

Introduction and background to Artificial Intelligence and Starship Technologies:

- This report is based around General Artificial Intelligence, current uses, common barriers and threats as well as Starship Technologies who were the first to develop and place in service the first autonomous robot (*level 4*).
- Levels are in relation to the degree of control by the robot and supporting AI such as drones or human control:
 - Classification of autonomy
 - 1: A single function is automated
 - 2: Acceleration, deceleration and steering are automated
 - 3: All safety functions are automated
 - 4 / 5: Fully autonomous subject to area of working

(Abdul Dremali @ AndPlus 2018) + (L A Bush & A.Wang @ MIT Lincoln Laboratory 2017)
- The world is always evolving; however AI is developing at an even greater pace. Currently AI is already at a pace that the everyday person cannot fully comprehend or know how it will be managed by humans in the future.
- General catch all descriptions are Artificial general intelligence (AGI) or general (AI) for the purposes of this report I will refer to Artificial Intelligence (AI)

Definitions of AI:

- The General Definition: is the theory and development of computer systems able to perform tasks normally requiring human intelligence, such as visual perception, speech recognition, decision-making, and translation between languages. (*Oxford dictionary*)
- In its simplest form: AI is a field, which combines computer science and robust datasets, to enable problem-solving. It also encompasses sub-fields of machine learning and deep learning, which are frequently mentioned in conjunction with artificial intelligence. (*IBM*)
- “systems that act like humans.” (*Erick Brynjolfsson @ MIT May 2022, plus Alan Turing’s definition via IBM*)
- “does this artificial intelligence think like a human?” (*Adam Zewe @ MIT April 2022*)

Examples of AI:

- **Weak AI:** also called Narrow AI or Artificial Narrow Intelligence (ANI): AI trained which is focused to perform specific tasks. Weak AI drives most of the AI that surrounds us today. ‘Narrow’ might be a more accurate for this type of AI but no AI should be thought of as weak. It operates major applications such as Apple’s Siri, Amazon’s Alexa, IBM Watson as well as some autonomous vehicle operations.
- **Strong AI:** is made up of Artificial General Intelligence (AGI) and Artificial Super Intelligence (ASI). Artificial is a theoretical form of AI where a machine would have an intelligence equal to a human. It would have a self-aware consciousness that has the ability to solve problems, learn, and plan for the future. ASI also known as superintelligence would surpass the intelligence and ability of the human brain! (*IBM*)

Overview of significant AI advancements and betterment over the human brain:

- **1950:** Alan Turing publishes Computing Machinery and Intelligence. In the paper, Turing—famous for breaking the Nazi's ENIGMA code during WWII—proposes to answer the question 'can machines think?' and introduces the Turing Test to determine if a computer can demonstrate the same intelligence (or the results of the same intelligence) as a human. The value of the Turing test has been debated ever since.
- **1956:** John McCarthy coins the term 'artificial intelligence' at the first-ever AI conference at Dartmouth College. Later that year, Allen Newell, J.C. Shaw, and Herbert Simon create the Logic Theorist, the first-ever running AI software program.
- **1967:** Frank Rosenblatt builds the Mark 1 Perceptron, the first computer based on a neural network that 'learned' through trial and error. Just a year later, Marvin Minsky and Seymour Papert publish a book titled Perceptions, which becomes both the landmark work on neural networks and, at least for a while, an argument against future neural network research projects.
- **1980s:** Neural networks which use a backpropagation algorithm to train itself become widely used in AI applications.
- **1997:** IBM's Deep Blue beats then world chess champion Garry Kasparov in a chess match (*and the rematch*).
- **2011:** IBM Watson beats champions Ken Jennings and Brad Rutter at Jeopardy (*A USA quiz show*)
- **2015:** Baidu's Minwa supercomputer uses a special kind of deep neural network called a convolutional neural network to identify and categorize images with a higher rate of accuracy than the average human.
- **2016:** DeepMind's AlphaGo program, powered by a deep neural network, beats Lee Sodol, the world champion Go player, in a five-game match. The victory is significant given the huge number of possible moves (*over 14.5 trillion*) the game progresses with Deepmind becoming successful after just four moves (*Google purchased DeepMind for an disclosed sum believed to be in the region of \$400 million*)
- **2023:** A rise in large language models, or LLMs, such as ChatGPT create an enormous change in performance of AI. With these new generative AI practices, deep-learning models can be pre-trained on vast amounts of raw, unlabelled data.
- (*IBM*)

