

DJI and the take-off of the drone market



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Flying high through innovation



Frank Wang (Tao Wang) wasn't a particular star at school. So his parents, a teacher and an engineer, decided to offer an incentive to get him to study harder. His hobby was radio controlled vehicles and so they promised him a helicopter if he improved at school; it worked in terms of his studies but it had an even more significant side effect. One that took him a lot further than his home town of Hangzhou, China.

The grades improved, the long-awaited helicopter arrived – but duly crashed on its maiden flight. His frustration with the primitive control system spurred him on and led him to study at Hong Kong University of Science and technology (HKUST) where he followed his passion by studying at the Department of Electronic and Computer Engineering. His final year project involved another helicopter; although he had designed this one himself it met the same fate as his earlier one, crashing on demonstration. Fortunately his supervisor, Professor Zexiang Li saw potential and took him on as a research student in 2005 to work further on radio control.

During the following year he improved his design and posted an advertisement for his prototype on a website (RC Forum) for radio control enthusiasts; he was surprised to receive an order from the USA at a price of around \$7500 although the cost to produce it was only a third of that. Wang wasn't just a nascent technologist; he could also spot a business opportunity and so persuaded a couple of classmates to join him in renting a studio in Shenzhen, close to Hong Kong, and setting up a company to make supporting controls and components for radio controlled devices. That company was DJI - Da Jiang Innovation Science and Technology Co Ltd .

It has grown somewhat since its start-up days. DJI currently has an estimated 70 percent market share of the global market for drones (2021), employs over 14,000 people and has offices in 17 countries. Wang is one of the wealthiest people in China and in 2017 became the world's first 'drone billionaire'.

A brief history of drones/UAVs

Drones aren't a new idea; back in 1839 Austrian soldiers attacked the city of Venice with unmanned balloons filled with explosives. During the early years following the Wright brothers successful flight researchers began looking at the possibilities of unmanned aircraft. The first prototype took off in 1916 in the form of the Ruston Proctor Aerial Target; as its name suggests it was a pilotless machine designed to help train British aircrew in dogfighting. Importantly it drew on early versions of radio control and was one the many brainchildren of Nikolai Tesla but its early performance was unremarkable and the British military chose to scrap the project, believing that unmanned aerial vehicles had limited military potential.

A year later, an American alternative was created: the Hewitt-Sperry Automatic Airplane and successful trials led to the development of a production version, the Kettering Bug in 1918. Although its performance was impressive it arrived too late to be used in the war and further development was shelved.

By the time of the Second World War the enabling technologies around control and navigation had improved enormously; whilst still crude the German V1 and V2 rockets and flying bombs provided a powerful demonstration of what could be achieved at scale. Emphasis was placed on remote delivery of explosives – using UAVs as flying bombs or aerial torpedoes – but the possibilities of using them in other applications such as reconnaissance were beginning to be explored.

The Vietnam war saw this aspect come to the fore; the difficulties of operating in remote jungle and mountain zones made reconnaissance flying hazardous and the risks to aircrew who were shot down led to extensive use of UAVs. The Ryan Firebee drone flew over 5000 surveillance missions,

controlled by a ground operator using a remote camera. Its versatility meant that it could be used for surveillance, delivery of supplies and as a weapon; UAVs began to be viewed as an alternative to manned aircraft. But despite their success and promise it was not until the 1990s that they began to occupy an increasingly significant role.

The technology found more support in Israel and during the 1973 Yom Kippur war UAVs were used in a variety of ways, as part of an integrated approach alongside piloted aircraft. A great deal of learning in this context meant that for a while Israel became the key source of UAV technology with the US acquiring and deploying this knowledge to improve its own capabilities, leading to the new generation deployed in the Gulf War. UAVs emerged as a critical tool for gathering intelligence at the tactical level. These systems were employed for battlefield damage assessment, targeting, and surveillance missions, particularly in high-threat airspace.

Fast forward to today. There's been an incredible acceleration in the key enabling technologies which has helped UAVs established themselves as serious contenders for many aerial roles. For example GPS has moved from its early days in 1981 where a unit weighed 50kg and cost over \$100k to a current cost of less than \$5 for a chip-based unit weighing less than a gram. The Internal Measurement Unit (IMU) which measures a drone's velocity, orientation and accelerations has followed a similar trajectory; in the 1960s an IMU weighed several kilograms and cost several million dollars but today the chipset which puts these features on your phone costs around \$1. Kodak's 1976 digital camera could only manage a 0.1 megapixel image from a unit weighing 2kg and costing over \$10,000. Today's digital cameras are approximately a billion times better (1000x resolution, 1000x smaller and 100x cheaper). And (perhaps most important) the communications capabilities now offered by Wi-Fi and Bluetooth enable accurate and long-range communication and control.

One consequence of this military development has been the spill over into the civilian sector and an explosion in the range of applications for which small UAVs can be used.

DJI and the beginnings of the drone business

Which is where Wang and DJI came in. Their early focus was on providing the peripheral systems needed to support professional applications – for example in the gimbals needed to ensure vibration free photography. The strategy was to use their deep understanding of radio-controlled aircraft and associated control systems to offer better or at least comparable performance at a much lower cost.

An early target was the professional aerial photography market – of interest to a wide range of users like farmers, surveyors, film-makers, etc. Drones could offer a lot if the cost of hiring a plane

and pilot could be taken out of the equation but in order to enter this market DJI had to develop highly stable platforms and lightweight cameras to deliver the high quality the industry required.

Significantly DJI works on enabling technologies to support drone based work but which also have value in their own right – for example as camera systems and accessories. In particular DJI worked on the reliability and interoperability of components and control systems, creating the basis for a platform model which could be adapted to suit the needs of many differing professional user sectors. It worked; amongst many other accolades in 2017 DJI won a Technology Emmy award for its camera technology which by then was used in many TV shows including ‘Game of Thrones’.

An indication of the disruptive challenge DJI posed to the film-making market can be seen in the cost comparison; the standard platform for cinematography since the 1970s was the Steadicam with a cost of around \$120,000 for a top of the range system suitable for TV or movie work. By contrast the Ronin with its gimbal-stabilised MOVI technology costs around \$2500.

Estimates suggest the 2021 drone services market is worth \$9 billion with predictions of growth rates as high as 45% per year. Application sectors outside mainstream aviation include infrastructure, agriculture, transport, security, media and entertainment, insurance, telecommunication and mining.

Moving to the mass market

Having established a strong reputation and pushed the technological envelope in these highly demanding markets DJI set out to open up the (relatively) simpler application sector of hobby drone users. They pioneered a platform model, working on the system elements and, from an early stage, building in the feedback from a growing community. The model which has helped push DJI to its prominent position in the hobby market has been one of crowdsourcing; the company has an active Forum in which thousands of enthusiasts provide ideas, test prototypes, offer constructive criticism and help drive development quickly up a learning curve. Importantly this has been underpinned by a cost leadership approach; not only are DJI drones very advanced in terms of their technologies, they are also low cost, fitting the budget of the mass market of hobbyists.

DJI focused on solving problems around keeping and using small UAVs such as hovering and turning in the air, avoiding obstacles, preventing blurred images, fast transfer of photos, and ensuring there was enough battery life to bring the drone back to earth. 2013 was a turning point with the launch of the Phantom which brought together their learning in a simple low-cost but powerful platform; it caught the attention of many people in the photography business. By 2016 the fourth generation Phantom 4 was able to carry over a kilogram of payload to a height of 6000m and stay

there for half an hour – all for a price of around \$1300. The alternative cost of a plane and pilot hire would be around \$500 for one half hour session plus the costs of camera equipment and specialist operator. The attractions were quickly visible and DJI became a key player in the sector.

They continued to innovate, introducing the Mavic range of light-weight foldable drones in 2016 and, in response to regulatory authorities placing restrictions on who could operate drones without formal licences and training, a lightweight sub-250g drone which sells for \$350.

Their development has continued to be characterised by technological breakthroughs around the drone itself- for example in the Lightbridge transmission system. Before Lightbridge technology, users had no way of viewing footage being recorded at long distances by their drone's camera, which hindered more widespread usage in both the recreational and commercial sectors, especially in the world of aerial photography and videography. With the invention of Lightbridge, drone pilots could view live footage shot by their drone in HD quality straight from their Smartphone, enabling users to observe and perfect their aerial photos and videos for the very first time.

Innovation strategy at DJI

DJI is a classic example of technology-led innovation. Wang's crashed helicopter experiences led him to work on trying to solve problems of control and communication and much of his early work was in finding solutions to these problems. Gradually he moved into building complete drone systems and broke through to the mass market for UAVs (unmanned aerial vehicles) with the Phantom model launched in 2013. The company has continued to invest heavily in R&D and holds nearly 700 Chinese patents (according to China's State Intellectual Property Office) and close to 100 in the USA; it has been involved in a number of lawsuits to enforce those and support its strong presence in the field as a technological leader. Wang himself is named on nearly 100 of these.

Although they have emphasised a home-grown approach to technology development they have also entered into some key strategic alliances, notably in 2015 with the camera and lens maker Hasselblad. and in November 2015. This proved such a valuable complement to their capabilities that in 2019 they acquired a majority stake in Hasselblad.

But in parallel with their technology push approach building strong competencies has been an approach to fast learning by working in demanding markets. They are a good example of a 'born global' business; they began selling in 2008 to the Chinese market but quickly expanded the business to overseas markets in the following year. Their current sales distribution is split almost equally between North America, Europe, Asia (including China), each of which accounts for 30% with the remaining 10% coming from South America and Africa.

Whilst design and manufacturing are concentrated at home sales and distribution are global with an increasing component coming from online presence. They have also developed some key sales partnerships such as that with Apple where their drones are designed to work seamlessly with the iPhone platform and are sold in Apple stores.

They set themselves aggressive targets in terms of product updating, quickly bringing new features to the market and making use of their large and active user base to collect feedback and test early stage prototypes. This challenge-led approach also helped them with the value and technical engineering needed to quickly produce a drone which complied with the regulatory requirements for non-licensed drone operators, reducing the operating weight to just under the 250g limit.

Product development cycles are short with a constant upgrading of features and the release of new models building on user feedback. The interval between the first Phantom and subsequent models (the latest version is the Phantom 4) has been around 2 years and there has been extensive broadening of the range to suit different market segments and user profiles.

Part of their strategy has been one of classical disruptive innovation, working with an underserved market (hobbyists) to learn and develop low cost but reliable solutions and then migrating to increasingly demanding sectors where they can deploy this cost advantage whilst also taking on technological leadership.

A key part of their strategic approach has been to remain a largely privately owned business which gives them considerable autonomy in terms of decision-making. Although there is some external shareholding the bulk of control remains concentrated amongst family and friends. For example Wang's old university supervisor tight Professor Liu holds 10% of the shares, an old school friend who helped support the early days has another 14% and Wang's uncle has 16%. Wang himself still holds 45% of the shares and in 2017 became China's youngest tech billionaire; his company is now worth over \$8bn.

Challenges ahead

For a company scarcely fifteen years old DJI has achieved a great deal. It has successfully penetrated a number of markets and deployed disruptive strategies to build a strong position as the world's most successful drone maker. But there are challenges on its horizon.

Regulation of airspace has become increasingly significant with the proliferation of drones. Whilst collision avoidance technology has helped regulatory requirements still mandate the only very small (sub 250g) drones can be operated without a licence. Even then concerns about the potential misuse of drones – for example in deliberate disruptive and terrorist actions – place the unregulated sector under threat. (A suspected drone incident closed the runway at London’s Gatwick airport in 2018 with consequent disruption of over 1000 flights and around 140,000 passengers affected).

A further challenge to DJI because of its Chinese origins has been the increasing control and restriction placed on the use of Chinese technology in some regions of the world.

Further resources

DJI website:

<https://www.dji.com/uk>

https://www.kindai.ac.jp/files/rd/research-center/management-innovation/kindai-management-review/vol5_6.pdf

<https://medium.com/@askdroneu/how-dji-became-the-drone-industrys-most-valued-company-526f5bf6141d>

Timeline of drone history

<https://dronesgator.com/the-history-of-drones/>

Timeline of DJI innovation

<https://www.drdrone.ca/blogs/drone-news-drone-help-blog/timeline-of-dji-drones>

Reflection and discussion questions

Read the case and do your own research around the company to build a rich picture of how they manage innovation.

1. DJI is a good example of the kind of entrepreneurial venture which is '[born global](#)' – that is, it has built its growth model on scaling at international level. What are the key factors in their success story?
2. DJI's innovation strategy has been built up on the basis of acquiring and then deploying key technological competencies. What have been the key elements in this approach?
3. A widely-used model for innovation strategy is the '[Innovation ambition matrix](#)' model developed by Nagji and Tuff, based on positioning and then expanding from the core. How far does this model explain the DJI approach?
4. How influential do you think the user community has been for the success of DJI?