THE DRONES ARE TAKING OFF

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Drones are one of the hottest technologies right now, and for good reason.

Their superb data gathering capabilities will affect our lives in ways we cannot yet imagine. They will shape our lives as much as cell phones, tablet computers and other similar game-changing technologies that has disrupted business models as we once knew them.

As we read about them and constantly see them all over the news, drones are making their way into more and more business areas at a rapid pace. We are already witnessing the effect drones have on our daily lives as they are deployed more and more places, from aerial photography to surveillance of crops and delivering of packages.

But - so far the real impact of drones has far from been felt. Drones are an emerging technology, yet it is no wonder that the EU Commission compares the impact of drones on the economy with that of the internet in the 1990s (1).

The Drone sector is projected to create hundred thousands of jobs across the world in the coming years, and with estimates of making up a multi-billion dollar industry already in 2020.

Drones can and will completely disrupt existing business models as we know them. It is merely a matter of time before this happens on a large scale. In this report, BrainBotics explores the impact of the drones' invasion on our economy in detail.

The report serves as a guide to understand how drones affect both economic growth and jobs as they find their way into numerous business sectors and disrupts their core value propositions.

The purpose with this report is to enable people and organisations to navigate the emerging technology of drones by allowing them to harness the opportunities and mitigate the challenges that follow.

By fully appreciating where drones have their origin, it allows for an understanding of why and where they are appearing now in such great numbers along with which jobs they are good at performing.

Along with drone-specific commercial insights, BrainBotics makes it possible for businesses, public entities as well as local and internationally oriented organisations to make informed strategic decisions and to navigate safely in a world of this new emerging technology.

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THE DRONES ARE COMING

CHAPTER 1

THE DRONES ARE COMING

From war zones to business opportunities.

With recent technological advances, drones are a cost-effective solution that is extremely easy to operate.

Military drones have been used for decades, but the technology has until recently been too expensive for the business sector to even consider exploiting.

When simplifying matters, the coming of drones is a question of how the overall cost-level has fallen. The low cost of the technology behind them now makes them commercially viable.

The concept of a drone still has strong associations to military deployment. Yet, in recent years it has become increasingly common to refer to drones used for commercial purposes. And - it is here that the impact of drones will make their real noticeable mark, affecting economic growth and jobs on a large scale.

Like many other technologies, drones are a classic spillover technology. They are born from intensive R&D efforts linked to military uses that have lowered prices significantly.

We are today witnessing four trends marking the coming of the drones on a large scale:

• Companies that formerly only made drones for the military have diversified into the civil commercial sector in order to exploit the market opportunities available here, e.g. Aerovironment Inc. [USA], Boeing Company [USA], Airbus SAS [FRA], Lockheed Martin Corporation [USA] and Israel Aerospace Industries [ISR].

• Completely new players are beginning to appear around the world that purely focus on the civil and commercial sectors, e.g. 3D Robotics [USA, 2009], iRobot [USA], DJI [CHN, 2006], Parrot SA [FRA, 1994] and Airware [USA, 2011]. The number of drone manufactures in the world already amount to almost 500 by now, with many more companies making complementary services available. • Large private companies with current business models that on the surface do not have anything to do with drones, like Google, GoPro, Amazon, Facebook and DHL, are opening up the commercial drone market and are starting to position themselves in this new market. They are in pursuit of new business models that make use of drones for a variety of different purposes, and have begun to acquire smaller companies or even start-ups that have very unique products or services that these larger companies expect will earn them fortunes.

• Some of the world's largest tech companies like Qualcomm, Intel and GE have invested heavily in drone start-ups. In the US alone, VC investment into drone technology soared almost 420%, in one year, from USD 108 million in 2014 to USD 450 million in 2015 (2). 2016 looks to beat this record. An iResearch report even suggests that Chinese drone companies received approx. twice as much funding in 2015 compared to US based companies (3).

These developments confirm that drones represent an emerging technology.