The principal drivers for the innovation:

- To make money
- Existing, evolving, perceived and potential market opportunities, development, new market which is untapped.
- Massive potential, almost uncapped as the limitations of AI are unknown as are the future needs of the world.
- For innovators working at the forefront of developing new technologies.
- AI can provide a wide range of benefits, social, medical which include significant in breakthrough lifesaving medicines, techniques also reducing medical care.
- New Business with advantages over none AI using companies.
- The use of AI to design, produce a manufactured food in a laboratory environment future proofing food supply.
- Speech recognition with the ability to use human speech to carry out actions or create written documents.
- Customer service, customer interfacing roles, virtual agents / chat boxes, Full Q&As
- Computer vision: Radiology imaging in healthcare, autonomous vehicles

- Mapping & Satellite navigation
- Entertainment TV & Radio streaming services
- Engineering developments combined AI such as mapping, with preselection of the correct gear and engine speeds appropriate to the road type and driving conditions cars, with the added sustainability efficiencies and carbon savings adding to the case.
- Search Engines; monitors past behaviours, shopping trends and used for addons.
- Money market and stock trading, to manage stock & shares with the ability to make thousands of transactions daily without the need of human supervision.
- Repetitive but high value workloads or positions with high repetition of activities such as X rays, radiographers, legal docs, document control such as passport and boarder control as well environments which could be harmful to humans with dangerous conditions, atmospheres, or hostile environments.
- Help with mobilities / disability challenges, artificial limbs, and advancement in mobility chairs with powered chairs, advancement with increased battery range while offering the ability to climb steps and cross slightly rough terrain.
- The ability to deliver goods autonomously, move freight or assist with moving aircraft as part of the airside tug & place equipment.
- Home help, carers, company, reminders or dispensing drugs, the ability to make tea, some foods as well mental health monitoring and interactive games.

The barriers and risks faced by the company in developing this innovation:

- Start-up costs.
- High failure rate.
- Patents and copies and mass production distributed globally without adequate controls.
- It can be used to be a disruptive influence in a global position as we have seen with fake news which has also tricked the media who have used the pictures (*The Pope & Donald Trump as used by CNN Annex1*)
- The risks from AI could include anything from physical harm undermining Governments and potential to affect mental health.
- The development and deployment of AI can also present ethical challenges which do not always have clear answers.
- Household consumers, public services and businesses will not trust the technology and will be nervous about adopting it.
- Legislation, changing legislation, liability
- In previous decades when cash was seen as king, we now see opposite moving to a cashless society unfortunately cash the favoured currency by criminal activities, we now see the trading of the bitcoin.
- Managing risk known, known unknowns the unknown unknowns which risk will vary greatly subject to the situation from AI used in a chat box to medical procedures or air traffic control.
- Public understanding, perception, the public do not understand AI its limitations or controls and seen as a threat.
- Trust, access to and use of private data.
- Loss of employment, longer-term future when humans are required less for work as AI develops.
- How will humans survive, income, mental and physical wellbeing, disillusionment, and rebellion could follow.
- Some government “think tanks” see a future where the population does not work but is subsidised by the Government with the wellbeing of the population becoming the major challenge.

- Fake news, disinformation Evidence of the international press being tricked into break news stories that were fake news. Recently the pope was seen wearing a long white puffer Jacket, also Donald Trump arrested and placed in prison (*Annex 1*)
- Fear: AI used by hackers, which could impact everyone; personal, group, companies, finance houses, government agency. (*The Scottish Environment Agency were hacked and held to ransom and out of action for 6 months, no emails back to telephone and postal system and still resolving issues*).
- Fairness & Bias, impartiality, ethics, how will these be managed.
- Environmental impacts – will AI see environmental risk as a threat to humankind or see humankind as a threat to the environment.
- How reliable is AI, would we know if a fault has occurred? Would AI have the ability to self-diagnose and repair (*Tesla can already part of the process*)
- Security, Privacy; always at risk and major concern.
- If used incorrectly it could be very harmful in a variety of ways.
- Autonomous, who is accountable, in which Country, traceability how will action be taken against ASI and prove liability if it can learn and developer its own processes.
- Business pressures and entrepreneurialism could take shortcuts to keep ahead of the competition as well as potential cost benefits could lead to weaker control measures in production and aftermarket controls.

