



Introduction to Innovation Management

Assessment A

Team Flint



WAYMO

Autonomous Driving Technology Company



The Assessment

- You will all work in teams.
- Your team is required to review the recent innovation history (say, over the past five or ten years) of a company of your choice that is involved in manufacturing, product development or service provision, anywhere in the world.

Categorise the innovation developments which have taken place in terms of Greg Satell's typology and analyse them in relation to:

1. The extent to which they have shifted the chosen company's market position.
2. The extent to which they have influenced the company's internal structures and management processes.
3. The extent to which they have been technology dependent - and if so which technologies.
4. A consideration as to the outcome of the innovation.

Prepare a presentation of your findings. The presentation should end with:

1. An outline of what each of you contributed to the review on which the presentation is based
2. What each of you learned in undertaking this assessment



Waymo Jaguar I-Pace

Company Overview

- Waymo LLC is an American autonomous driving technology development company.
- It is a subsidiary of Alphabet Inc, the parent company of Google.
- Referred to as the “driver” rather than the software – recognised by the National Highway Traffic Safety Administration
- Mission statement - The company hopes to tackle the huge "waste" in underutilised vehicles and time spent commuting, as well as reducing the 1.2m fatalities on the world's roads every year. Original mission statement was ‘to make it safe and easy for people and things to get where they are going’ (1)
- Innovation in hardware, software and algorithmic patterns.
- Waymo uses state of the art Cameras, Lidars and Radars to control, navigate and drive the vehicle. The make up consists of sensing, computing and embedded controls.
- Waymo operates a commercial self-driving taxi service in greater Phoenix, Arizona called Waymo One. Also offering a Haulage solution in the form of Waymo Via.
- By 2018 they had driven over 10 million miles on public roads in 25 cities across the US (2)
- Today Over 20Bn miles driven in simulation and real world.
- **Date founded:** 2009 developed by Google X moonshot division – Rebranded as Waymo in 2016
- **Sector:** Technology
- **Category:** Automotive



Innovation Categorisation

- Satell (2017) developed an Innovation Matrix, to help designate the type of innovation and typical resources deployed in explaining the nature of the problem and the methods needed to solve the problem
- He had also identified The 9 rules of Innovation in his 2016 article, which identified a number of different paths to innovation – Satell (2016)
- Utilising these two ‘models’ it is possible to consider the innovative steps that Waymo have taken in the push to develop an autonomous driving system, as the problem became better defined and they understood means in which to deliver.



Timeline

2009

SELF DRIVING CAR

GoogleX SDC

2016

WAYMO ONE
RIDE HAILING SERVICE

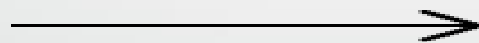
Waymo

2018

EXTEND OFFERING TO
HAULAGE WAYMO VIA

2019

OPEN MOTION DATASET
RELEASED TO PUBLIC
RESEARCH COMMUNITY



Describing Waymo's Innovation - 'Satell's Typology'

Satell's 9 rules

- Rule 1: Innovation is never a single event – the development of the system has taken more than 10+ years.
- Rule 2: Innovation is combination – Waymo have developed both software and hardware solutions in order to deliver the autonomous driving system.
- Rule 3: First, ask the right questions (this is best expressed as Satell's Innovation Matrix) see slide 10

Problem definition	Well defined	Breakthrough Innovation	Sustaining Innovation
	Not well defined	Basic Research	Disruptive Innovation
		Not well defined	Well defined
		Domain definition	



Describing Waymo's Innovation - 'Satell's Typology'

