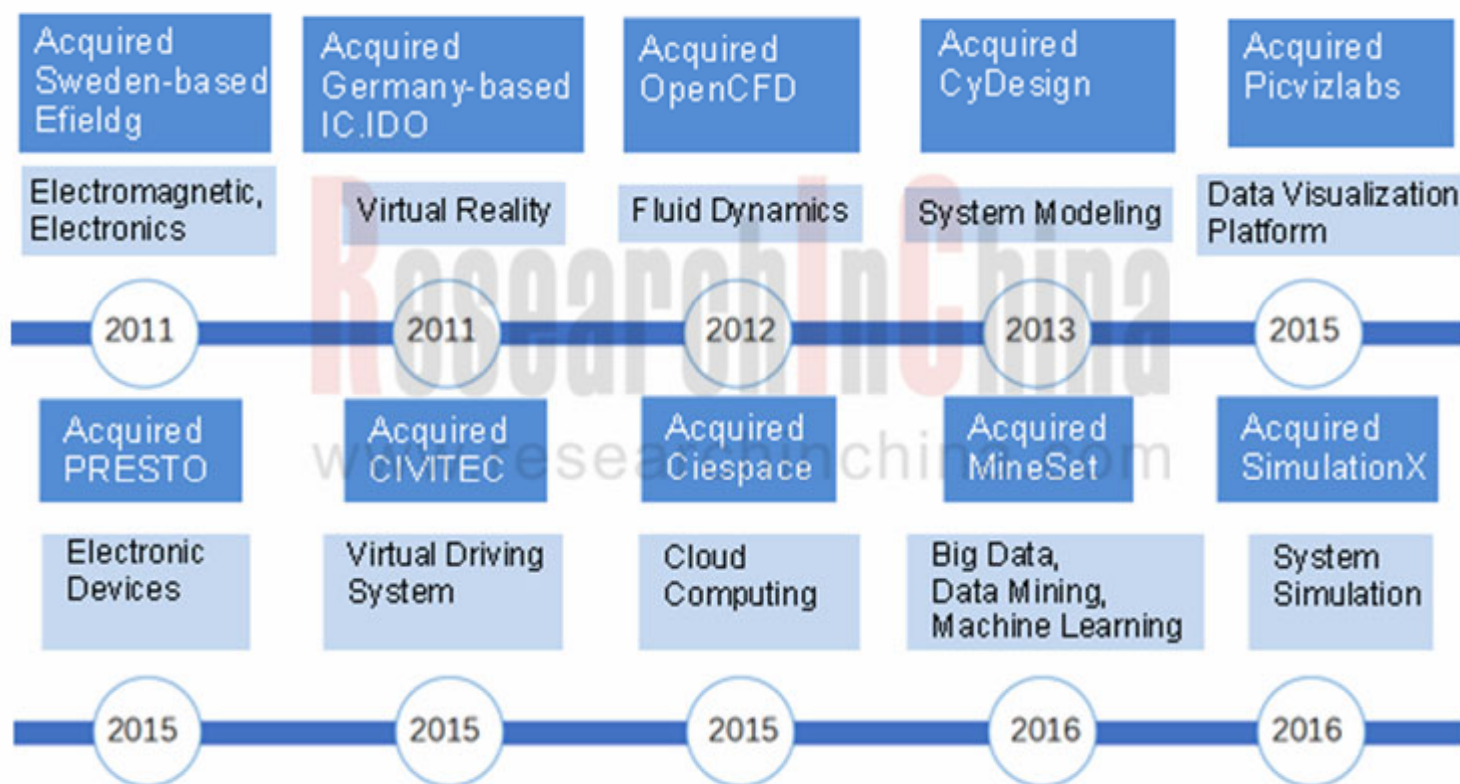
User interface for virtual road construction



