Whenever you open an app on your phone or a webpage on your computer, you are seeing the results of a software developer's hard work. While software was initially created by developers line by line, technology has rapidly advanced, providing them with tools that have made the development process more efficient and automated. Now, with the rise of artificial intelligence (AI), large portions of the software developer's job are being completed by AI-powered tools. The question is, with the rise of AI, will you still need developers for your upcoming projects? read on Artificial intelligence (AI) is taking the world by storm, and the software industry is at the forefront of the curve. However, while AI-powered tools have received accolades for their ability to perform repetitive coding and debugging tasks, their role in the design phase has received less attention. But AI is indeed entering the design phase of the software development lifecycle, and so, what does this mean for the future of user experience (UX) design?   read on Artificial Intelligence (AI) continues to rapidly evolve, fundamentally changing how apps are conceptualized, developed, and maintained. As we look forward, the role of AI in app development is becoming increasingly sophisticated, empowering developers to build smarter, more intuitive, and highly personalized apps. Here's a look at the future of AI in app development, along with some real-world examples of companies leading the way. read on As artificial intelligence (AI) tools gain more prevalence in the software industry, many positions are evolving to adapt to the changing workflows. AI can complete many of the time-consuming tasks that were previously done by software professionals, allowing software development companies to streamline their teams and shift their workflows to account for AI's growing presence. One of the roles that has been most impacted by the rise of AI is that of the product manager. The question is, has AI altered the role of the software product manager or wiped it out completely? read on Artificial intelligence continues to redefine industries, unlocking powerful capabilities and opportunities. However, alongside these advancements come significant challenges and ethical questions. As businesses and developers, it's critical for us to understand and navigate the complexities of AI, including issues related to bias, transparency, privacy, and workforce implications. Let's explore these challenges and outline some practical considerations for ethically responsible AI adoption. read on Approximately 70-95% of software developers have begun incorporating artificial intelligence (AI) into their workflows, according to recent surveys by GitHub and Stack Overflow. AI-powered tools have the power to help make the development process more efficient and enjoyable for software engineers, especially once they can fully incorporate the tools into their workflows. GitHub Copilot has gained a large following in the software world – pretty much everyone who has dabbled in AI coding has at least heard of it, and most have even tried it out. In this blog post, I'll look at what Copilot is, how we have started using it at Grio, and how I see it shaping the future of software development. read on Artificial intelligence (AI) is shaking things up in app development, making everything from automation to personalization feel like magic. Companies across industries are harnessing AI to improve efficiency, reduce costs, and deliver innovative products to their users. In this blog post, we'll explore some real-world examples of companies that have successfully integrated AI into their apps and app development workflows. read on AI is rapidly transforming app development by optimizing workflows, refining user experiences, and enhancing decision-making at every stage of the development lifecycle. From ideation to post-deployment, AI tools are enabling development teams to work smarter, and more efficiently. Here are some practical examples of how AI is transforming each phase of modern app development, as well as some recommended tools to get you started. read on Congratulations-you've launched your app! The work is finally done… right? Wrong. Once your app is deployed, maintenance and enhancements are regularly required to keep it running smoothly. While these tasks have typically required a continual influx of time and money, artificial intelligence (AI) tools are now allowing app owners to automate many of these repetitive processes. In this blog, we will examine how you can leverage AI to maximize your success after your app launches. read on Today's digital age demands speed, innovation, and precision — qualities that traditional app development methods often struggle to deliver consistently. Enter artificial intelligence (AI), a transformative force reshaping the way apps are conceptualized, designed, built, and maintained. AI is not just a buzzword; it's a game-changer that empowers developers to work smarter, create faster, and achieve more. This blog kicks off a comprehensive series on how AI is revolutionizing app