The Growth of Autonomous Car Market

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# The Beginning, in a Nutshell

* **The 1920’s:** The plans on having autonomous cars had already started.
* **1939:** The GM's Futurama exhibit at the World’s Fair gave the ideas a public exposure.
* **1953:** GM and RCA had supposedly developed a scale model automated system.
* **1958:** GM successfully tested a 1958 Chevrolet with a front-end featuring "pick-up coils" that could "sense the alternating current of a wire embedded in the road and would adjust the steering wheel accordingly.
* **1977:** S. Tsugawa and his colleagues at Japan’s Tsukuba Mechanical Engineering Laboratory created an autonomous car that was equipped with two cameras that used analogue computer technology for signal processing.
* **1979:** Hans Moravec enabled the Stanford Cart to successfully manoeuvre through a chair-filled room for about 5 hours without human intervention.
* **1987:** Headed by Ernest Dickman, VaMoRs, outfitted with two cameras, eight 16-bit Intel microprocessors and a myriad of other sensors and software, drove more than 90 km/h for roughly 20 km.
* **1994:** Ernest’s VaMP drove at up at 130 km/h in simulated traffic, and could recognize road markings, its relative position in the lane, the presence of other vehicles, and whether it was safe to change lanes.
* **1995:** Lead by Ernest Dickman again, a Mercedes S-Class drove more than 1,600 km at a maximum speed of 180 km/h, with 95% of the drive being fully autonomous.
* **1995:** Carnegie Mellon University roboticists drove NavLab 5, a 1990 Pontiac Trans Sport, achieving an autonomous driving percentage of 98%.

# The Challenges involved in engineering the coveted autonomous car:

1. Sensing
2. Processing
3. Reacting, with appropriate movement

Though the first and the last steps were achievable with known technology, the processing part was the most exigent.

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# Driving into the Millennium

**The Grand DARPA Challenge**

To encourage the transformation of the autonomous dream into reality, DARPA, in 2004, arranged the first long-distance competition for autonomous vehicles.

Course length: 142 miles

Time limit: 10 hours

Prize money: **$1 million!**

# Participants: 15

The Results:

* None could touch the finish line!
* The best competitor Sandstorm, the autonomous Humvee of Carnegie Mellon's Red Team Racing, completed 7.5 miles.

**The Challenge Goes Bigger**

In 2005, DARPA gave another shot at bringing out the best of autonomous vehicles, and this time the task was more alluring.

Course length: 132 miles

The rub:

* 3 tunnels
* more than 100 turns
* a steep pass with sharp drop-offs

Prize money: **$2 million!!**

# Participants: 23

The Results:

Stanford University’s autonomous Volkswagen Tourareg “Stanley” won the challenge, completing the course in 6 hours & 54 mins.

**The Grand Challenge, Now Urban**

In 2007, DARPA decided to make the race even tougher by introducing it to an urban environment.

Course length: 60 miles

The rub:

* 4 miles of k-rail enclosed "streets"
* coping with manned-vehicle traffic
* obeying traffic regulations

Prize money: **$2 million**

# Participants: 89

The Results:

* Of 89, only 11 made it to the start.
* A Chevrolet Tahoe named “Boss”, belonging to Carnegie Mellon's team, Tartan Racing, won the race in a little more than 4 hours & 10 min.

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# The Advent of Google X

**The Pribot**

**Sebastian Thrun**, the man who co-developed the fantastic Street View for Google Maps, collaborated with **Anthony Levandowski**, to create the **Pribot** – a Prius modified to fetch pizza on its own.

**Google X**

The success of the Pribot encouraged Google to assign the team a series of challenges such as driving 100,000 miles on public roads, as well as descending San Francisco’s twisty Lombard Street!

The team passed.

**And the Venture Continues**

Since then, Thrun and Levandowski along with Chris Urmson, have geared Google’s system towards the successful development of autonomous cars that have even carried live passengers through real traffic.

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# The Science Behind The Wheels

So, how do autonomous cars steer themselves through obstacles, hair-pin turns and obey all the rules of the road? These are the magic ingredients:

* **Radar sensors:** Dotted around the car, these track the position of surrounding vehicles.
* **Video cameras:** These read traffic lights & road signs, and monitor obstacles.
* **Lidar sensors:** These detect the edge of the road and lane markings by bouncing pulses of light off the car’s surroundings.
* **Ultrasonic sensors:** Located in the wheels, these detect the position of curbs and nearby vehicles while parking.
* **Central computer:** This mastermind analyses input from various sensors to control steering, acceleration and braking.

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# Accelerating Into The Future

An in-depth study by BCG has lead to the following expectations:

* By 2035, the annual global sale of fully autonomous vehicles might be more than **12 million**.
* By 2035, partially autonomous vehicles can have an annual global sale of **18 million**.
* From 2025 to 2035, the market for partially and fully autonomous vehicles is expected to grow between **$42 billion and $77 billion**.
* By 2035, **25%** of the new car market might be captured by autos with autonomous vehicle features.

**Projected size of the Global Autonomous Vehicle Market by 2025:**

|  |  |
| --- | --- |
| Partially autonomous vehicles | £29.0 billion |
| Fully autonomous vehicles | £4.8 billion |

**Number of Global Autonomous Driving Patent Filings:**

|  |  |
| --- | --- |
| **Company** | **# Patents filed** |
| Bosch | 545 |
| Audi | 292 |
| Continental | 277 |
| GM | 246 |
| Google | 198 |
| VW | 184 |
| Toyota | 166 |
| Daimler | 156 |
| BMW | 142 |
| Ford | 103 |

*\*data as of June 2016*

**Projected Launch Dates of autonomous cars for test or commercial purpose:**

|  |  |
| --- | --- |
| **Company** | **Projected launch date** |
| NuTonomy | 2016\* |
| Audi A8 | 2017 |
| Tesla | 2018 |
| Delphi | 2019 |
| MobilEye | 2019 |
| Toyota | 2020 |
| Nissan | 2020 |
| Ford | 2021 |
| BMW iNext | 2021 |

*\*already launched for test in August 2016*

In the UK alone, the production of L3 autonomous vehicles are assumed to reach a peak of 88% by 2028.

**Projected Market Penetration of autonomous vehicles in the UK, by level of automation\*:**

|  |  |  |  |
| --- | --- | --- | --- |
|  | **Connected cars** | **L3 cars** | **L4/5 cars** |
| **2016** | 55% | 0% | 0% |
| **2017** | 59% | 4% | 0% |
| **2018** | 64% | 7% | 0% |
| **2019** | 68% | 8% | 0% |
| **2020** | 73% | 12% | 0% |
| **2021** | 77% | 16% | 0% |
| **2022** | 82% | 25% | 0% |
| **2023** | 86% | 48% | 0% |
| **2024** | 91% | 75% | 0% |
| **2025** | 95% | 81% | 4% |
| **2026** | 100% | 83% | 7% |
| **2027** | 100% | 87% | 8% |
| **2028** | 100% | 88% | 12% |
| **2029** | 100% | 84% | 16% |
| **2030** | 100% | 75% | 25% |

**\*The SAE Level of Automation indicates the capability of the car to operate without human intervention:**

|  |  |  |
| --- | --- | --- |
| **SAE Level** | **Automation Level** | **Human driver monitors driving environment** |
| 0 | No Automation |
| 1 | Driver Assistance |
| 2 | Partial Automation |
| 3 | Conditional Automation | **Automated driving system monitors driving environment** |
| 4 | High Automation |
| 5 | Full Automation |

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