- Rule 4: There is no optimal size for innovation – as part of the Alphabet group, they have a large resource, but are a much smaller organisation. Despite having a large resource in its parent company Alphabet, Waymo has secured investments upwards of \$5.5bn from Investors and private equity firms.
- Rule 5: Leverage open innovation to expand capabilities – in 2019, Waymo gave access to the Waymo Open Motion Dataset, allowing public research to utilise their model for scenario testing
- Rule 6: Disruptive innovation requires New Business Models – Waymo, established in 2016, is a 'spin out' from the Google SDC project. Producing the GoogleX SDC as the Minimum viable product. Continued in section 4
- Rule 7: Innovate the core – the 70/20/10 rule – here Waymo represents the 10%, basic and breakthrough innovation element known as "Horizon 3" in relation to the three horizons of innovation. The 10% could also be considered as a constituent of the 'Capital Ration' being used to develop new core technologies and its own learning and capabilities (Schilling [2005]) that Alphabet are prepared to deploy in the 'New markets/New capabilities' arena
- Rule 8: In the digital age, we need to use platforms to access ecosystems – their open dataset, use of google maps and access to ride hailing platforms has generated a user population
- Rule 9: Collaboration is the new competitive advantage – a move towards providing driving systems to other manufacturers, partnering with ride hailing firms and road haulage companies is embedding Waymo technology



Describing Waymo

- A review of Satell's work in mapping the area of innovation suggests that Waymo may well have moved through the different quadrants of his matrix, demonstrating all variants of innovation in different stages of their maturation.

	GOOGLEX SDC	← WAYMO →		
	Self Driving Car	Autonomous Driving Technology ‘The Driver’	Autonomous Ride Hailing Service Waymo One	Autonomous Road Haulage Waymo Via
Basic Research	Government funded DARPA Grand Challenge with \$1million prize for best autonomous vehicle in 2005. Moving to employ all of the eventual winners into their GoogleX (Moonshot) division.			
Breakthrough		Further development of the SDC transitioning into the Waymo Driver, a truly autonomous driving system.		
Sustaining			Robo Taxi first offered with minivans in 2017. Ride hailing service opened to the public in 2020	After investments of €2.25Bn Waymo via was officially Launched
Disruptive		The Driver changed the basis of the question and the competition – complete change of business model for a seamless transition into autonomous driving technology		



Section 1

The extent to which they have shifted the chosen company's market position

- It should be noted that the self-driving, autonomous vehicle market is not a highly developed one, with a variety of vehicles on the roads and users having a broad spectrum of offering or choice
- There is a subtle change in direction of the organisation over time and as it developed, as well as the development/innovation in the technology it deploys with the focus now on the 'system'
- This reflects a 'move' across the Innovation Matrix described by Satell (2017)
- 2009 - Google Self-Driving Car Project – Autonomous vehicle project
 - Google X was a 'Skunkworks' set up to pursue 'moonshots'
 - They employed the team who had won the 2005 DARPA Grand Challenge to build a driverless car to head up their efforts in this area, giving them strong links to the academic research arena
 - Focus is on developing a self-driving car (Google XSDC)



Section 1A

The extent to which they have shifted the chosen company's market position

- 2016 - Waymo
 - Spin out of Google and part of Alphabet
 - Utilise Google maps to offer an 'App' for hailing their autonomous taxi service – Waymo One
 - Partner with the ride hailing firm Lyft to also allow access to their taxi service
 - Develop a system that can be utilised for large delivery vehicles – Waymo Via
 - Give access to their Open Dataset
 - "We're not a car company," Krafcik said. "We're not a self-driving car company either. Our mission is to build the world's most experienced driver." (Noble [2019])
- Whilst the 'offer' from Waymo has changed over time, as the innovative technology available has developed, they have offered the market a number of different 'products' – a Portfolio of Innovation.
- However, each of these has facilitated the means for Waymo to capture and better understand the driving experience. This has been used as an iterative learning experience to better develop 'the world's most experienced driver' and give them a significant advantage in the autonomous driving sector leading them into the Sustaining Innovation quadrant.
- This technology allows them a unique opportunity to provide this driver to automotive manufacturers for inclusion in their vehicles.