development. Over the coming articles, we'll take an in-depth look at how AI integrates into every stage of the app development lifecycle, from conception to deployment, and how it addresses some of the most pressing challenges faced by developers today. The goal is to equip you with actionable insights and practical knowledge to harness the power of AI in your projects. read on With so many options on the market, and so many features to consider, choosing the best aviation headset can seem like a daunting task. This is why I… How can financial brands set themselves apart through visual storytelling? Our experts explain how.Learn MoreThe Motorsport Images Collections captures events from 1895 to today's most recent coverage.Discover The CollectionCurated, compelling, and worth your time. Explore our latest gallery of Editors' Picks.Browse Editors' FavoritesHow can financial brands set themselves apart through visual storytelling? Our experts explain how.Learn MoreThe Motorsport Images Collections captures events from 1895 to today's most recent coverage.Discover The CollectionCurated, compelling, and worth your time. Explore our latest gallery of Editors' Picks.Browse Editors' FavoritesHow can financial brands set themselves apart through visual storytelling? Our experts explain how.Learn MoreThe Motorsport Images Collections captures events from 1895 to today's most recent coverage.Discover The CollectionCurated, compelling, and worth your time. Explore our latest gallery of Editors' Picks.Browse Editors' Favorites The jet engine is arguably fundamental to modern aviation. Not many people think about it, but jet engines are a vital part of our world and how it works.Jet engines allowed us to travel faster and farther than older propeller-driven airliners. The more extended range between fuel stops made intercontinental travel more straightforward and quicker. The world became more accessible, and intercontinental travel within one day was now possible for the first time.Jet airliners also brought social change. Large jet airliners could carry more passengers, and combined with increasing fuel efficiency, fares declined. Now more people from different socioeconomic levels could travel the world.From a technical perspective, the jet engine is a technological marvel. Whether you are interested in aviation technology or not, most people have seen one and seen it spinning. Sitting in an airliner, watching the jet engines rotate leads to an obvious question:How many RPM does a jet engine spin?On large modern airliners, the jet engine fan runs at between 2500 and 4000 RPM. However, some parts of the engine spin many times faster.What Is a Jet Engine and How Does It Work?When we talk about jet engines, we typically refer to an air-breathing engine powered by a turbine and with internal combustion. They are complex machines and are one of the most expensive parts of an aircraft. The jet engines are typically mounted under the wings on modern airliners, while some older airplanes have them mounted near the tail. Most planes in service today are equipped with two engines, while some larger models have four.Turbofan engines are the most common type on airliners today. They are typically mounted under the wings.In simple terms, a jet engine works by pulling in atmospheric air, compressing it, mixing it with fuel, and igniting it. The compressed air expands by the heat, and the pressure directs the air rearwards, propelling the aircraft forward.Early jet engines were relatively weak and ineffective. Over the four decades, between the 1950s and late 1990s, the typical jet airliner engine went from producing 5000 lbf (de Havilland Ghost) of thrust to about 115.000 lbf (General Electric GE90). More recent engines, like the General Electric GE9X powering the Boeing 777X, can produce 134.000 lbf.Engine reliability also took a turn for the better. Reliability went from 40 in-flight shutdowns per 100.000 flying hours to less than one.A Short History LessonThe principles behind the jet engine and jet power are pretty old.In fact, in ancient times, water- and windmills employed some of the same turbine principles as jet engines. When the Chinese invented gunpowder-powered fireworks in the 13th century, they utilized another jet propulsion principle as hot gasses expand and propel the rocket forward.Englishman Frank Whittle devised an early version of a jet engine in 1928. He developed his design further in the following years and even patented his designs. However, the government did not show enough interest.German engineer Hans von Ohain started work on similar designs in 1935. A collaboration with Ernst Heinkel, who saw potential in the idea, culminated in the Heinkel HeS 3 engine - The world's first operational jet engine. Heinkel fitted the HeS 3 into the Heinkel 178 aircraft, becoming the world's first jet aircraft.The world's first commercial airliner to be powered by jet engines was the de Havilland Comet. Photo via Wikimedia Commons.By the 1950s, aircraft manufacturers primarily used jet engines in fighters. However, the military cleared select engine models for early civilian jet airliners-like the de Havilland Comet. Popularity grew in the 1960s, and most large airliners were now jet-powered. In the 1970s, fuel efficiency enhancements were made possible by the invention of the high-bypass turbofan engines—the same type used today on modern jet airliners.Anatomy of a Jet EngineAlthough many types of jet engines exist, the most common on large jet airliners today is the turbofan. It provides excellent fuel efficiency, relatively low noise, and high thrust levels.A turbofan engine consists of many different parts. In simple terms, a turbofan engine works like this:Cross section diagram illustrating how a turbofan jet engine works.Suck: The front fan sucks in a large amount of air. A fraction of it goes to the core and the combustion process.Squeeze: The air is squeezed together in the compressor stages, increasing the pressure and temperature of the air.Bang: Fuel is mixed with the compressed air and ignited in the combustion stage. The ignition causes expansion of the air, and the force is directed rearwards.Blow: The hot exhaust from the combustion forces its way through the turbine. This force drives the fan and compressor (from points 1 and 2 above).Bypass: The air not directed through combustion bypasses the engine core without further processing. Accelerated by the powerful and fast front fan, this air provides the majority of the engine's thrust, as the fan directs the air rearwards.Now the question of how many RPM a jet engine spins becomes a little complicated to answer: Because not all engine parts rotate at the same speed. Sometimes not even in the same direction. Turbofan engines have an inner core with higher rotational speeds than the outer. It has something to do with how high the pressure should be in that particular stage. Generally, higher rotation rates mean higher pressure.The speed at which a jet engine spins depends on the type and model.As we established earlier, there is no single rotation speed in a jet engine. In this case, however, we focus on the most visible and perhaps most characteristic part: The front fan.The front fan is perhaps the most characteristic part of the jet engine. It spins fast to suck in air and propel the aircraft forward.On large modern airliners, the front fan runs at between 2500 and 4000 RPM.For comparison, the high-pressure compressor and turbine will run at more than 10.000 RPM.Large diameter fans generally spin at lower speeds than smaller diameter fans. In addition, large engine fans typically move more air which is an excellent advantage as it improves efficiency.Generally, the larger the diameter, the lower the fan spins. In other words, fans on larger engines spin slower than their smaller siblings. The fan's job is to produce a high amount of thrust to propel the aircraft forward. For that job, they need to run fast, but not too fast. The tip of the blades should not exceed the speed of sound. Otherwise, the airflow becomes too unstable and ineffective. Therefore, a large diameter fan has to rotate slower than a small one to stay under the speed of sound.Examples of Jet Engine RPM Engine Model RPM Application General Electric GE90 2261 / 2355 RPM* Boeing 777 General Electric GE9X 2355 RPM Boeing 777X General Electric GEnx 2560 / 2835 RPM* Boeing 787 Dreamliner and 747-8 Rolls-Royce Trent 1000 2683 RPM Boeing 787 Dreamliner Rolls-Royce Trent 7000 2683 RPM Airbus A330neo Rolls-Royce Trent XWB 2700 RPM Airbus A350 Rolls-Royce RB211 3900 / 4500 RPM* Boeing 747-400, 757, and 767 * depending on variant.Is the Jet Engine RPM Shown in the Cockpit?As described above, not all parts of the engine rotate at the same speed. However, the flight crew needs to monitor the engine rotation speeds. For that purpose, the engine parts are grouped into what spins at the same rates. These groups are called N1 and N2.Cross section of a turbofan jet engine. The N1 and N2 groups are highlighted.The N1 is the rotation speed of the first part of the compressor and the rear part of the turbine. The N1 is expressed as a percentage of the maximum allowed rotation speed. The N2 group is the rotation speed of the end part of the compressor and the forward part of the turbine. N2 is also expressed as a percentage of the max RPM allowed.The engine displays in the cockpit show both the N1 and N2 values to the pilots. These values are essential for flying the aircraft safely.The location of the N1 and N2 readouts on the engine display in the cockpit of a Boeing 737-800.N1 indicates the "health" of the engine's air intake and compressor stages. More directly, N1 indicates how much air the engines take in overall.The N2 value indicates how much power the engine-driven systems are getting. Systems like hydraulic pumps, fuel pumps, and generators are getting their power from the N2 stages of the engine.ConclusionA jet engine is a complex machine. Its many parts work together to create pressure and propulsion for the aircraft.It opened the world for both faster and longer travel, without fuel stops. Rising efficiency meant declining costs, and more people could afford airline tickets.Jet engines fascinate us because of their size, power, and importance to aviation. When at an airport, it is easy to wonder:How Many RPM Does a Jet Engine SpinThe short answer is that the front fan on large modern airliners runs between 2500 and 4000 RPM. And because of the way a jet engine works, some parts of the engine spins even faster. Explore the key differences between turbofan and turbojet engines to understand their advantages and applications in the aviation industry. Jet engines undergo rigorous testing before being used in aircraft. Learn about the various testing procedures and quality control measures involved in ensuring the safety and efficiency of jet engines. Jet engine noise at airports can have a significant impact on communities. Learn about the effects of this noise pollution and the measures being taken to address it. Years ago, cockpit visits were common, but modern security rules have made them rare—though you might still get a chance after landing. Cold weather can have a significant impact on jet engines, affecting their performance and efficiency. Learn more about how extreme temperatures can affect jet engines. Cargo planes fly at night for several reasons, including reduced air traffic, cooler air temperatures, and the ability to take advantage of lower operating costs during off-peak hours. Discover why airplanes have pressurized cabins and the importance of maintaining a comfortable environment for passengers at high altitudes. Have you ever wondered why planes board front to back? Discover the reasons behind this common boarding process and how it impacts your travel experience. Share — copy and redistribute the material in any medium or format for any purpose, even commercially. Adapt — remix, transform, and build upon the material for any purpose, even commercially. The licensor cannot revoke these freedoms as long as you follow the license terms. Attribution — You must give appropriate credit , provide a link to the license, and indicate if changes were made . You may do so in any reasonable manner, but not in any way that suggests the licensor endorses you or your use. ShareAlike — If you remix, transform, or build upon the material, you must distribute your contributions under the same license as the original. No additional restrictions — You may not apply legal terms or technological measures that legally restrict others from doing anything the license permits. You do not have to comply with the license for elements of the material in the public domain or where your use is permitted by an applicable exception or limitation . No warranties are given. The license may not give you all of the permissions necessary for your intended use. For example, other rights such as publicity, privacy, or moral rights may limit how you use the material. Whether they're small planes, private jets, military planes or commercial airliners, airplanes are expensive. Unsurprisingly, the jet engines that power these aircraft are also expensive. While the price of a jet engine depends on the jet it's designed for, we can tell you that jet engines can cost anywhere between $50,000 for small planes to over $20 million for the Rolls Royce Trent 1000 that is used in Boeing 787 jetliners. Cost of Jet Engines – By Aircraft Type Small Planes A majority of small planes use turboprop engines instead of jet engines. The small planes that do use jet engines are usually unmanned aerial vehicles(UAVs). Depending on the model, a small plane's jet engine can cost anywhere between $50,000 to $80,000, which is considerably less expensive than large planes. Examples of popular small jet engines include the PBS TJ150 and PBS TJ40-G1 Private Jets Most private jet engines are produced by either General Electric or Rolls Royce. The price range for a private jet engine begins at $750,000 and can reach several millions of dollars. Private jet engines are much more expensive than small plane engines, though are still cheaper than passenger plane engines. Examples of popular jet engines include the AE3007C2 and TAY 611-8C. Related: How Much Does a Private Jet Cost? Commercial Airliners A commercial airplane's jet engine generates massive amounts of thrust, equivalent to a force of 55,000 lbs to 77,000 lbs. Commercial airline engine prices vary, but they usually run into the several millions of dollars. One of the most common commercial airplane jet engines is the Rolls Royce Trent 1000, which costs $20 million. Military Jets Military jets typically use more powerful jet engines than civilian aircraft. The F135, for example, produces 40,000 lbf (191 Kn) of thrust. Depending on the jet engine's model and availability, military jet engines are typically the most expensive. The costs of the latest military jets as well as their parts are not publicly available, but it's known that the US government has spent billions of dollars on military jet development. Cost of Jet Engines – By Aircraft Model Small Planes AVIC 601-S The AVIC 601-S is a small UAV that's only 2.1m or 7 feet long. It uses a single turbojet engine whose specifications are unknown. The cost of the plane itself