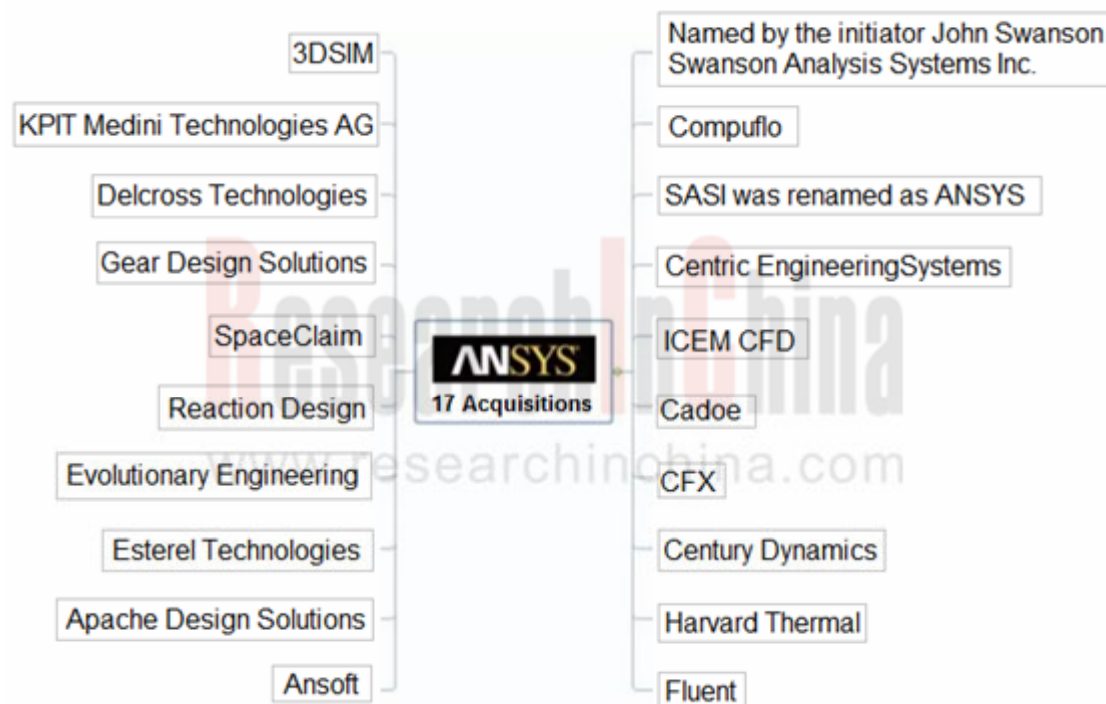
ASM Drivetrain Basic

Simulation model of a dual clutch transmission

History of ESI's Acquisitions



Through over ten acquisitions on companies inside and outside the industry, ANSYS dominates the CFD market, develops the embedded codes, beefs up chip encapsulation design, and enriches internal combustion engine simulation products. ANSYS purchased OPTIS in 2018 and improved the simulation technologies about sensors like LiDAR, camera and radar.



