The innovation of the flying machine management essay

One of the greatest inventions that have amazed me since the beginning was the invention of flight. There have been great many innovations during the 20th century but one of the most beneficial to today's world is the innovation of the airplane. However, the concept of the airplane has only been around for two centuries now. Before that time, people tried to fly by imitating the birds. They built machines with flapping wings such as the " Ornithopters" (Akira, 1992). The problem was that it was possible for birds to fly due to their light weight, than it does at the much larger scale needed to lift both a man and a machine off the ground. So people began to look for other ways to fly. Beginning in 1783, a few aeronauts made daring, uncontrolled flights in lighter-than-air balloons, but this was hardly a practical way to fly (Rumerman, 2010). There was no way to get from one place to the other unless the wind was blowing in the desired direction. As per McKeown (2008), Innovation is new stuff that is made useful. I strongly believe that the construction of the airplane was not just an invention but also an innovation as it involved the change in the thinking process and the idea applied successfully in practice. As per Smith (2010), Innovation is the process whereby an idea is transformed into a commercial product or service and the innovation of the airplane serves as a perfect example.

The Wright brothers, Orville and Wilbur, were two Americans who are generally credited with inventing and building the world's first successful airplane and making the first controlled, powered and sustained heavier-than-air human flight, on December 17, 1903 (Dulken, 2000). This innovation was patented as the " Flying Machine" and hence the title of this essay. The innovation of the airplane falls into the " Completely new product" category

in the “ Different degrees of Innovation” model as it had never been introduced into the market before. (Source – Lecture Slides)

As per Henderson and Clark (1990), Radical innovation establishes a new dominant design, and hence a new set of core design concepts embodied in components that are linked together in a new architecture. The innovation of the airplane can be considered as a radical innovation as it was the result of a major technological breakthrough, represented non-linear, discontinuous (disruptive) change, required new knowledge sets and skills, involved the application of a new business model and finally resulted in a new dominant design.

The innovation of the airplane not only led to creation of today’s $429. 9 billion industry (prlog, 2010) but also has led to the innovation of various other technologies such as the helicopters, rockets and space shuttles which contribute to mankind and science. The creation of the flying machine is a classic example of the “ garage” model of innovation, i. e. starting at home where the Wright Brothers who were individuals started working on it as a hobby (wright-brother. org, 2010). One of the main reasons as to why “ Individual Innovation” still continues is because of the Growth of small firm sector, New organisational arrangements e. g. strategic alliances, Availability of financial support and finally because of “ Role models”. Few of the recent individual innovations have been Gore Tex, Freeplay, Velcro, Visicalc, Google, Apple and HP.

Before we study about this great invention, let us look into the history behind what influenced the Wright Brothers.

The Process of Innovation

The discovery of the kite that could fly in the air by the Chinese started humans thinking about flying. Kites have been important to the invention of flight as they were the forerunner to balloons and gliders (Britannica, 2009).

The ancient Greek engineer, Hero of Alexandria, worked with air pressure and steam to create sources of power. One experiment that he developed was the “ aeolipile”, which used jets of steam to create rotary motion. The importance of the “ aeolipile” is that it marks the start of engine invention. The engine created movement will later prove essential in the history of flight (Nasa, 2010).

Leonardo da Vinci made the first real studies of flight in the 1480’s. He had over 100 drawings that illustrated his theories on bird and mechanical flight. The Ornithopter flying machine was a design that Leonardo da Vinci created to show how man could fly. The modern day helicopter is based on this concept. Leonardo da Vinci’s notebooks on flight were reexamined in the 19th century by aviation pioneers (Akira, 1992).

Later the brothers, Joseph Michel and Jacques Etienne Montgolfier, were inventors of the first hot air balloon. In 1783, it climbed to a height of about 6, 000 feet and traveled more than one mile (Rumerman, n. d).

Sir George Cayley is considered the father of aerodynamics. Cayley experimented with wing design, distinguished between lift and drag, and formulated the concepts of vertical tail surfaces, steering rudders, rear elevators, and air screws. George Cayley also recognized that there would be a need for machine power if the flight was to be in the air for a long time.

George Cayley wrote “ On Ariel Navigation” that showed that a fixed wing aircraft with a power system for propulsion, and a tail to assist in the control of the airplane, would be the best way to allow man to fly (aviation-history, 2010).

