

Human History of Technological Development#1

In December 1903, Orville and Wilbur Wright succeeded in the first manned powered flight in history. Let us _____ some _____ questions _____ remarkable achievement. If they _____, _____ have never been invented? If they had been born 10 years earlier, _____ have had airplanes 10 years earlier? Either of these questions should be answered “No”. The general impression may be _____ technological developments were the products of _____ efforts by gifted _____ and _____ represented by James Watt, Thomas Edison, and Henry Ford. However, this understanding is missing the point. First, technologies develop _____ and _____. The history of inventions _____ of contributions by countless engineers rather than the _____ achievements of individual geniuses. The Wright brothers had a lot of _____ who _____ the essential groundwork for manned flight, and The Wright brothers _____ the last piece of the puzzle. Also, inventions are _____. By _____, an invention appears _____ where _____ foundation and demand for it. The Wright brothers and Edison happened to be in an _____ where their inventions were _____ to _____. How have humans developed technologies?

In December 1903, Orville and Wilbur Wright succeeded in the first manned powered flight in history. Let us ponder some hypothetical questions on their remarkable achievement. If they hadn't been around, would airplanes have never been invented? If they had been born 10 years earlier, would we have had airplanes 10 years earlier? Either of these questions should be answered “No”. The general impression may be that technological developments were the products of strenuous efforts by gifted inventors and entrepreneurs represented by James Watt, Thomas Edison, and Henry Ford. However, this understanding is missing the point. First, technologies develop gradually and cumulatively. The history of inventions is a relay of contributions by countless engineers rather than the overnight achievements of individual geniuses. The Wright brothers had a lot of predecessors who laid the essential groundwork for manned flight, and The Wright brothers added the last piece of the puzzle. Also, inventions are inevitable. By necessity, an invention appears in the time and place where there are foundation and demand for it. The Wright brothers and Edison happened to be in an era where their inventions were ripe to be discovered. How have humans developed technologies?

manned powered flight	動力有人飛行	cumulatively	次第に増加するような
ponder	～を熟考する	relay	リレー
hypothetical	仮説の	predecessor	前任者
strenuous	熱心な	by necessity	必然的に
entrepreneur	起業家	ripe	熟した

Human History of Technological Development #2

The fundamental _____ of technological development will eventually come down to the following sentence; technology _____ to the _____ possible when society is motivated to _____ resources _____ it. Firstly, there has to be a demand. Due to the success of airships in 1900, the demand for air transportation was rising, _____ a growing frustration for the _____ to fly freely, which _____ the motivation of many engineers. Both the public and private sectors recognized the military and economic potential of aircrafts, making it easier for them to invest resources. Innovation is not _____ a technological matter. It has always been influenced by socio-economic conditions. Secondly, inventions require _____ of existing technologies. Henry Ford once _____ a car the discoveries by other people in history. Inventing manned powered flight needs _____ of other technologies, such as efficient engines and propellers, the best shape of the wing based on fluid dynamics, and skills for _____ flight control. The Wright brothers didn't discover all of them; their achievement was preceded by numerous enabling technologies, including the invention of _____ engines, which far _____ steam engines in power weight _____. Some engineers attempted to build airplanes powered by steam engines, but they couldn't fly because the power output was too _____ to their weight. Also, The Wright brothers had a lot of predecessors, from Isaac Newton in the 17th Century to Otto Lilienthal in the 19th Century, who _____ and data on aerodynamics and aeronautics. These _____ had already made the cup almost full, and The Wright brothers added the last drop. Invention occurs inevitably when it's needed by _____ from the _____ technologies.