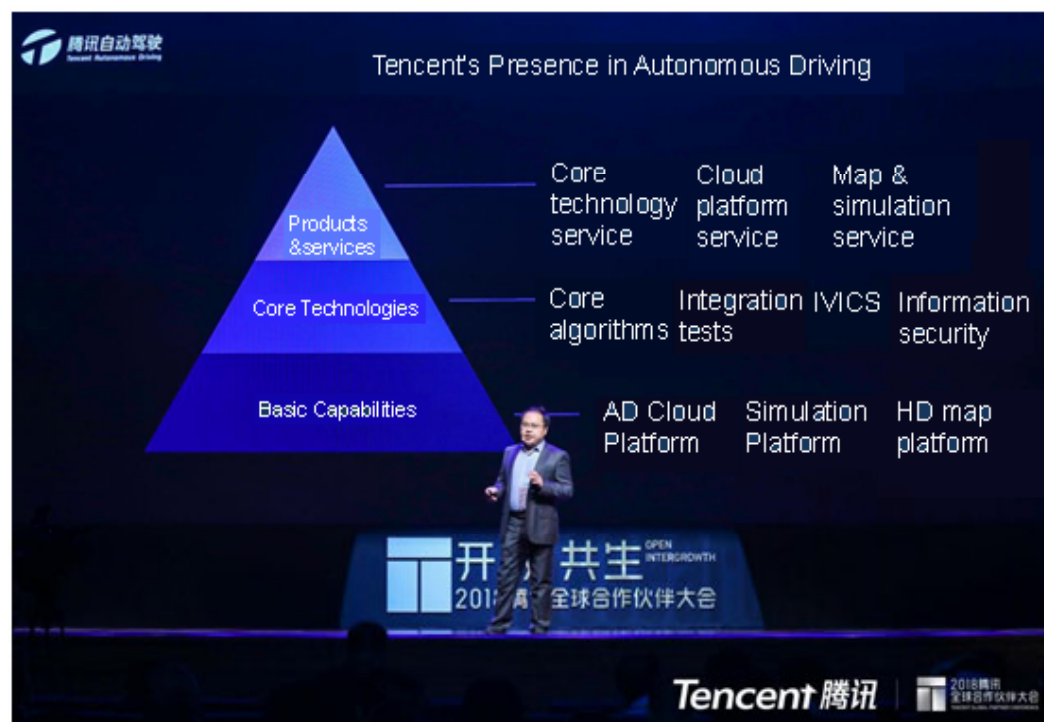
The potentiality of the autonomous driving simulation market has allured the inrush of many enterprises outside the automotive sector.

Autonomous driving tests call for various traffic scenarios simulation tool and massive scenario library. This is a totally new market, bringing traditional simulation companies, startups and new entrants on a par, and attracting the inroads of game firms, VR/AR firms and internet firms.

In October 2018, Cognata -- the Israel-based autonomous driving simulation startup -- completed the B-round funding of \$18.5 million. Cognata reproduces the cities on its 3D simulation platform by fusing artificial intelligence, deep learning and computer vision, and provides the customers with a variety of the driving test scenarios simulating the real world. AID (Autonomous Intelligent Driving GmbH) under Audi reached cooperation with Cognata.

Founded in 2015, 51VR was grown from real property market and then made its foray in automobile, education, games and other fields, and is now primarily focused on 3D simulation reconstruction. In December 2017, 51VR conducted its B-round funding of RMB210 million. For now, 51VR boasts nearly 100 talents in the automotive business covering three modules, i.e., simulated driving experience (VR car), vehicle visualization, and autonomous driving simulation platform, of which simulation platform team accounts for more than a half of its workforce.

Baidu Apollo simulation platform is in-built with simulation scenarios with HD maps in favor of multi-algorithm (sensing, planning and control) module verification, making the autonomous driving algorithm verification more rigorous. Apollo 1.5 version began to open its simulation platform, empowering autonomous driving companies like Idriverplus to significantly improve their efficiency in R&D via Apollo cloud simulation capabilities. Baidu Apollo could sell HD map, simulation platform, computing hardware ACU in future, said by Li Yanhong, the chairman of Baidu. So, simulation platform will be one of the profit points of Baidu self-driving platform.



In line with Tencent's layout in autonomous driving, simulation platform is one of the three basic competencies; maps and simulation services will be one of three profit engines of Tencent in future. Thanks to its superiorities in game engine, virtual reality, cloud games technologies, etc., Tencent has successfully built the simulation system TAD Sim (virtual + real combination) that is capable of verifying the closed-loop simulation of all modules (like sensing, decision, control algorithm) of a real car. Tencent wishes its simulation platform can help the automakers shorten development cycle, improve development efficiency, and reduce the costs of tests.

Since simulation software involves with hundreds of product categories, into which there are many ways to go. In comparison with difficulties in chassis and vehicle chip, the (automotive) industrial software represented by autonomous driving simulation is possibly the best field where IT/AI/VR firms can make investments.

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