The key determinants in the process of committing to develop the innovation:

- The specific type of AI business I propose to look at is a company called Starship Technologies.
- Starship Technologies (ST) innovative idea was to be the first to develop and produce a different type of robot for a unique environment.
- Following ST innovation there are now similar AI systems with working robots although they operate in different surroundings, controlled and managed within enclosed areas i.e. warehouses, private land some working remotely in the military sector or field work situations.
- ST were looking to put autonomous robots into a real-world environment a unique and high-risk area
- Interacting with the public at all aspects of everyday life can be unpredictable; considerations include interacting with changeable humans with additional considerations i.e. individuals with loss of sight, partially sighted, disabled and assisted individuals along with a service dog or equipment aids.
- Connecting in everyday activities such as crossing the road, weather extremes, roadworks, curbs, steps, road diversions, rubbish bins, bus stops and the odd pedestrians who do not wish to move, many variables without any agreed perimeters or predetermined routes.
- The robots known as Personal Delivery Devices (PDDs)
- The company's autonomous are designed to provide, restaurant delivery, groceries & retail delivery, parcel delivery, and industrial-campus delivery. (*Written evidence submitted by Starship Technologies - SDV0019*)
- ST services are commercially available in the United States, United Kingdom, Finland, and Estonia with partners like Sodexo, Daimler AG, Intuit, Tesco, Co-op, Volkswagen, Novo Nordisk, Bayer.
- ST founded in July 2014 Ahti Heinla and Janus Friis with Lex Bayer joining as CEO in June 2018
- ST aims were to fundamentally change how the last-mile of a delivery is concluded, making local deliveries more convenient, environmentally efficient, and less expensive.
ST operates in Milton Keynes, Northamptonshire also conducting trials in Bedford, and Cambridgeshire.
- ST serve nearly 200,000 homes.
- ST robots in the UK have driven 1.3 million miles making over 1 million deliveries. Globally we have crossed more than 60 million driveways and roads and made over 3.5 million deliveries. (*Written evidence submitted by Starship Technologies - SDV0019*)

The key determinants in the process of committing to develop the innovation:

- The idea or a variant of an preexisting idea which could be developed and expanded into a successful business.
- Heinla had been building and working with robots since his early years he had spear headed a bid to build for the NASA rough terrain vehicle for Mars.
- Experience of the product available if not how and where to source:
- Two entrepreneurs the founders Ahti Heinla (Estonian) and Janus Friiss (Danish)
- Heinla & Friiss were part of the original Skype team, Friiss a Co-Founder, Heinla a lead engineer.
- Skype was sold after a couple of years of being established to Ebay for \$2.5 billion
- With Lex Bayer from Airbnb joining as CEO in June 2018
- The right people? in the case of Starship technologies experience, knowledge with the ability to create their vision.
- The opportunity to either to build a profitable business or create one for interested parties to buy the technology, the business or both.
- Strategy: Secure investment with a successful business plan to expand existing operating areas such as Finland to double its existing footprint
- Review the existing business models and develop bigger robots, payload and range which would use the road networks instead of the footpaths and cycleways.
- Finance and Profitability: Previous experience developing and running a business already existed with the founders of the business as well a personal wealth.
- ST in 2017 were a “start-up” or “seed” business who successfully raised \$17.2 million with a further \$25 million in the second round of investors, then in 2022 raising \$42m to which was to be used to increase its fleet of level 4 autonomous robots (*Techcrunch March 2022 – Ingrid Lunden*)
- Further investment has followed from the European Investment bank who invested \$57 million (*Techcrunch March 2022 – Ingrid Lunden*)
ST has raised in excess of \$202 million dollars in its early investment stage.
- In 2018 ST started operating in Milton Keynes in the United Kingdom with fully Autonomous level 4 (*Newstech Aug 2019*)
- Equipped with AI and sensors to navigate its way around its area. The fully autonomous robot can “look” before crossing roads and has the ability stop or avoid obstacles buy using ultrasonic sensors, radar, time of flight cameras to cover all angles with object detection running at 2,000 frames per second.
- Although the PDDs are autonomous the system is operated by humans who can take back control of at any time or answer questions or issues instructions if requested by the PDDs.
- The controllers are not necessarily in the same Country as the Robot.
- Customers can be notified of the delivery progress as well as track the delivery and unlock using a smart phone app.
- In 2018 Worldwide stats for Starship Technologies claim the robo deliveries made more than 50,000 deliveries covering 200,000 miles working in more than 100 cities (*Jennifer DeLaOsa April 2019 Advantage Business Media*)
- For reference the robot pod is h57cm x w57 x l70cm weighing at circa 33kg (*unloaded*) carrying 3 shopping bags travelling at an average speed 2.3mph.