is unknown to the public, but it's estimated that its engine cost is higher than $1 million. DRDO Ghatak The Ghatak is a stealth combat UAV that's only 4m long. This plane uses a variant of the GTRE GTX-35VS Kaveri engine. The cost of the engine itself is not publicly disclosed, but the plane's total development cost was $377 million, which suggests the engine cost was also several million dollars. Private Jets Embraer Legacy 600 The Embraer Legacy 600 uses Rolls Royce AE 3007 engines, which are common in both private jets and military aircraft. This engine generates a thrust of 6,442–7,042 lbf (28.66–31.32 kN). The estimated cost per engine is $3.76 million. Gulfstream G650 The Gulfstream G650 uses the Royce BR710, which is extensively used for corporate and private jets. This engine generates a thrust of 68.4 kN (15,400 lbf). The estimated cost of this engine is $1.8 million per unit. Commercial Planes Boeing 777 The Boeing 777 uses the General Electric GE90 engine family. These engines generate thrusts of 110,760–115,540 lbf (492.7–513.9 kN). In 2014, BOC aviation purchased two of these engines for a Boeing 777ER for $140 million total or $70 million per engine. Airbus A330 The Airbus A220 uses two Pratt & Whitney PW1500G engines. The Pratt & Whitney 1500G produces 17,000–23,000 lbf(76–102 kN) of thrust. The cost of each unit is reported to be approximately $10 million. Military Planes F-15 Eagle The F-15 fighting eagle uses the Pratt & Whitney F100 engine, an after-burning turbofan engine. This engine produces 7,800 pounds-force lbf (79 kN) of military thrust and 29,160 lbf (129.7 kN) of thrust with the afterburner. The Pakistani airforce acquired 60 engines in 1989 for a total of $220 million. Boeing B-52 Stratofortress The Boeing B-52 Stratofortress uses a Pratt & Whitney JT3D turbofan aircraft engine. This engine generates 17,000 lbf (76kN) of thrust during takeoff. This engine is no longer available for purchase today, but in the 1960s, it sold for between $600,000 to $850,000 per unit. Cost to Design a Jet Engine A jet engine could cost several billion dollars over its development cycle. This cost is spread between designing, adding improvements, and preparing for mass production. The high cost is due to the expensive hardware, infrastructure, simulations and stress tests. Cost to Build a Jet Engine Production costs depend on the complexity of the jet engine. Generally, production of a jet engine will run into the millions or tens of million dollars. Manufacturing is expensive because of the high manufacturing requirements in addition to the complexity of jet engine design. Cost to Overhaul a Jet Engine A full overhaul is usually anywhere between one-third to one-fifth of an engine's original price. Jet engine overhaul prices are usually between $200,000-$300,000 per engine. Most major jet engine OEMs provide maintenance plans to create better value for their customers. Why Jet Engines Are So Expensive Jet engines contain thousands of moving parts. Most of these parts are constructed using expensive materials. Some of these parts are difficult to manufacture, while others take long production times. Most of these parts are designed and built by very skilled mechanics and engineers. After production, an engine has to be tested to ensure very high safety standards are met. After all, most jet engines have to be cleared for propelling hundreds of passengers over 500 mph at an altitude higher than 30,000 feet. Helen Krasner holds a PPL(A), with 15 years experience flying fixed-wing aircraft; a PPL(H), with 13 years experience flying helicopters; and a CPL(H), Helicopter Instructor Rating, with 12 years working as a helicopter instructor. Helen is an accomplished aviation writer with 12 years of experience, having authored several books and published numerous articles while also serving as the Editor of the BWPA (British Women Pilots Association) newsletter, with her excellent work having been recognized with her nomination of the "Aviation Journalist of the Year" award. Helen has won the "Dawn to Dusk" International Flying Competition, along with the best all-female competitors, three times with her copilot. The Wright brothers could not have imagined that their visionary insight would help man fly faster than sound just a few decades later. Aeronautics made great strides in the early 19th century, and the war time efforts during World War I and World War II pushed aircraft design and manufacturing to new heights. Engineers knew that propeller driven aircraft were limited due to significant decreases in efficiency as the blade tips reached the speed of sound. A new evolution in aircraft propulsion was needed to build next generation aircraft. In the early 1930's, a patent was granted to one Frank Whittle for the design of one of the first practical jet engines. The theory was relatively simple: compress incoming air using either a centrifugal or axial compressor, inject fuel for combustion, and force the exhaust out the back of the engine. Groundbreaking as it was, the Royal Air Force did not consider it useful at the time, and so Whittle continued his work independently. Eventually forming Power Jets Ltd, Whittle and his team built the first prototype which ran in early 1937. It was around this time that German companies had also started working on jet engines, notably Junkers and Heinkel. Heinkel soon produced the famed Heinkel He 178, the first aircraft to fly using a jet engine. The engine was a Heinkel HeS 3, a centrifugal flow turbojet engine. Note: Understanding the basic types of compressors used in jet engines is important. The first jet engines, like the Heinkel HeS 3, used centrifugal compressors. Centrifugal compressors are large spinning components of an engine that take input air perpendicular to the axis of rotation of the compressor and force it outwards, compressing it. On the other hand, axial compressors take input air parallel to the axis of rotation, or axially, and compress it through a series of stages. BMW and Junkers soon produced axial flow turbojet engines. The design process of these engines was complex, and at the time the lack of modern computing made the idea of simulations a distant reality. Instead, various physical methods of testing were used. Wind tunnel testing, first invented in the late 19th century and still used today, was a necessary tool in the engineers testing arsenal. It allows engineers to determine the flight characteristics of engines as well as entire aircraft without actually being airborne. It wasn't until the late 1950's that the first turbofan jet engine was born. The Rolls-Royce RB.80 Conway was used in multiple iconic mid century aircraft, such as the Boeing 707 and Douglas DC-8. Turbofan jet engines provided significant improvements over their turbojet counterparts, including increased efficiency, lower noise, and lower exhaust temperatues. Note: Turbofan jet engines are found in almost all modern jet aircraft, including the engines on the aircraft of your favorite airlines. Turbofans are an ingenious design, expanding on the simple design of turbojets. Turbojet engines work by taking incoming air, compressing it using a compressor, igniting it, and expelling the exhaust. The exhaust is then used to power the front compressors and propel the aircraft forward. Turbofan engines work similarly, with minor changes. Turbofan engines have a large front facing fan, which turns rapidly to suck air into the engine. Part of the air enters the "core" of the engine, where it is compressed, ignited, and expelled, turning the rest of the engine. The rest of the air bypasses the core entirely, and is known as bypass air. This bypass air provides the majority of the engines thrust. Over the next several decades, major advances in jet engine design increased their fuel efficiency, thrust capacity, safety, and more. The advent of more powerful computing began to enable engineers to use these computers for complex calculations for both designing and testing engines. The use of pencils, slide rules and draft tables we're slowly replaced by computers and complex mathematical simulations. These included various differential equations, time based transients, and more. Computers enabled quick computations for performance and structural analyses, reducing the cost and increasing the safety of prototyping initial designs. Jet engine design in the modern world uses a variety of complex software. Determining the proper materials needed for specific operating temperatures and engine strain is just one of many cases that custom software has provided engineers with more advanced ways to design engines. CAD (computer-aided-design) software like AutoDesk or Solidworks enables engineers to prototype entire engines without manufacturing a single part. Software like Ansys Fluent allows engineers to test the heat transfer in an engine, as well as visualize and analyze the flow of air using computational fluid dynamics. It's interesting to think about how far jet engines have come since their inception. They've enabled transformations in various sectors like energy production and transportation, and due to their advanced requirements have pushed the boundaries in areas like material science and computing. Engine design and innovation continues at a rapid pace, with new technologies like 3D printing being used to manufacture turbine blades using lighter and stronger composite materials. The next decade will see very interesting ideas and inventions take shape, and new and groundbreaking engines will continue to transform modern society. The paper presents a comprehensive overview of the major components of jet engines, focusing on the axial flow design and its various configurations like turbojets, turbofans, turboprops, and turboshafts. It details the cold section, specifically the air intake dynamics and compressor mechanisms, as well as the lubrication and pressure systems necessary for efficient operation. The emphasis on technological frameworks like Full Authority Digital Electronics Control (FADEC) highlights advancements in jet engine management, positioning the content as a valuable reference for both academic and practical applications in aerospace engineering.