The most prone sectors to be affected by drones are where there is a large potential of replacing humans doing dull, dirty and dangerous jobs, i.e. generally within labour-intensive tasks. Here drones provide cost efficient solutions and can even substitute man-hours.

But - this is merely the beginning.

Sectors implicated are very diverse and range from the offshore sector to logistics, agriculture, and beyond – creating a parallel to the disruptive force of the internet in the 1990s, as the EU Commission refers to, that brought with it both e-commerce and massive amounts of readily available information.

It is no wonder that the World Economic Forum proclaims drones as a one of the Top 10 Emerging Technologies that will improve lives, transform industries and safeguard the planet.

⁽²⁾ https://www.cbinsights.com/blog/drone-funding-2015/

In a world driven by information, drones offer unparalleled opportunities to gain access to vast amounts of data from the physical world. This will increase economic efficiency in so many ways that we have yet to uncover the real potential.



New areas for use of drones are continuously seeing the light of day. Google recently bought US-based Titan Aerospace to provide internet to remote areas via drones high up in the skies. Facebook also wanted to get its hands on Titan, for its <u>internet.org</u> project that is to provide the same service as Google of beaming down internet from the skies, and ended up acquiring UK-based Ascenta instead.

THE BUSINESS OF DRONES

CHAPTER 2

"We are in the early days of an aviation revolution that will change the way we do business, keep people safe, and gather information about our world"

US President Barack Obama, 2016

DRONE TECHNOLOGY IS EXPONENTIAL

Humans do not tend to think exponentially – we instead think linearly.

This is why we in the beginning of an exponential curve do not observe the disruptive forces of an emerging technology. To start with, most exponential technologies appear to be inferior to a linear development. The technology disappoints us.

Once the exponential technology reaches a certain limit, it will move so fast that we humans are not able to comprehend it – this is sometimes referred to as the 'deception of exponential growth' that results in either chaos or wonder.

We need to be careful not to let the coming of the drones disappoint us at the current stage because this means that the technology suddenly will come as a surprise to us and wreak havoc instead of being a delightful wonder that helps organisations grow and prosper.



One way to make people realise the importance of exponential growth and its deception is to use an analogy. Imagine yourself being tied up to a seat at the top of a football stadium with a water tap dripping each minute. For each dripping, the amount of water is doubled, from 1 to 2 to 4 to 8, etc.

What is baffling to most people is that it takes less than 50 minutes to fill the whole football stadium with water.

What's more striking is that due to the exponential growth of the drops, after about 45 minutes all you see is the playing field covered with water. At this point you still feel safe. Then, within four more minutes, the water fills the entire stadium, leaving you to drown.

Some argue that this is what occurred to the huge corporations Kodak and Blockbuster. These companies failed to pay attention to emerging technologies and the deception of exponential growth that firstly did not appear to have any disruptive powers to destroy their business model.

What since happened was catastrophic to Kodak and Blockbuster and occurred so swiftly that it was unavoidable once perceived as a real problem.

This brings us back to the case of drones.

From a technical point of view, the technology behind drones is digital and is therefore developing along Moore's Law of exponential growth, i.e. doubling their capacity for every 18 months at the same price point.

In 1965 the co-founder and former chairman of Intel, Gordon Moore, made a projection that would be termed Moore's Law. He predicted that for the coming 10-15 years, computers would double their computing power every second year.

Gordon Moore himself was skeptical about for how long this exponential growth in computing power could last. Today, more than 50 years later, it is nonetheless still being observed, although the period of doubling has changed to 18 months.

Put differently, the price of drone technology follows a curve where it is halved every 18 months.

The new generation of cheap, small drones is essentially a fleet of flying smartphones with low-cost builtin sensors. With prices plummeting they are already popping up everywhere. It is vital that organisations pay attention to this emerging technology today rather than tomorrow. If not, they lose the race to organisations that are already incorporating them into their business models and could end up repeating the mistake of Kodak and Blockbuster.

The underlying reasoning for why drones follow an exponential growth curve is that they are built by components that follow Moore's Law, i.e. the fitting of more processing power on a continuously smaller area. Such rapid development has a significant importance when it comes to drones, as drones are for example very much dependent on being light weight in order to gain more flight time.

The development of drones follows in parallel how sensor- and mobile technology has developed and is developing exponentially over time, with smaller and smaller devices available at continuously lower price points as a result, as indicated in the below illustration that depicts this development over the past 10 years.





THE BUSINESS CASE

The business case for drones is the cost-efficient solution for data gathering they bring.

Drones are quicker and more agile at many tasks that previously required human hands or costly machinery. The possibility of obtaining data such as close-up video, images and other sensory data input automatically, makes drones a very valuable tool for a wide range of tasks.

When digging deeper into the exponential features of drones, two attributes make sure that drones are in the technology fast-lane and make their business case very solid. These are linked to the cost side, and do not even begin to explore the immense revenue possibilities:

- 1. The return on investment (ROI) can be tremendously favourable for drones
- 2. Drones collect data, and data-driven business models have marginal costs going towards zero

Firstly, the capital expenditure (CAPEX) is swiftly dropping as a consequence of what Moore's Law predicts. Together with a lower operating expenditure (OPEX), the ROI for making drones part of your business becomes very encouraging.

The OPEX of drones is considerably lower compared to a person. In instances where drones directly replace helicopters doing the same job, the operating expenses are comparatively very low. And – with fully autonomous drones on the horizon, the operating costs will practically solely relate to maintenance costs of the drones.

Secondly, drones have the capability of gathering vast amounts of data from the physical world that can then be analysed for an unlimited amount of purposes. Data, if anything, follow an exponential curve, and so-called 'connected devices' is by Cisco projected to reach 50 billion units in 2020 from merely 500 million in 2003 (4). As these devices are swooping over us in great numbers, so are data-driven business models. What is special about data-driven business models is that their marginal costs tend to go towards zero. This means that the costs to a company of producing yet another product nears null.

This relationship occurs because data, as opposed to physical products, can be copied indefinitely with a minimum of costs related hereto. This is essentially the business model of Uber, Airbnb, Netflix, TripAdvisor, Spotify, and many more.

> Airbnb's business model does not require any large capital investments. Making available one more apartment via Airbnb's online marketplace is virtually at zero cost to the company, whereas a similar product means a large capital investment to a hotel.

> Consider also Uber versus traditional taxi companies. For a taxi company to add another taxi to its fleet, a car and license must to be acquired at a significant capital expenditure. Uber can add a similar offer to its inventory at almost no cost by enabling people to share their existing cars.



⁽⁴⁾ https://www.cisco.com/c/dam/en_us/about/ac79/docs/innov/IoT_IBSG_0411FI-NAL.pdf

Similar data-driven business models are already seeing the light of day using drone technology.

Along with so-called smartphone technology, the exponential advances within Next Generation Robotics, Big Data and Cloud Computing are fuelling drones as one of the hottest tangible technologies today.

Next Generation Robotics are making human-machine collaboration a reality, with both better and cheaper sensors enabling drones and other robots to understand and respond to its environment like never before.

Cloud Computing is the brain that enables drones to become smart machines. It is now possible to access data already gathered by other smart machines, effectively creating a machine-network that smoothly communicates and exchanges observations.



Big Data creates the analytical capabilities for the data harvested through sensors and cameras to be used in countless ways that will be a main driver for the formation of new business models.



A major driver for the takeoff of drones is the Internet. The exponential properties of the Internet created the foundation for hobbyists to self-organise and crowdsource technical challenges related to drones.

In this way, the co-founder of 3D Robotics, Chris Anderson, in 2007 created an online community called DIY Drones drone enthusiasts. It has been a key component for the commercialisation of drones by creating the autopilot 'ArduPilot'.

THE MARKET FOR DRONES

CHAPTER 3

ECONOMIC IMPACT

It is widely agreed that the so-called hockey-stick effect soon will kick in. With this, the market for drones will truly take off, as the hockey-stick effect entails a very rapid growth boom hitting the industry, followed by a more continuous growth rate.

Industry experts disagree about when exactly this growth boom will happen, but most agree that regulation plays a significant role in when it occurs. In other words, the current regulation void is halting the drones to really take off.

One study by Mike Blades, senior industry analyst for aerospace and defense at Frost & Sullivan, suggests that the world market will grow from USD 693 million in 2014 to USD 6,7 billion by 2020 (5). The Teal Group projects that the market will be worth USD 11,5 billion by 2024 (6), while Business Insider projects that the market will be worth USD 12 billion already by 2021 (7).

Regional projections have also been published, with the Association for Unmanned Vehicle Systems International (AUVSI) providing its primary forecast of the UAS market as reaching a whopping \$1.14 billion in the first year once favorable regulation in the US is put in place. Within three years after, the total market for drones in the US will have accumulated to USD 13,6 billion according to AUVSI.

As shown in the below graph, the AUVSI estimates that by 2025 the US market alone will have grown to USD 5.1 billion (8), following the hockey-stick effect, with a more continuous growth rate after the sharp rise.



Even bigger numbers been published as you cross the Atlantic, with the European Commission being cited for how the market in Europe alone will be worth EUR 15 billion EUR by 2025 (9), and according to an iResearch report, it is predicted that by 2025, the Chinese market will be worth a staggering USD 75 billion (10).

It is also widely agreed upon that the commercial drone market surpasses both the hobby and military markets by volume. According to ABI Research, the world market for only small drones will grow at a Compounded Annual Growth Rate (CAGR) of 51% from 2014 until 2019.

As shown in the below illustration, with steady growth following the hockey stick effect, the commercial drones market, by 2019, will have surpassed the currently relatively larger military market for drones by 2,3 times its size, as well as dwarf the hobby market by approx. 5 times (*11*).



(5) http://www.frost.com/sublib/display-report.do?id=NFC4-01-00-00-00

(6) http://www.tealgroup.com/index.php/about-teal-group-corporation/press-releases/118-2014-uav-press-release

(7) http://www.businessinsider.com/uav-or-commercial-drone-market-forecast-2015-2

(8) http://www.auvsi.org/auvsiresources/economicreport

(9) http://www.iresearchchina.com/content/details8_22801.html

(10) http://www.iresearchchina.com/content/details8_22801.html

(11) https://www.abiresearch.com/press/small-unmanned-arial-systems-market-exceeds-us84-b/



An estimated 446 manufactures of drones currently exist in the world, with Europe taking up the leading position *(12)*.

North America however has the biggest manufactures and surpasses both Europe and Asia-Pacific in sales volume.



Not all relies on regulation. Gartner, a leading information technology research and advisory company looks to the technology side of drones and specifically when fully autonemous drones will conquer the skies. In their 2015 Hype Cycle, Gartner projects that there is still 5-10 years of innovation before such drone technology reaches a plateau of maturity.

⁽¹²⁾http://www.uavglobal.com/list-of-manufacturers/ ac79/docs/innov/IoT_IBSG_0411FINAL.pdf

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ABOUT BRAINBOTICS

MEET THE COMPANY



WHAT WE OFFER

At BrainBotics we enable companies, organizations or individuals to navigate safely through the new frontier of robot technology to make informed and sound decisions for their business.

Disruptive technology is changing business models faster than ever before. We deliver high level insights with a balanced and nuanced perspective. The team represents a perfect match between technological expertise and business understanding. Get access to years of knowledge and a global network within cutting-edge technology.

We focus on robots, drones and AI and combine our technological expertise and business understanding to help you understand the opportunities and challenges of disruptive technology.

We provide the following services:



In-Depth Analysis





Robot as a Service



ARTIFICIAL INTELLIGENCE



DRONES



NEXT GENERATION ROBOTICS

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