Section 2 - Company Structure

The extent to which they have influenced the company's internal structures and management processes

Trott (1998) offers a summary of organisational characteristics that can facilitate the innovation process, which can be applied to Waymo, with the following characteristics being prevalent;

- Organisational heritage and innovation experience – the success of a company doesn't just rely on its knowledge and understanding, but on its ability to share this across the organisation. Waymo's heritage demonstrates this by, for example, Google's use of 'Testing on the Toilet' (Murphy Hill [2019])
- Vigilance and external links – their scientists publish numerous papers on hardware and software. The availability of the Open Motion Dataset makes sure they keep up to date with current thinking and advances.
- Commitment to technology and R&D intensity – the development of the autonomous driving system has been running for over 12 years.
- Acceptance of risk – carefully considering 'risky opportunities' they have raised significant funds to support their R&D programs whilst diluting their own capital.
- Receptivity – which, as a characteristic is demonstrated by their willingness to partner with ride hailing platforms who have excellent 'front ends' (and commercial advantage) as well as developing their own.



Section 2

The extent to which they have influenced the company's internal structures and management processes

- In 2021 the CEO of Waymo stepped down from his role, staying within the company in a different capacity as their advisor. Takeda Mawakana with a Dr in Law and Dimitri Dolgov was one of the founders of the Google SDC, took over as Co CEO's.
- "When you get people of varied skills, perspective and experiences together, they tend to come up with solutions that would be unlikely to arise in any single domain." (Satell, 2017, p.50) Mawakana and Dolgov both coming from diverse backgrounds, thus meaning a varied skillset and field of knowledge. Opening up a pathway for a varied perspective, given the different sets of knowledge.
- Trott (1998) presents the work of Prajogo and Ahmed (2006) showing the strong link between innovation capability and innovation performance. It implies that firms wanting to improve their performance need to put in place factors that will stimulate performance, such as, appropriate leadership, R&D and creativity.
- "By focusing on the culture within an organisation and coupling with other technologies and innovation management efforts, leaders will have a more systemic understanding of how to sustain and increase the innovation capabilities of the organisation." (John Saiz 2020) Within an organisation, collaboration is paramount in order to achieve innovation in its full capacity.



Section 3

The extent to which they have been technology dependent - and if so which technologies.

- Waymo focus on 3 main areas in the technologies that make up the system. This consists of;
 1. Sensing – Cameras, Lidars, Radars
 2. Computing
 3. Embedded controls
- The sensors detects motion, scanning the surroundings proving the data input needed for the next stage.
- Lidars measure the distance between an object utilising pulses of light. This in turn enables a 3D image to be created.
- Radars are used to locate objects in the surrounding parameter.
- The computer then collates and analyses all of this data to dictate the vehicle pathway. The computer then sends the retrospective signals to the embedded controls. This is then what controls the core driving features (steering, acceleration, braking etc)



Section 3A

The extent to which they have been technology dependent - and if so which technologies.

- Throughout all of the different stages of Waymo's development they have always been heavily technology dependent.
- Technology is embedded in Waymo's DNA, as this is the basis in which the company was founded, and also the key to its success. Technology advances drive success or lack of.
- The crucial component in the driving system is the semiconductor, Waymo rely heavily on the advances in this field in order to keep evolving their technology and surpassing its associated 'limits' to maintain distance, and separate them from their main competitors.
- "Waymo's self-driving cars contain a broad set of technologies that enable our cars to sense the vehicle surroundings, perceive and understand what is happening in the vehicle vicinity, and determine the safe and efficient actions that the vehicle should take. Many of these technologies are rooted in advanced semiconductor technologies, e.g. faster transistors that enable more compute or low noise designs that enable the faintest sensor signals to be perceived" (Rosenband 2017)
- The technology has helped to revolutionise the concept of 'driver' and redefined the associated standards. Along with new business developments, new technologies lead a clear pathway to solving problems that are yet to be defined.



Section 4

A consideration as to the outcome of the innovation

- Waymo continue to disruptively innovate in the automotive sector as a technology driver. Bringing to light a problem, or solution to a problem that Global OEM's were not aware yet existed. Forcing top OEM's to form partnerships to gain traction and close the gap on Waymo's technological advances.
- GoogleX SDC can be classed as the Minimum viable product, Now a thorough understanding in the difficulty of car production taking into consideration the gulf in production ability and knowledge, and the correlating technology compared to other OEM's. This was the catalyst for a radical change of business model. Leaving car manufacturers to produce the cars, and instead focusing on software and hardware advances and perfecting the algorithm.
- Customer development – Partnering with Fiat-Chrysler and Jaguar to produce a fleet of self driving cars using the Waymo Driver system.
- Waymo Open Motion Dataset – Waymo have released their dataset model publicly to the research community for motion forecasting research. Having completed millions of miles in real time test driving, and simulation using the virtual dataset. This even has far reaching effects as far as Local authorities calling on the help of Waymo's technology to identify suspects in criminal cases.
- Using this model allows Waymo to gain valuable insight into competitors model structures. The data is owned, analysed and used by Waymo to learn local traffic rules and improve their own software. Strategically placing Waymo as the front runner in autonomous driving.
- This encompasses the key elements of Alphabet's business model. One is that basic research is delivered in the form of academic partnerships, sabbaticals and technology transfers. Concurring that there is no actual direct investment in exploratory research, but valuable knowledge and insight gained through building strong links in the academic field. "Open data gives access to basic research"



Section 4A

A consideration as to the outcome of the innovation

- Referred to as the “driver” rather than software or a system. “We are not a car company, We are not in the business of making better cars. We are in the business of making better drivers. We are a self-driving technology company.” This was supported by National Highway Traffic Safety Administration comments in 2018, stated they “Agreed with the company's proposed interpretations of Federal Motor Vehicle Safety Standards” Removing a significant barrier to the implementation and approval of the Waymo driver for use on public roads” This helps clarify one of the question in Satell’s innovation matrix, helping to giving a clear insight as to the requirements needed for Waymo to offer a commercially viable autonomous ride hauling service.
- Without earning anything in revenue, Waymo have managed to capture large investments from investors and private equity firms. Recognising the support of these institutions the bank Morgan Stanley valued Waymo at \$70bn. With no thought given to the potential of Waymo licensing its software and saving firms valuable time and money with shorter delivery times and logistical planning (Realised in Waymo Via) it was later revalued at \$175bn.
- Waymo “aspires to drive anything that moves on public roads” – not limiting themselves to one sector in the automotive market, thus increasing the potential revenue stream. Laying the foundations for a seamless transition through each domain of innovation. Breakthrough-disruptive-radical innovation to sustaining/incremental innovation.
- With the potential to license its software, offer an autonomous ride hailing taxi service, HGV delivery service, Collaboration with firms like UPS to form other revenue streams in the delivery of goods and access to open motion dataset gives the consideration the outcome or success of the innovation, is captured in the evolution through Satell's innovation matrix. The business model they deploy is flexible and agile, in that it can be adapted without radical change, to be successful in different markets.
- The business continues to position itself at the competitive forefront of the autonomous vehicle sector, and take advantage of the innovation quadrants described by Satell as the environment continues to be dynamic.



Elin Davies

What did I contribute?

- Shared thought and ideas amongst the group about the work.
- Article and relevant information shared and discussed in group meetings
- Created slides and contributed to slide formatting

What did I Learn?

- How to distinguish what information is relevant and important whilst researching
- How to work within a team with not only splitting work but piecing the work together
- Learned about a new field of work that I have not looked into or considered before
- Looking at a company from a different perspective - why they do things that way and the way things are laid out and structured.
- Collaborating and being open to work with others with different skills can be a key part of a successful innovation.



Neil Quigley

- What did you contribute?
 - Shared various articles on the concept and the particular chosen company
 - Discussed and developed ideas across the group
 - Reviewed slide/pack layout
 - Organised on-line calls
- What did you learn in undertaking the assessment
 - A better understanding of the library facility and searching for articles
 - The need to stay focussed when reviewing various articles and literature and not to disappear down a rabbit hole
 - How interesting it can be to research a topic and read in-depth about a subject
 - The difficulties in working as a group remotely and the time consumed in discussing topics (which would be more straightforward face to face)
 - A more thorough understanding of innovation, the different types and some of the difficulties associated with managing/facilitating it
 - Recognition that a company, particularly if it wants to be successful, is generally moving forward/evolving



Brandon Luffman

- What did you contribute?
 - Organised the presentation – design, typing, formatting, editing content whilst in a group call with the team.
 - Contributed to the information on slides
 - Shared articles and papers highlighting the innovation developments and strategy's within on our chosen company
 - Shared and developed ideas/inputs across the group
 - Set up a group to keep in touch and on track
- What did you learn in undertaking the assessment?
 - Innovation truly is a combination of advances in technology, collaboration in expertise, developments in science, and the ever evolving ability to interpret past research and implement this into the pathway of a commercially viable product. With many Ground breaking innovations coming from the developments maturing well over a ten year time period.
 - The importance of having a clear business model and defining each stage of the innovation matrix
 - Improvement on how to asses and navigate innovation within my own company structure
 - A better understanding of the library resources
 - Asking the right questions initially is paramount and also being open to collaboration and embracing another skillset.
 - Unlocked a completely new outlook on how to assess/implement innovation within different market sectors.
 - Knowledge is power. Working in a team, especially with different backgrounds allows for a more diverse approach and a new perception on a problems or solutions to a problem to be applied within the different fields of expertise.

References

- Bradshaw (2016): T. Bradshaw, “US regulator removes significant roadblock to Google’s driverless car”, Financial Times, 11th February 2016. (Online). Available: [US regulator removes significant roadblock to Google's driverless car: Technology - ProQuest Central – ProQuest](#) (Accessed 23rd March)
- Bradshaw (2016): T. Bradshaw, “Google self-drive car unit rebranded as Waymo”, Financial Times, 14th December 2016. (Online). Available: [Google self-drive car unit rebranded as Waymo: Automobiles - ProQuest Central - ProQuest \(uwt.ac.uk\)](#) (Accessed 28th March 2022)
- Ettinger et al (2021): S. Ettinger, S. Cheng, B. Caine, C. Liu, H. Zhao, S. Pradhan, Y. Chai, B. Sapp, C. Qi, Y. Zhou, Z. Yang, A. Chouard, P. Sun, J. Ngiam, V. Vasudevan, A. McCauley, J. Shlens, D. Anguelov, Waymo LLC, Google Brain, “Large Scale Interactive Motion Forecasting for Autonomous Driving: The WAYMO OPEN MOTION DATASET”, in 2021 IEEE/CVF International Conference on Computer Vision (ICCV), 2021, pp 9690-9699
- Financial Times (2016): Google self-drive car unit rebranded as Waymo, 14th December 2016
- Iyer (2019): C. Iyer and R. Alton, The race for Autonomous Ride-hailing: Developing a strategy for success, Clayton Christensen Institute, TATA consultancy services, September 2019
- John (2021): A. John, “Waymo chief steps up as Krafcik exits CEO position”, Automotive News, 5th April 2021. (Online). Available: <https://www.autonews.com/executives/waymo-chiefs-step-krafcik-exits-ceo-position> (Accessed 29th March 2022)
- McGee (2019): P. McGee, “Catching up with driverless cars: Carmakers will need to reinvent themselves if they are to compete with Waymo in the new market for autonomous vehicles. The good news is there is a network of small tech companies they can partner with”, Financial Times, 1st February 2019. (Online). Available: [Catching up with driverless cars: Carmakers will need to reinvent themselves if they are to compete with Waymo in the new market for autonomous vehicles. The good news is there is a network of small tech companies they can partner with. - ProQuest Central – ProQuest](#) (Accessed 28th of March)
- McGee (2021): P. McGee, “Waymo’s driverless vehicles rollout proves tougher test than space travel: Google sister group’s chief says the sector faces ‘an extraordinary grind’ but its success remains inevitable”, Financial Times, 5th January 2021. (Online). Available: [Waymo's driverless vehicles rollout proves tougher test than space travel: Google sister group's chief says the sector faces 'an extraordinary grind' but its success remains inevitable - ProQuest Central – ProQuest](#) (Accessed 24th March 2022)
- Murphy-Hill (2019): E. Murphy-Hill, E.K. Smith, C. Sadowski, C. Jaspan, C. Winter, M. Jorde, A. Knight, A. Trenk, S. Gross, “Do Developers Discover New Tools on the Toilet”, in 2019 IEEE/ACM 41st International Conference on Software Engineering (ICSE)
- Nasdaq.com (2021): Zacks Equity Research (2021): “Alphabets (GOOGL) Waymo Brings Waymo One to Maps App”, June 2021. (Online). Available: <https://www.nasdaq.com/articles/alphabets-googl-waymo-brings-waymo-one-to-maps-app-2021-06-07>. (Accessed 28th March 2022)
- Noble (2019): B. Noble “Detroit plant now producing self driving vehicles with Waymo”, The Detroit News, October, 2019. (Online). Available: <https://eu.detroitnews.com/story/business/autos/2019/10/28/detroit-waymo-self-driving-vehicles/2459915001/>. (Accessed 25th March 2022)



References (continued)

- O'Connor (2020): M. O'Connor, "Chandler hit-and-run highlights Tech Companies' Cozy Relationship' with Police", Voice Media Group, 10th January 2020. (Online). Available: [Chandler Hit-and-Run Highlights Tech Companies' Cozy Relationship With Police - ProQuest Central – ProQuest](#) (Accessed 23rd March 2022)
- Rosenband (2017): D. L. Rosenband, "Inside Waymo's self-driving car: My favourite transistors", in 2017 Symposium on VLSI Circuits Digest of Technical Papers, 2017
- Saiz 2020: J. Saiz, N. Saiz, D. Denton-Misfeldt, K. Wooten, "How culture affects innovation in an organization" (online). Available: [*How Org Culture Affects Innovation Rev I \(cam.ac.uk\)](#). (Accessed 27th March)
- Satell (2016): G. Satell, "The 9 Rules Of Innovation", DigitalTonto, 6th March 2016. (Online). Available: [: https://digitaltonto.com/2016/the-9-rules-of-innovation](https://digitaltonto.com/2016/the-9-rules-of-innovation). (Accessed: 22nd March 2022)
- Satell (2017): G. Satell, Mapping Innovation: a playbook for navigating a disruptive age, McGraw-Hill, New York, 2017
- Schilling (2005): M.A. Schilling, Strategic Management of Technological Innovation, 4th ed., McGraw-Hill, New York, 2013
- Tripp (2021): M. Tripp, "Waymo Opens Robotaxi Service in San Francisco for Ride Hailing; Google's sister company offers driver-supported rides to some residents in business model test case", Wall Street Journal, 24th August 2021. (Online). Available: <https://www.proquest.com/central/docview/2563805897/C62E38506DE74FE0PQ/9?accountid=130472&parentSessionId=54gN8kekhkVeMCG6fBPpp2SB2ePDW4p3I12> (Accessed 27th March 2022)
- Trott (1998): P. Trott, Innovation Management and New Product Development, 6th ed., Pearson, Harlow, 2017
- U.S. Newswire (2017): "Waymo is Poised to become the largest Autonomous Technology Company in the Automotive Industry by 2030: Waymo's autonomous software may cause disruption across the automotive value chain from OEMs to dealerships, finds Frost & Sullivan's Mobility Team", U.S. Newswire, 6th September 2017. (Online). Available: [Waymo is Poised to Become Largest Autonomous Technology Company in the Automotive Industry by 2030: Waymo's autonomous software may cause disruption across the automotive value chain from OEMs to dealerships, finds Frost & Sullivan's Mobility team - ProQuest Central - ProQuest \(uwtsd.ac.uk\)](#) (Accessed 25th March 2022)
- Waymo.com: The Waymo Company website. (Online). Available: <https://waymo.com/company/#story>. (Accessed 22nd March 2022)
- Gu et al (2020): Z. Gu, Z. Li, X. Di, R. Shi, "An LSTM-Based Autonomous Driving Model Using a Waymo Open Dataset", in Applied Sciences, Basel, Vol.10 issue 6, 2020