The processes and technologies which the company used to carry this development forward:

- Market Knowledge – the Starship founders identified 50% of all delivery costs were transport, most of which are increased in the last couple of miles.
- Also identified that 95% of the items purchased online by the general public are not overly big and could possibly be delivered by a small Robot. Deliveries arranged when the customer is available right size of transport, no wasted deliveries.
- Smart and efficient.
- Build a product
- Trial and prove – 2019, 25 robots delivering to George Mason University campus with a capture market of 40,000 students would embrace new technology and to make their life easier.

The extent to which the development relied on resources external to the company and the ways in which the deployment of these resources was managed:

- The development did not rely on external resources, it took the idea and made it its own, however ST did need partnerships to prove the PDDS overall package worked.

How management overview of the development was maintained:

- A new company starting from scratch closely managed by the co-founders.
- Development; right tech at the right time; with a public who believed and embraced the new technology.
- Improve and monitor and improve.

The extent to which you feel this innovation process represents best practice:

- ST: took a totally different approach to others for their development.
- A better understanding of the task required and how to meet the task.
- Forward thinking, research, and development.
- Market research and intelligence, great job.
- Good ideas get copied- Kiwi Bot, Robo Mart, Teleretail following in the footsteps Starship Technologies closely followed by Amazon & Fedex who are also developing their own variants (Annex 1)

Critique:

- Starship Technologies were the first in its field and continues to prove the concept works on daily.
- A similar concept failed for its original intended purpose.
- Innovation found a solution, created by experts in their field, the design brief and market intelligence were spot on.
- A great product with a long-term business strategy, it is going places others will follow or consider acquiring the business or technology.
- As independent business it has resisted technical collaborations.
- Although business was boosted by the Pandemic, I believe it would have still been a winner.
- Retaining many customers reducing shopping trips by car up to 70% pre pandemic.
- Although currently ahead of the competition Amazon & Fedex are catching up fast.
- Amazon new company which has grown greater than anyone original expected and now in a world dominant position, embracing technology, efficiencies and associated cost benefits it's a must have.

- Historic giants such as UPS & Fedex will need this type of technology to stay in business; daily post & parcels will become part of the additional functions of Starship and Amazon as example.
- AI is “unknown” to the incumbent generation; however the last 150 years from chalk and slate to smart phones, fingers to laptops, lifesaving surgery, improved survival rates and recovery times, horse and cart to autonomous vehicles, first flight by man to everyday travel around the globe, placing man on the moon these are just a few examples where significant change has helped Humankind who has accepted and adopted changes as part of everyday life.
- We are or will be effected by AI; the developing world necessitates the drive in technology to survive and sustain the digital world, to care for the environment and the global population.
- AI will enhance human understanding; however I believe in some areas it will be human assistants to AI as opposed to AI assisting a human. i.e., radiographers will use AI to improve efficiencies the radiographer could become the AI assistant with AI taking the lead and the human assistant by prioritising workload.
- AI will improve and rewrite scientific fields; from medical breakthrough and developments to scientific discovery, medical research diseases and antibiotic resistance through to producing images from space which could never have been seen without AI.
- The world is always evolving however AI developing at an even faster pace one that we cannot fully understand or honestly say we will know how it will be managed by humans in the future.
- As the new generations grow in the next 20 years AI of the future today will be adopted in everyday life from which we can learn, hopefully manage the AI opportunities to review and rewrite science and current accepted practices.
- World of Holman must have:
 1. An off switch.
 2. A contingency for when the off switch is pulled.
 3. Contingency for when AI under our control is taken out of our control!