(Source – about, 2010)

This led to the development of the first flight by the Wright brothers. Prior to the Wright brothers using an engine to power the flight, few scientists and researchers such as Otto Lilienthal, Samuel Langley and Octave Chanute contributed to the brains behind it.

German engineer, Otto Lilienthal, studied aerodynamics and worked to design a glider that would fly. Samuel Langley was physicist and astronomer who realized that power was needed to help man fly. Octave Chanute designed several aircrafts and the Herring – Chanute biplane was his most successful design and formed the basis of the Wright biplane design (nasa. gov, 2010).

(Source – about, 2010)

(Source – Lecture Slides)

Innovation is closely linked to invention. In fact invention becomes a part of innovation. “ Innovation involves new ideas, new discoveries and new breakthroughs” (Smith, 2010, p. 9). These have been developed through the process of experimentation to arrive at a workable invention. This is normally a part of the research element in R & D. “ A key feature of inventions is their newness, which means that they incorporate some inventive step” (Smith,

2010, p. 9. However, the invention is normally not ready for the market at present. The innovation is the invention, commercialization and distribution of the product. Invention is the picture of something new (Stamm, 2008). While both invention and innovation have a “ unique” impact, innovation also carries a low voice performance and market expectations of performance. An improvement on an existing form or embodiment, the composition or procedures could be an invention, an innovation, both or neither if it is not significant enough (Stamm, 2008). According to some literature of business, an idea, a change or improvement is only an innovation when put to use and effectively causes a social or commercial reorganization. In business, innovation can be easily distinguished from the invention. Invention is the conversion of cash into ideas. Innovation is turning ideas into cash. Lets us look at how the Wright brothers converted their ideas into profitable ventures.

Orville Wright and Wilbur Wright were very deliberate in their quest for flight. First, they spent many years learning about all the early developments of flight. They completed detailed research of what other early inventors had done. They read all the literature that was published up to that time. Then, they began to test the early theories with balloons and kites. They learned about how the wind would help with the flight and how it could affect the surfaces once up in the air (wright-brothers. org).

The next step was to test the shapes of gliders much like what George Cayley did when he was testing the many different shapes that would fly. They spent much time testing and learning about how gliders could be controlled. The Wright Brothers designed and used a wind tunnel to test the

shapes of the wings and the tails of the gliders. After they found a glider shape that consistently would fly in the tests in the North Carolina Outer Banks dunes, then they turned their attention to how to create a propulsion system that would create the lift needed to fly (wright-brother. org).

http://www. wright-brothers. org/TBR/History%20Images/1901%20Wind%20tunnel%20in%20bike%20shop. jpg

The wind tunnel, (Source – wright-brother. org, 2010)

The early engine that they used generated almost 12 horsepower.

Picture of the Wright Brothers first engine.

Picture of the actual 12 horsepower engine used in flight (Source – nasa. gov, 2010)

In 1899, after Wilbur Wright had written a letter of request to the Smithsonian Institution for information about flight experiments, the Wright Brothers designed their first aircraft: a small, biplane glider flown as a kite to test their solution for controlling the craft by wing warping. Wing warping is a method of arching the wingtips slightly to control the aircraft’s rolling motion and balance (nasa. gov, 2010).

The Wright Brothers spent a great deal of time observing birds in flight. They noticed that birds soared into the wind and that the air flowing over the curved surface of their wings created lift. Birds change the shape of their wings to turn and maneuver. They believed that they could use this

technique to obtain roll control by warping, or changing the shape, of a portion of the wing (wright-brothers. org).

(Source – Lecture Slides)

“ Development is about turning ideas and technologies into products” (Smith, 2010, p. 107). The product resulting from the development phase will be ready to sell to consumers, but it has many of the operational characteristics of the finished product. The product will work and thus prove the feasibility of placing on the market, even though there is still more to do before produced in quantity and reliability standards demanded by consumers. Central to development of the innovation process is the construction of models and prototypes. The purpose of models is to convey the form, style and feel of an object (Leonard-Barton, 1991 cited in Smith, 2010, p. 107). Models are used to communicate the appearance of the proposed product. It is usually used to give the impression that the product actually looks like. Original counter usually have little to do with the format and instead is all about function. In contrast to the finished product, a prototype is a version of the product is manufactured as a single piece. Prototypes are typically constructed on a jobbing basis using general purpose equipment rather that specialist purpose built equipment (Smith, 2010, p. 107). They are often made of different materials from those who would go to the final product. This is usually because the materials used for prototypes are easier to work with and more flexible.

2D Prototype

http://www. wright-brothers. org/TBR/History%20Images/1904%20Flyer%202%203-View. jpg(Source – wright-brothers. org)

Over the next three years, Wilbur and his brother Orville would design a series of gliders which would be flown in both unmanned (as kites) and piloted flights. They read about the works of Cayley and Langley, and the hang-gliding flights of Otto Lilienthal. They corresponded with Octave Chanute concerning some of their ideas. They recognized that control of the flying aircraft would be the most crucial and hardest problem to solve (Honious, 2003).

Following a successful glider test, the Wrights built and tested a full-size glider. They selected Kitty Hawk, North Carolina as their test site because of its wind, sand, hilly terrain and remote location.

In 1900, the Wrights successfully tested their new 50-pound biplane glider with its 17-foot wingspan and wing-warping mechanism at Kitty Hawk, in both unmanned and piloted flights. In fact, it was the first piloted glider. Based upon the results, the Wright Brothers planned to refine the controls and landing gear, and build a bigger glider (Honious, 2003).

In 1901, at Kill Devil Hills, North Carolina, the Wright Brothers flew the largest glider ever flown, with a 22-foot wingspan, a weight of nearly 100 pounds and skids for landing. However, many problems occurred: the wings did not have enough lifting power; forward elevator was not effective in controlling the pitch; and the wing-warping mechanism occasionally caused the airplane to spin out of control. In their disappointment, they predicted that man will probably not fly in their lifetime (Honious, 2003).

In spite of the problems with their last attempts at flight, the Wrights reviewed their test results and determined that the calculations they had used were not reliable. They decided to build a wind tunnel to test a variety of wing shapes and their effect on lift. Based upon these tests, the inventors had a greater understanding of how an airfoil (wing) works and could calculate with greater accuracy how well a particular wing design would fly. They planned to design a new glider with a 32-foot wingspan and a tail to help stabilize it (Honious, 2003).

User Test Prototype

File: 1902 Wright glider fly. jpg

(Source – wright-brothers. org)

The 1902 Wright Glider with Wilbur piloting on one of its early test flights before replacement of the fixed double vertical rudder with a single steer able rudder (Honious, 2003).

Functions of the Prototype

Prototypes are used to facilitate the integration of components and sub-systems (Smith, 2010, p. 108). This is especially true in the case of complex products with many components and subsystems to interact and collaborate. Another feature of the prototype is to facilitate learning. The process of testing enables those who have developed a new technology to learn its properties, through the acquisition of formal technical knowledge (Smith, 2010, p. 108). When it comes to innovation, knowledge is cumulative and hours spent testing prototypes can help developers learn about the

properties of a new technology. However, learning on the acquisition of tacit or informal knowledge may be equally important. User testing prototypes in the form of working prototypes are often used to allow companies to learn about users and user behavior. Finally, prototypes have a role to play in reducing risk. Tests carried out with prototypes can help identify potential risks. It is not technology but the market risks that are identified this way. Products generate significant safety issues if they do not work correctly and this is very important to be looked into.

During 1902, the brothers flew numerous test glides using their new glider. Their studies showed that a movable tail would help balance the craft and the Wright Brothers connected a movable tail to the wing-warping wires to coordinate turns. With successful glides to verify their wind tunnel tests, the inventors planned to build a powered aircraft (Smitson, 2001).

After months of studying how propellers work the Wright Brothers designed a motor and a new aircraft sturdy enough to accommodate the motor’s weight and vibrations. The craft weighed 700 pounds and came to be known as the Flyer (Smitson, 2001).

File: First flight2. jpg

First flight of the Wright Flyer I on December 17, 1903 with Orville piloting and Wilbur running at wingtip (Source – aviationhistory. info)

It is required to determine the design features and characteristics of the final product which would be sold in the market. This is likely to be involved in determining the exact form of this product, which has the endurance to be

manufactured, for use in the manufacture of materials and the process that the product is manufactured.

The brothers built a movable track to help launch the Flyer. This downhill track would help the aircraft gain enough airspeed to fly. After two attempts to fly this machine, one of which resulted in a minor crash, Orville Wright took the Flyer for a 12-second, sustained flight on place on November 9. The Flyer II was flown by Wilbur Wright (Smitson, 2001).

The “ Flyer” lifted from level ground to the north of Big Kill Devil Hill, at 10: 35 a. m., on December 17, 1903. Orville piloted the plane which weighed six hundred and five pounds (Smitson, 2001).

The first heavier-than-air flight traveled one hundred twenty feet in twelve seconds. The two brothers took turns during the test flights. It was Orville’s turn to test the plane, so he was credited with the first flight (Smitson, 2001).

Humankind was now able to fly! During the next century, many new airplanes and engines were developed to help transport people, luggage, cargo, military personnel and weapons. The 20th century’s advances were all based on this first flight at Kitty Hawk.

The video of the first flight of mankind has been recorded and can be viewed at http://www. youtube. com/watch? v= uT2dQB_OgFE&feature= related

File: 1904WrightFlyer. jpg The picture shows Orville in flight over Huffman Prairie in Wright Flyer II. Flight #85, flew approximately 1, 760 feet (536 m) in 40 1/5 seconds on November 16, 1904. (Source – loc. gov)

In 1908, passenger flight took a turn for the worse when the first fatal air crash occurred on September 17. Orville Wright was piloting the plane. Orville Wright survived the crash, but his passenger, Signal Corps Lieutenant Thomas Selfridge, did not. The Wright Brothers had been allowing passengers to fly with them since May 14, 1908 (Schlenoff, 2003)

In 1909, the U. S. Government bought its first airplane, a Wright Brothers biplane, on July 30. The airplane sold for $25, 000 plus a bonus of $5, 000 because it exceeded 40 mph (Schlenoff, 2003)

A business model is an enabling device that is a tool that allows inventors to profit from their ideas and inventions (Smith, 2010, p. 12). According to Chesbrough (2006, cited in Smith, 2010, p. 12) a business model performs two functions as far as the commercialization of an invention is concerned. These functions are to create value and capture value. Value creation refers to a series of activities which enables the user to identify the benefits and value that they are unable to achieve gains from the invention. With new technologies, in particular, this is the function of vital importance because the technology may be the product of a scientific breakthrough, rather than seeking to meet the specific need for the user to solve the problem of the user. The business model first identifies the user who will use innovation and then elaborate the proposal “ value” so that the users are aware of the purpose and the benefit they can expect to reap. Only when the user recognizes the benefit to be derived from the new generation is that they are likely to be willing to consider the purchase.

The second function of the business model is to capture value. This includes access to the value of the activities undertaken by the innovation. The value that the innovator typically hopes to gain is revenue, though there could be other gains as well (Smith, 2010, p. 14). The most obvious way of generating revenue is through outright sale where the consumer exchanges money in return for ownership of the product or service, but there is a variety of other methods of generating revenue including renting, charging by transaction, advertising, subscription and charging for after sales support (Chesbrough and Rosenbloom, 2002 cited in Smith, 2010, p. 14).

In 1911, the Wrights' Vin Fiz was the first airplane to cross the United States. The flight took 84 days, stopping 70 times. It crash-landed so many times that little of its original building materials were still on the plane when it arrived in California. The Vin Fiz was named after a grape soda made by the Armour Packing Company (Schlenoff, 2003). As per Karl Sabbagh (1996 cited in the Lecture Slides) stated in his book '21st Century Jet' that pilot testing of a new aircraft as " another illustration of how the plane makers explored the far corners of the envelope in their attempts to make the plane safer."

In 1912, a Wright Brothers plane, the first airplane armed with a machine gun was flown at an airport in College Park, Maryland. The airport had existed since 1909 when the Wright Brothers took their government-purchased airplane there to teach Army officers to fly (Schlenoff, 2003).

On July 18, 1914, an Aviation Section of the Signal Corps (part of the Army) was established. Its flying unit contained airplanes made by the Wright

Brothers as well as some made by their chief competitor, Glenn Curtiss (Schlenoff, 2003).

Market launch

Among the activities involved in market launch are:

Ensuring that retail outlets have appropriate stocks

Booking advertising space

Designing and producing advertisements

Booking exhibition space

Ensuring that literature about the product has been designed, written and printed

Informing the press and ensuring that they’ve had time to familiarise themselves with the product

Rothwell’s 5 Models of the Innovation Process

Technology Push

Demand Pull

Coupling model

Integrated model

Network model (Open Innovation)

The technology push model is very much the traditional perspective on the process of innovation. It is effectively the research led version of the generic model presented earlier, since one of the features of this model is that it is driven by the developments in science and technology (Smith, 2010, p. 114). It assumes that more technology, resulting from the additional expenditure on research and development, will inevitably lead to more innovation. This process is completely linear and sequential, each stage of the stages following the completion of the previous one. Model ignores the practice in the market, which are portrayed as passive and just take what technology has to offer. This model is naive as far as the process itself is concerned.

Technology Push

Design &

engineering

Manufacture

Marketing

Sales

Basic

science

Technology

(Source – Lecture Slides)

The factors that helped and/or hindered the process of innovation

As their fame grew, orders for aircraft poured in. The Wrights set up airplane factories and flight schools on both sides of the Atlantic. Unfortunately, once they had demonstrated their aircraft in public, it was easy for others to copy them and many did. The Wrights were dragged into time-consuming, energy-draining patent fights in Europe and America. The bitterest legal battle was with Glenn Curtiss, who, as part of his defense, borrowed Langley's unsuccessful aircraft from the Smithsonian Institution and rebuilt it to prove that the Aerodrome could have flown before the Wright Flyer. The ruse didn't work — Curtiss made too many modifications to get Langley's aircraft in the air and the courts ruled in favor of the Wrights. Yet although the case resolved the Wright/Curtiss dispute, it left an enduring resentment between the Wrights and the Smithsonian (Schlenoff, 2003).

Outside the courtroom, the world seemed no friendlier to Wilbur and Orville. The aircraft business was uncertain and dangerous. Most of the money to be made was in exhibition flying, where the audiences wanted to see death-defying feats or airmanship. The Wrights sent out teams of pilots who had to fly increasingly higher, faster, and more recklessly to satisfy the crowds. Inevitably, the pilots began to die in accidents and the stress began to tell on the Wrights. Additionally, their legal troubles distracted them from what they were best at — invention and innovation. By 1911, Wright aircraft were no longer the best machines flying (Schlenoff, 2003).

In 1912, Wilbur Wright, worn out from legal and business problems, contracted typhoid and died. Orville, his heart no longer in the airplane

business, sold the Wright Company in 1916 and went back to inventing (Schlenoff, 2003).

(Source – United States Patent and Trademark Office, 2010)

Patent fights and business troubles behind him, Orville Wright built a small laboratory in his old West Dayton neighborhood. Here, he contracted out as a consultant on a wide variety of engineering problems. He also took up a number of projects that caught his imagination. He did much aeronautical work, helping to develop a racing airplane, guided missile, and “ split flaps” to help slow an aircraft in a dive. But he also worked on aerodynamic automobile designs, toy designs and manufacture, even a cipher machine for encoding communications (Schlenoff, 2003).

(Source – Lecture Slides)

Forms of Intellectual Property Rights

Patent

Registered Design

Trademark

Copyright

Design right

Passing off

Nature of the Intellectual Property Right (IPR)

Creation of IPR

Creative

Reputation

Inherent

Registered

(Source – http://www. ipo. gov. uk/ cited in Lecture slides)

Intellectual Property Rights

They give legal recognition to the ownership of new ideas, designs etc.

They give the owner of IPR the right to stop others exploiting his/her property

They create for the innovator a system by which he/she can benefit from his/her ingenuity

The IPR may be licensed to others provided certain conditions are met

As per Smith (2010), Patent is “ a reward for technical innovation through the granting of monopoly rights for disclosure of the innovation.”

(Source – Lecture Slides)

3 conditions have to be met:-

Novelty

The invention must not have been made public anywhere in the world before the date on which the patent application is filed. It is new if "...does not form part of the state-of-the-art".

Inventive Step

Compared with what is already known i. e. not " obvious to a person skilled in the art"

Capable of industrial application

Must be capable of being made in some kind of industry. i. e. have a technical effect. For example the drug penicillin could not be patented, but the process for making it could

Patenting Process

File application with Intellectual Property Office (http://www. ipo. gov. uk/)

Showing: request for patent; name & address of applicant; description of the invention

Search & Publication

Patent Office Examiner does preliminary check of patent records to see if invention is new

Publication

Full (“ substantive”) examination

The final stage before a patent is granted. Particular attention is paid to whether invention is new

Potential Penalties for Patent Infringement

Patent holder has to take the alleged infringer to court claiming the patent has been infringed

If the claim is upheld the court may impose:

Infringer required to cease production of offending product

All current production to be handed over to the patent holder

Infringer required to pay damages to patent holder