The fundamental principle of technological development will eventually come down to the following sentence; technology proceeds to the adjacent possible when society is motivated to allocate resources toward it. Firstly, there has to be a demand. Due to the success of airships in 1900, the demand for air transportation was rising, while there was a growing frustration for the inability to fly freely, which sparked the motivation of many engineers. Both the public and private sectors recognized the military and economic potential of aircrafts, making it easier for them to invest resources. Innovation is not purely a technological matter. It has always been influenced by socio-economic conditions. Secondly, inventions require accumulation of existing technologies. Henry Ford once admitted that he just assembled into a car the discoveries by other people in history. Inventing manned powered flight needs countless of other technologies, such as efficient engines and propellers, the best shape of the wing based on fluid dynamics, and skills for stable flight control. The Wright brothers didn't discover all of them; their achievement was preceded by numerous enabling technologies, including the invention of internal combustion engines, which far outperform steam engines in power weight ratio. Some engineers attempted to build airplanes powered by steam engines, but they couldn't fly because the power output was too weak relative to their weight. Also, The Wright brothers had a lot of predecessors, from Isaac Newton in the 17th Century to Otto Lilienthal in the 19th Century, who had left behind theories and data on aerodynamics and aeronautics. These forerunners had already made the cup almost full, and The Wright brothers added the last drop. Invention occurs inevitably when it's needed by proceeding only one step ahead from the existing technologies.

come down	伝わる	outperform	～より性能が優れている
adjacent	隣接した	aerodynamics	空気力学
assemble	組み立てる	aeronautics	航空学
fluid dynamics	流体力学	forerunner	先駆者
combustion	燃焼		

Human History of Technological Development #3

Sometimes it is extremely difficult to come up _____ . Some of the inventions _____ transformed the world _____ from accidental discoveries, such as the antibiotic properties of Penicillium, the relationship between electricity and magnetism, and the utility of X-rays. Inventions often depend on _____, but if the number of attempts _____ is large enough, an invention will occur almost by necessity. Let's say there is _____ of 10 percent chance of winning. If you draw the _____ 22 times, the _____ of getting at least one success exceeds 90 percent. When there are the right _____ and _____ for the discovery, many people will work on it. The more people enter the venture, the more likely _____ of them will _____ upon the solution. This fact does not _____ the _____, passion, and _____ of The Wright brothers and Thomas Edison. They are great individuals. It is _____ to learn how they _____ the challenges, went through a _____ of hardships, and eventually achieved their dreams. However, when a _____ number of people work on the same invention, it is statistically likely that some of them are talented and _____ enough like The Wright brothers. In fact, many engineers _____ different countries in the same _____ were working on the discovery of manned powered flight, including Samuel Langley, Ninomiya Chuhachi, Henri Farman, and Gabriel Voisin. Likewise, more than 20 people _____ the _____ for inventing _____ of the light bulb before Edison. It is not that the airplane was invented thanks to The Wright brothers. It was _____ inevitable that we had somebody who had the gift and _____ to achieve the first manned powered flight _____.

Sometimes it is extremely difficult to come up with an idea from scratch. Some of the inventions that transformed the world were resulted from accidental discoveries, such as the antibiotic properties of Penicillium, the relationship between electricity and magnetism, and the utility of X-rays. Inventions often depend on coincidence, but if the number of attempts across society is large enough, an invention will occur almost by necessity. Let's say there is a lottery of 10 percent chance of winning. If you draw the lottery 22 times, the probability of getting at least one success exceeds 90 percent. When there are the right conditions and incentives for the discovery, many people will work on it. The more people enter the venture, the more likely it becomes that some of them will stumble upon the solution. This fact does not deny the talent, passion, and perseverance of The Wright brothers and Thomas Edison. They are great individuals. It is inspiring to learn how they set off for the challenges, went through a series of hardships, and eventually achieved their dreams. However, when a certain number of people work on the same invention, it is statistically likely that some of them are talented and passionate enough like The Wright brothers.

In fact, many engineers in different countries in the same decade were working on the discovery of manned powered flight, including Samuel Langley, Ninomiya Chuhachi, Henri Farman, and Gabriel Voisin. Likewise, more than 20 people are known to deserve the credit for inventing some version of the light bulb before Edison. It is not that the airplane was invented thanks to The Wright brothers. It was historically inevitable that we had somebody who had the gift and enthusiasm to achieve the first manned powered flight in that era.

scratch	最も初期の段階	deny	～を否定する
antibiotic	抗生物質の	talent	才能、適性
Penicillium	ペニシリン	perseverance	忍耐力
incentive	動機	set off	向かう、出発する
stumble	偶然出くわす、発見する	passionate	熱烈な

Human History of Technological Development #4

Flying freely through the sky seems to _____ a dream for _____. For example, Leonardo Da Vinci, a 15th-century Florentine artist, left _____ early flying machines in his _____. This _____ genius also discovered foundational ideas of hydrodynamics and helicopters. However, we don't recognize _____ as the inventor of the aero crafts. Both Da Vinci and the Wright Brothers were talented, _____, innovative people, but the brothers had 4 advantages that Da Vinci couldn't have. First of all, the Wright Brothers had predecessors, such as Alphonse Pénaud and Otto Lilienthal, whose experiments and discoveries had _____ important foundations for _____. When they were children, the brothers famously played _____ a rubber-powered toy airplane made by Alphonse Pénaud. Secondly, the Wright Brothers had access to _____ technologies for flying machines. No matter how great Da Vinci's idea might have been, it was just _____ without a light and effective engine. Da Vinci _____ his idea because necessary enabling technologies were absent in his era. Thirdly, the Wright brothers had a lot of other inventors who _____ manned powered flight in the same decade, including Samuel Langley and Glenn Curtiss, whom they learned from and _____ each other. Also, the fact that there were many other competitors have _____ more of the future success in this _____. On the other hand, Da Vinci was alone in the 15th Century, _____ whom he could inspire, compete with, and learn from. Lastly, the Wright brothers had a lot of successors who _____, improved, and commercialized their discoveries. One of the brothers' biggest _____ is the invention of the effective flight control system. Of course, modern airplanes don't use the very same system that the brothers invented, but their discoveries have been the _____ of the flight control up till now because their discoveries have been succeeded, updated, and _____ by later generations, without whom we may not know _____ of these great _____ from a century ago. The misfortune of Da Vinci was he had _____ that the Wright brothers could enjoy.

Flying freely through the sky seems to have long been a dream for humanity. For example, Leonardo Da Vinci, a 15th-century Florentine artist, left sketches of early flying machines in his manuscripts. This versatile genius also discovered foundational ideas of hydrodynamics and helicopters. However, we don't recognize him as the inventor of the aero crafts. Both Da Vinci and the Wright Brothers were talented, inquisitive, innovative people, but the brothers had 4 advantages that Da Vinci couldn't have. First of all, the Wright Brothers had predecessors, such as Alphonse Pénaud and Otto Lilienthal, whose experiments and discoveries had laid important foundations for modern aviation. When they were children, the brothers famously played with a rubber-powered toy airplane made by Alphonse Pénaud. Secondly, the Wright Brothers had access to enabling technologies for flying machines. No matter how great Da Vinci's idea might have been, it was just a pie in the sky without a light and effective engine. Da Vinci couldn't even test his idea because necessary enabling technologies were absent in his era. Thirdly, the Wright brothers had a lot of other inventors who ventured into manned powered flight in the same decade, including Samuel Langley and Glenn Curtiss, whom they learned from and imitated each other. Also, the fact that there were many other competitors have convinced them more of the future success in this realm. On the other hand, Da Vinci was alone in the 15th Century, where he had nobody whom he could inspire, compete with, and learn from. Lastly, the Wright brothers had a lot of successors who inherited, improved, and commercialized their discoveries. One of the brothers' biggest contributions is the invention of the effective flight control system. Of course, modern airplanes don't use the very same system that the brothers invented, but their discoveries have been the fundamental principle of the flight control up till now because their discoveries have been succeeded, updated, and implemented by later generations, without whom we may not know the name of these great inventors from a century ago. The misfortune of Da Vinci was he had none of these advantages that the Wright brothers could enjoy.

manuscript	原稿	a pie in the sky	絵に描いた餅
versatile	多才の	venture	思い切って挑む
hydrodynamics	動水力学	realm	領域
inquisitive	研究好きな	inherit	～を相続する
aviation	航空学	implement	～を実行する

Human History of Technological Deployment #5

Technologies, once invented, can easily be _____. It is quite difficult for a society to keep its _____ of technology. The knowledge cannot be maintained _____ continuously _____ demand and a _____ number of experts _____ exist. Even if we have technological books and blueprints, somebody has to be able to understand and _____. In addition, the more _____ and complex the society is, the wider variety of experts are needed. Each of the _____ - _____ technologies _____ an enormous support network of other technologies. Here are just tiny examples from the _____ of technologies that _____ modern aviation; the manufacturing technology of carbon fiber and composite materials to _____ aircraft; sensors and software that enable flight control systems; infrastructures necessary for flight, such as Air _____ and how to _____ airports. No single individual brain can store all this information necessary for the aviation industry. Even The Wright brothers' contribution is just one piece of these _____ of technologies. An advanced civilization is only possible _____ a large number of people in society who share their knowledge and _____ with each other. Indeed, _____ the population size of a community _____, we cannot maintain our _____ technologies. For example, Tasmania used to be connected to the Australian Continent until the end of the last _____, _____ 10,000 years ago, the sea level rose and the island became isolated. After the isolation, the technological standard of Tasmanian people did not just _____ but lost many technologies that their _____. This is _____ because Tasmanian people were _____ the large _____ network with Australian societies and could not access the _____. In other words, they _____ the _____ population size to _____ level of technology. Today, humanity can continue to fly airplanes safely because a large global population brings together their knowledge and expertise. Next time you enjoy your flight, be thankful, not only to The Wright brothers, _____ to all the inventors and _____ in history that contributed to the development of aviation technology, as well as _____ people _____ with you who support, maintain, and enable this technology.

Technologies, once invented, can easily be lost. It is quite difficult for a society to keep its level of technology. The knowledge cannot be maintained unless it is continuously in demand and a certain number of experts constantly exist. Even if we have technological books and blueprints, somebody has to be able to understand and implement it. In addition, the more advanced and complex the society is, the wider variety of experts are needed. Each of the cutting-edge technologies requires an enormous support network of other technologies. Here are just tiny examples from the multitude of technologies that support modern aviation; the manufacturing technology of carbon fiber and composite materials to lighten aircraft; sensors and software that enable flight control systems; infrastructures necessary for flight, such as Air Traffic Control and how to operate airports. No single individual brain can store all this information necessary for the aviation industry. Even The Wright brothers' contribution is just one piece of these vast array of technologies. An advanced civilization is only possible when there is a large number of people in society who share their knowledge and expertise with each other. Indeed, when the population size of a community shrinks, we cannot maintain our existing technologies. For example, Tasmania used to be connected to the Australian Continent until the end of the last ice age, but around 10,000 years ago, the sea level rose and the island became isolated. After the isolation, the technological standard of Tasmanian people did not just stagnate but lost many technologies that their ancestors used to possess. This is apparently because Tasmanian people were cut off from the large trade network with Australian societies and could not access the collective intelligence. In other words, they lacked the adequate population size to sustain their level of technology. Today, humanity can continue to fly airplanes safely because a large global population brings together their knowledge and expertise. Next time you enjoy your flight, be thankful, not only to The Wright brothers, but also to all the inventors and entrepreneurs in history that contributed to the development of aviation technology, as well as numerous people contemporary with you who support, maintain, and enable this technology.

maintain	維持する	stagnate	停滞する
blueprint	設計図	isolation	孤立、隔離
cutting-edge	最先端の	collective	集団の、共同の
composite	複合の	sustain	維持する、支える
infrastructure	基盤、インフラ	adequate	十分な
multitude	多数	contemporary	同時代の、現代の