Annex 1:

1. Starship Technologies PDDs



Fake News examples which fooled the global media:

2. Pope improves his street cred with a Puffa Jacket:



3. Donald Trump arrested:

4. YouTube link to the PDD's being used : <https://youtu.be/Z417CncwQsg>

5. Examples of the top six which follow Starship Technologies

[Top 6 Delivery Robots - Self Driving \(Autonomous\) Delivery Robots - YouTube](#)

Referencing:

- *AI Regulation – DSI&T Uk Gov*
- *What are Large Language Models used for? NVIDIA, 2023.*
- *Black hole pictured for first time – in spectacular detail, Nature, 2019.*
- *Accelerating the race against antibiotic resistance, Deepmind, 2022.*
- *Stopping malaria in its tracks, Deepmind, 2022.*
- *Creating plastic-eating enzymes that could save us from pollution*
- *Mia mammography intelligent assessment, NHS England, 2021.*
- *Robotics and Autonomous Systems for Net Zero Agriculture, Pearson et al., 2022.*
- *Artificial intelligence, big data and machine learning approaches to precision medicine and drug discovery, Current Drug Targets, 2021.*
- *Unlocking de novo antibody design with generative artificial intelligence, Shanehsazzadeh et al. 2023.*
- *Pioneering new tools to be rolled out in fight against child abusers, Home Office, 2019.*
- *Paul Trott / Alan Mumby May 2023.*

Models of innovation

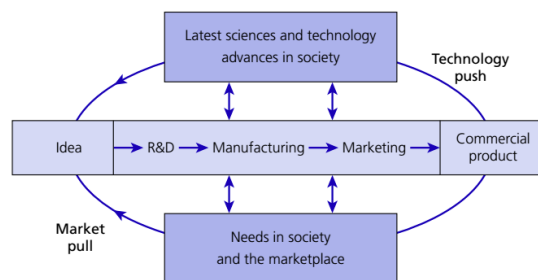


Figure 1.7 Interactive model of innovation

The study of innovation

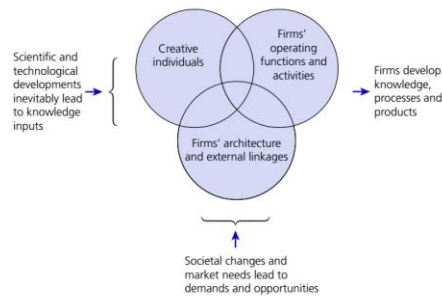
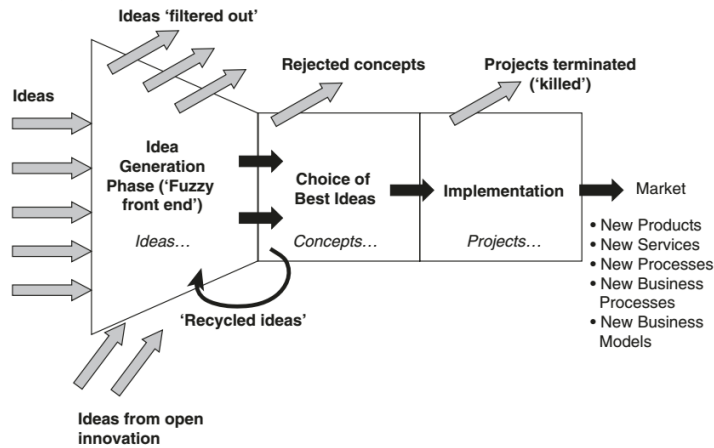


Figure 1.1 Overview of the innovation process

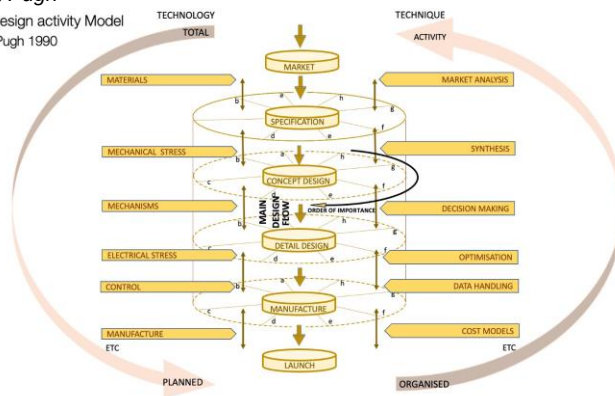
Greg Satell – Alan Mumby

How well is the task defined?	Well	BREAKTHROUGH Mavericks Skunk Works Open innovation	SUSTAINING INNOVATION Roadmaps R & D Design thinking Acquisitions
	Not well	BASIC RESEARCH Research divisions Academic collaboration Publications	DISRUPTIVE INNOVATION VC Model Innovation labs 15% / 20% rule Lean launch-pad
		Not well	Well
	How well is the domain defined?		

K.Goffin & R.Mitchell

FIGURE 1.4: The Typical Phases of an Innovation: 'The Development Funnel'³³

Stuart Pugh

Total Design activity Model
Stuart Pugh 1990

Alan Mumby May 2023:

