

# Novel technologies as Therapy of modern engineering Problems and its prospects

Eruni Uku Philip<sup>1</sup>, and Lucia Omolayo Agashua\*<sup>2</sup>

<sup>1</sup>Chemical Engineering Department, Federal University Otuoke, Bayelsa State, Nigeria

<sup>2</sup>Civil and Environmental Engineering Department, Federal University Otuoke, Bayelsa State, Nigeria

Corresponding author: Lucia Omolayo Agashua | E-mail: [agashualight@gmail.com](mailto:agashualight@gmail.com)

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## Abstract

Persistent global issues like urbanization, public health, climate change and cybersecurity need inventive solutions. This scenario cannot be effectively tackled through traditional engineering that relies on manual ways and distinct disciplines. Therefore, there is need for modern engineering that combines live data, cutting-edge tools, and unified collaboration in tackling complex difficulties more proficiently and sustainably. Since, Engineering is progressing away from functionality to prioritize user security, approachability and experience, thus, Engineers need to create anti-aging infrastructure and resilient systems such as climate- adaptive structures that can tolerate these problems. As, these issues require human partner with machines to augment creativity, innovation, strategic, agility, efficiency and sustainability, which is modern engineering approach. Modern engineering depend greatly on cutting-edge technologies and its tools that assist engineers to modernize, streamline methods, and remain competitive in a swiftly embryonic landscape. These innovative technologies such as machine learning, Industry 4.0, robotics, the Internet of Things (IoT), digital twins and artificial intelligence, are restructuring the engineering landscape. From smart workshops to prognostic maintenance, engineers must now incorporate digital methods with traditional means. Integration of novel technology into engineering sector, resulted to optimize resources, lessen errors, predicting outcomes, and economical solutions.

**Keywords:** Robotics, 3D, IOT, AI-driven, Modern.

## 1. Introduction

The engineering sector is embryonic at an unprecedented stride, driven by high-tech evolutions and innovative approaches [1]. This sector is famous for its traditional systems and leisurely adoption of technological improvements and inventions [15]. It is regarded as one of the lowest digitized industries, with considerably small involvement in research and growth compared to other industries. Besides, it faces serious scarcities of labour [2, 4]. Consequently, its efficiency evolution is lagging behind other more digitalized companies, such as, the medical sector [1, 59]. In today's swiftly evolving realm, traditional engineering that depends on manual techniques and distinct disciplines working has been overtaken by modern engineering. Modern technology unites integrated alliance, onsite data and unconventional tools to solve multifaceted problems more proficiently and sustainably. Modern engineering involves usage of collaborative techniques, innovative technologies and approaches, to resolve today's multifarious societal and industrial matters [7, 10, 14]. Unlike traditional ways, modern engineering incorporates digital equipment, smart methods and real-time figures in designing and delivery prompter, better and more sustainable answers [15, 18]. From sustainable to automation approaches, modern engineering is restructuring how companies operate.

Modern engineering symbolizes a vibrant and inventive means of tackling complex tasks, making it indispensable for institutes targeting to flourish in a swiftly transforming technological setting [5, 19-23]. Modern Engineering evolved from orthodox techniques to advanced practices like real-time statistics, simulation for design and experimentation, incorporating digital revolution and automation, engaging Industry 4.0 principles for smarter production and spotlighting sustainability and incessant improvement -[11, 24 28]. Commencing from Industry 4.0 to AI-driven scheme, modern engineering plays a significant role in influencing how companies acclimate, compete, and bloom [29-32]. Likewise, the advent of trailblazing technologies has had a transformative impact on the engineering segment. Engagement of technologies like Internet of Things (IoT), Artificial Intelligence (AI), Digital Twins, robotics, 3D Printing and Industry 4.0 not only changed engineers way of working, but also helpful in reformation product growth, lessens research and development expenditures. For example, an investigation by McKinsey and Company discovered that digital twins technology can enhance product value by 25.0%, as well as accelerate time-to-market time by 50.0% [2, 33-36].

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This is one out of numerous instances of an engineering invention that has remodeled the sector, and triggers pledge of £22 billion investment by the UK government into development and research funding. It is expected that novel and innovative technology will continue to play a crucial role for numerous years to come [4, 37-41]. Because, these technologies are not just notions—they are realistic tools augmenting real-world problem-solving in engineering sectors (Figure 1).

**2. Modern Engineering Concept**

Grasping the meaning, main principles, contemporary fields, and real-world usage of Modern Engineering helps specialists and industries to stay ahead in an extremely competitive and hi-tech moving environment. Scoping investigation reveals most publications about innovative technologies and presented in Figures 2 and 3. A three-colour scale is utilized to boost discrepancy for republics with fewer statistics of publications. Figure 2 signifies that China (1072) was the republics with peak publications, then the United States (830), next was the United Kingdom (402). Others are Malaysia with value of 269, and Australia (230).

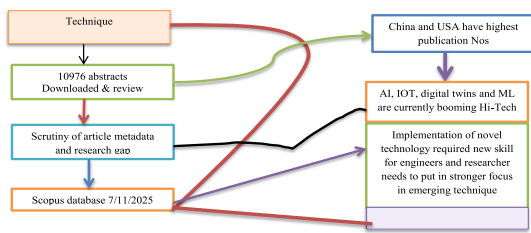


Figure 1: Abstract portrait of model engineering and review result

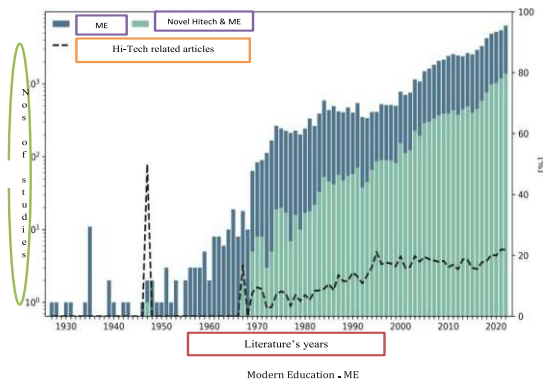


Figure 2: Graphical representation of peak publication list of nations

Table 1: Key Philosophies of Modern Engineering

Philosophy	Description
Innovation	Emphasizing creative problem-solving and the use of novel technologies to deliver efficient and intelligent solutions
Systems Thinking	Viewing projects as integrated systems with interrelated components rather than isolated elements
Digital Integration	Utilizing real-time data, digital twins, and simulation tools to improve accuracy and operational efficiency
Adaptability and Agility	Adopting flexible and agile frameworks to respond effectively to changing requirements
Sustainability	Designing solutions with environmental responsibility and long-term impact in mind

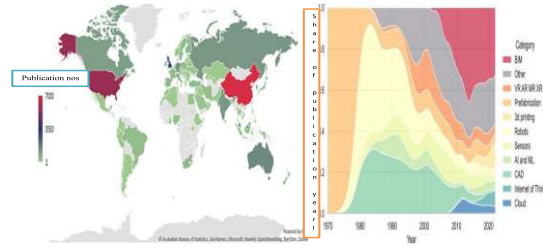


Figure 3: Displaying list of innovative technologies based on most published nations

**2.1. Keynote Philosophies and Approaches of Modern Engineering**

Modern Engineering is driven by clear philosophies and modern techniques that assist engineers in tackling multifaceted situations with alertness, exactitude, and innovation (Table 1a). Comprehension of these fundamental principles and verified techniques is indispensable for any institute or engineer accepting the change from traditional to modern engineering means [1, 42-45]. Also, modern engineering advanced approaches and tools that make it differ from traditional styles, are displayed in Table 1b.

Table 1a signifies what these philosophies entail, while Table 1b displays the keynote philosophies of modern engineering. Modern Engineering is driven by clear philosophies and modern techniques that assist engineers in tackling multifaceted situations with alertness, exactitude, and innovation. Comprehension of these fundamental principles and verified techniques is indispensable for any institute or engineer accepting the change from traditional to modern engineering means [1, 46-49].

**2.2 Modern Engineering Division and Fields with Strategic Technologies**

Modern Engineering spans across numerous fields and each of them applies unconventional tools, digital techniques, and inventive means in solving today's multifarious matters [50]. Comprehend about these fields' climaxes how Modern Engineering is reformating industries globally. Some of the key divisions are Civil, Chemical, Mechanical, petroleum, Electrical, Aerospace, and so on Table 2a.

Numerous staple technologies define how Modern Engineering works today are listed in Table 2b. Table 2b demonstrated that modern engineering depends profoundly on innovative technologies and potent tools that can aid engineers invent, modernizing processes, and remain competitive in a swiftly embryonic landscape [3. 51-54]. These technologies serve as pillar for smart, proficient, and sustainable engineering resolutions [19, 55]

## Strategic Technologies Influencing Modern Engineering Strategic Hi-Tech

Technique	Impact
Model-Based Systems Engineering (MBSE)	Enhances design accuracy and coordination through the use of digital models
Simulation and Digital Twins	Reduces costs and errors by enabling virtual testing prior to physical implementation
Industry 4.0 and Smart Construction	Integrates data analytics, IoT, and automation for intelligent and efficient operations
Collaborative Platforms	Enables seamless coordination among multidisciplinary teams using cloud-based engineering tools
Continuous Improvement	Promotes iterative development, feedback loops, and data-driven optimization

Table 2: Some of division and Strategic Technologies of Modern Technology with impact

### A. Engineering Divisions

Division	Impact
Electrical Engineering	Integrates IoT, automation, and renewable energy systems to develop smart electrical devices and networks
Civil Engineering	Applies advanced approaches for sustainable infrastructure, smart cities, and resilient construction
Mechanical Engineering	Utilizes smart manufacturing, 3D modeling, and digital twins to design efficient machines and systems
Software Engineering	Drives modern engineering through agile development, artificial intelligence, and big data for robust and scalable solutions
Aerospace Engineering	Employs advanced simulation, digital twins, and real-time data for safer and more efficient air and spacecraft design

### B. Strategic Technologies Influencing Modern Engineering

Technology	Description
Internet of Things (IoT)	Connects devices, sensors, and systems for real-time monitoring, data collection, and intelligent decision-making
Digital Twins	Create virtual replicas of physical systems to simulate, test, and optimize designs before implementation
Artificial Intelligence (AI)	Enables intelligent design automation, predictive maintenance, and real-time optimization of complex systems
Industry 4.0	Integrates automation, data exchange, and smart manufacturing for interconnected and efficient production environments

## 3. Innovative technologies for modern Engineering

### 3.1 Robotics as Innovative Hi-Tech

Robotics is a briskly embryonic field that considerably influences many aspects of the engineering field, with applications in construction, production, health-work, and so forth [56 - 60]. This front-line innovation can utterly adjust the way tasks are carried out, through heightening proficiency and expanding the possibilities of what engineering can accomplish. Based on Industry Week, it is appraised that robots will nearly take over roughly 26% of the work engineers presently do [1, 58-60]. This overwhelming figure validates just how vital robotics is to the prospect of engineering, and considering its innumerable uses, it is not anticipated. From mechanizing the manufacturing method with robot-regulated invention lines to superintending quality control ways, the sector of robotics already has an eclectic display of applications, and as this tools progresses, the likelihood of robotics becoming wholly self-directed in the nearest future is not far from truth [10-13].



Figure 4: Portrait of Artificial intelligent in action [7].

Some everyday usages of robotics in the engineering field are: Computerization of manufacturing jobs such as fusing, muster and painting, scrutinizing products to confirm that they are within quality standards, execution of material handling jobs in workshops and granaries, for instances conveying hefty loads and augmenting logistics tasks, performing construction jobs like demolition, bricklaying and pouring of concrete and observing environmental scenarios via sensors [5, 60]. Though a lot of people articulated about Robotics potential to eradicate the need for human worker; an issues that is utmost possible based on Industry Week facts mentioned earlier. Another concern is financial matters, especially the excessive start-up fees, technology repairing money and hiring of highly skillful workforce for programming, operation [14-17].

Despite of the snags, the escalated approval of robotic technology is likely to generate a variety of new hire and tutelage prospects, mostly in specialist and maintenance tasks [1-3].

### 3.2 Internet of Things (IoT) as inventive technology

IoT is another type of the inventive technologies that changes the style that the engineering firm works (Figure 5). IoT usage in engineering allows smarter construction with real-time records procurement, remote observing, and predictive repairs. From linked bridges to smart transportation systems. IoT is really transmuting how civil and highway engineers design built-up spaces [21]. Speak of networking of physical objects implanted with radars for substituting data with other devices and structures; the IoT has intensely impacted countless facets of engineers' professional and personal lives. Its capability to optimize manufacturing procedures facilitates real-time observing of structures, and ability to affords data-driven acumens make it an epitome device for engineers [4, 47]. The usage of the IoT has risen theatrically in contemporary years, and the data indicates it. It is anticipated that the number of IoT tools will upsurge to 19 billion by 2026, an attention-grabbing fact that highpoints just how distance this technology's impact will reach.

With 92.5% of firms anticipated to be influencing IoT by 2027, it is imperative for engineering trades to get to grips with this inventive technology to preserve their competitive verge [1-4].



Figure 5: Robotics images for Mechanical, Civil, and Chemical Field with IOT [4, 17]

Usages of IoT in the engineering field involve; observing the situation of equipment in real time to guess when maintenance is required, overseeing energy usage by pinpointing energy-saving prospects and lessening costs, tracing the whereabouts of goods in transit to optimize the supply chain route. Further, its sensors can enhance safety by perceiving hypothetically hazardous circumstances early [9-12]. IoT projecting maintenance competencies are advantageous for engineers, aiding them to ascertain prospective incongruities and failures in a timely and then lessen maintenance fees. Even though using IoT devices and radars affords copious benefits, it also rears a range of flouts, the most imperative of which is safety worries. Because, IoT devices are susceptible to cyber-attacks, and scrawny security protocols can lead to data breaches and hacking [2, 55 - 59]. Since IoT tools deal with gigantic quantities of data about individuals and firms, hence there is an issue concerning confidentiality. Other adverse effects of IoT technology comprise of data overwork, connectivity matters, and great implementation fees.

### 3.3. Concept of Machine Learning (ML) and Artificial Intelligence as Inventive Hi-Tech

Machine learning and AI (Figure 4) are among the key innovative machineries of this 21st era, and their speedy development serves as indication of no sign of weakening any time soon. Actually, there is a strong economic imperative for the rising adoption of AI, with data exhibiting that the UK's GDP will advance at rate of 10.2% by 2030 [19-24]. ML and AI are bringing about transmogrify change in several companies, and the engineering field using multifaceted equations such as Bogolyubov's theory proved by Gubal [19] and Stashenko and Gubal [53], is no exemption. AI and ML algorithms are capable of streamlining and automating strenuous jobs, letting engineers to concentrate most of their time on other, more indispensable onuses such as quality control and product design. Along with automation, AI can help improve design proficiencies, optimize for imperative factors like sustainability, fees and performance. Engineering firms are currently leveraging AI and ML for a range of uses, for instances; Analytical monitoring created on AI algorithms, Constructing AI-driven management structures for optimizing energy application, Procreative product design, Pinpointing product flaws in real-time though ML algorithms and others.

Despite AI and ML's uncountable profits and usages, there are numerous hitches engineering firms should ponder on before concluding the implementation of AI and ML into their task-flows. The key pressing matter is job disarticulation. Even though AI automation is helpful for industries, but there is a risk of making certain task redundant, meaning, joblessness for several engineering specialists [30-34]. Secondly, it also increases ethical worries associated with prejudice, as AI- created decisions are prone to discriminatory conclusions.



Figure 6: 3D Printing Illustration [12]

### 3.4. Notion of 3D Printing as Novel Technology

3D printing also identified as additive manufacturing is another front-line hi-tech that has made impact that is long-term within engineering field. Distinct as creating a physical entity based on a 3D digital model, this printing has turn out to be a decisive facet of product design and production (Figure 6). 3D printing permits engineers to form structures, complex mechanical parts quickly, economically and models that would be far too complex via traditional ways.

This technology is speedy prototyping, modernizing product design, besides, is also developed to include standby parts usable in automotive and aerospace fields [3-6]. Some of well-known usages of 3D printing in engineering are; lessening material waste by integrating material step by layer, constructing prototypes with multifaceted structures and geometries swiftly, reproducing legacy parts for older machinery with obsolete components, fabricating routine components for the automotive, and medical and aerospace, firms, as opposed to spendthrift subtractive manufacturing techniques [2, 26-30]

Numerous engineering forms are using this hi-tech because of several benefits such as the capability to allow efficient and economical manufacturing of exemplars, leading to quicker product growth sequences. Additionally, area that 3D printing outshines in is design elasticity, as it permits engineers to generate complicated structures that would have been awkward with traditional manufacturing technique [8, 20-23]. Similarly, 3D printing has numerous weaknesses to applying this technology. For antipasti, 3D printing characteristically involves big preliminary investment, chiefly down to the fee of 3D printers and appropriate materials. Similarly, there is a limited quantity of 3D printing materials equated to conventional manufacturing materials, to some degree that may confine its application in certain companies. Other disquiets comprise of large energy utilization, copyright intrusion matters, and overpriced post-processing jobs [5-8].

### 3.5. Conception about Augmented Reality (AR) as Novel Technology

Until quite recently, the notion of a technology proficient of blanketing computer- created imageries onto the actual world appeared impossible. At the moment, augmented reality is utilized to assist engineering within a diversity of fields, predominantly in automotive, mechanical and aerospace engineering (Figure 7). Nevertheless AR has yet to attain full capability, it has surfaced as a significant driving force for modernism in the engineering firm. Investigation advocates that the technology is competent to solve current talent scarcities, with 77% of engineers arguing that AR is vital to concluding the expertise gap in the industry [3-7]. Furthermore, a write-up circulated by the Institute of Electrical and Electronics Engineers ascertained that 71.9% of engineering industries guess that AR will turn out to be a strategic educational tool in the years to come. Some of its contemporary applications are; imagining 3D prototypes of designs, aiding remote repair assistance through wearable [19-23].

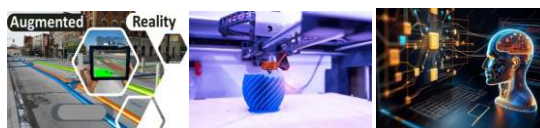


Figure 7: Images of Augmented reality, 3D and AI [35, 38, 40]

AR devices, productive immersive simulations for scholastic reasons, shepherding visual assessments, emphasizing flaws and irregularities in real-time. AR technology has profited an extensive array of engineering fields; for instance, civil, industrial, automotive, electrical, and mechanical. Not just that AR help engineers in ascertaining and remedying design errors before they cause to key harms, on the other hand, it is also active in enhancing spatial astuteness, specialized training, and enhancing safety criterions [17-21]. Although AR is indisputably cherished, the technology has numerous noticed shortcomings. AR devices tend to be costly and colossal, which then causes challenges for engineers to operate, whereas AR-driven usages can be prone to bugs and hiccups. Likewise, well-being and safety trepidations linked with lassitude and eyestrain that bosses must take note [16-21].

### 3.6. Notion of Digital Twins and Smart Simulations

Digital twins are computer-generated replicas of actual assets. They are design optimization and modernizing project administration. These virtual prototypes help engineers in monitoring, simulating, and scrutinizing systems in real-time, pinpointing potential concerns before they transpire. Smart simulations, powered by advanced software, offer predictive insights that improve decision-making processes and enhance system reliability [17-22].

### 4.0 Notion of Innovative Materials

#### 4.1 Sustainable Engineering Practices as Innovative Technology

With mounting environmental issues, the drive for sustainable engineering practices has become stronger. Engineers are now integrating renewable energy schemes, environmentally-friendly materials and energy-efficient designs into their works. Methods such as green construction warranties and life cycle evaluation ensure that sustainability remains as the fundamental of modern engineering deeds. These practices aid in mitigating environmental effect and also lessen operational fees in the long run [18-20].

#### 4.2. Concept of Advanced Materials and Nanotechnology as Novel Hi-Tech

The creation of innovative materials and nanotechnology is modernizing the engineering sector by unraveling new possibilities. For instances; self-cure materials, lightweight composites, and nano-materials with enriched conductivity and strength are propelling revolutionary inventions. These trailblazing materials not only enriched the performance of prevailing systems but also uncluttered ways to entirely novel applications in firms like renewable energy, Civil and biomedical engineering [7, 16-20]. As these skills continue to advance, they grasp the potential to shape the prospect of engineering, facilitating more proficient and sustainable resolutions across several fields.

Illustrations of advanced materials comprises of biomaterials, syntheses, inventive materials, and porcelains.

These materials frequently combine diverse constituents at the molecular state to generate structures with inimitable physiognomies that meet the demands of leading-edge technology [2-6].

### 4.3 Prospect of Innovations Technology and Challenges

#### 4.3.1 Engineering at a Revolving Point

Engineering currently stands at a precarious crossway (Table 3), shaped by swift technological expansions, rising environmental issues, and embryonic human wants. This revolving point is not only about embracing new devices, but re-defines the part of engineering in a changing world [1-3]. Table 1 displayed how environmental issues have modified engineering primacies. Especially advance push toward sustainable materials, green machineries, renewable energy, and environmentally friendly facilities. Engineers are currently anticipated to generate results that have equilibrium proficiency with environmental effect [7-9].

**Table 3: The stride of technological expansion generates significant issues**

Challenge	Impact	Required Response
Methodological Obsolescence	Systems and skill sets become outdated rapidly due to fast technological change	Continuous learning and adoption of flexible, adaptive design approaches
Integration Difficulty	Challenges in integrating legacy systems with modern technologies	Development of interoperable architectures and standardized interfaces
Digital Transformation	Need to redesign and modernize traditional processes and methodologies	Enhancement of digital literacy and adoption of innovative methodologies
Knowledge Management Issues	Information overload and fragmentation of data across silos	Implementation of efficient knowledge management and data-sharing systems

#### 4.3.2 Ethics and Responsibility as innovative technology driver

With excessive power comes huge functions, thus ethical deliberations like design environmental footprint, data confidentiality and algorithm prejudice, are becoming significant to engineering tutelage and practice [10-13]. Engineering is not about constructing things alone nowadays, but about generating a better prospect. At this revolving point, engineering career must develop to meet the requirements of a quick-changing, interrelated, and sustainability-engrossed world. Since, engineering is the fundamental motivating forces propelling the growth and improvement of our contemporary society [41 - 43]. From bridges construction to skyscrapers, from aircrafts to smartphones, engineering sector have participated critically in shaping the world.

#### 4.3.3 Revolutionize of Innovative Technology a Challenges Pace

As the engineering sector face the future, its experiences dual scenario, which are exhilarating innovations and frightening issues. These challenges facing novel technology are shortage of skilled experts, sustainable mentality, Hi-tech Tsunami and ethical direction finder [44 - 48]. Majorly engineering sector is witnessing lack of skilled experts. As the demand for technological expansions surges, there is an emergent need for engineers who acquire the needed expertise and skill. To tackle this scenario, learning institutions and firms must work in collaboration so as to fascinate and coach forthcoming engineers. Inspiring more learners, principally girls and understated minorities, to study engineering professions from a tender age would assist in differentiating the sector and nurturing creativity and modernism [38-41].

Another aspect is Hi-tech Tsunami, since the swift rate of technological growth displays its own bundles of issues. Engineers must unremittingly acclimate to novel tools, approaches, and hypotheses to remain relevant and bloom in an ever-changing setting. Moore's Law, which forecasts the replication of transistors on a microprocessor every two years,

accentuates the inexorable pace of technological expansion [19-21].

Additional concern is the ethical inferences of engineering expansions. Technology not only possesses enormous potential, but as well as raises ethical predicaments that engineers must circumnavigate. For instances, AI reveals questions concerning the ethics of decision-making, confidentiality, and prejudice. Engineers needed to preemptively tackle these trepidations and make sure that technological novelties are executed in a accountable and ethical style [19-23]. What is more, engineering witness issues correlated to constrained resources and sustainability. As the earth population keeps growing, engineers must find means to tackle the escalating demands while decreasing waste and lessening the environmental effect. Employing more proficient systems, circular low-cost principles, and applying sustainable production practices are just a few treads engineers can use to tackle these problems [2, 16-21].

More to it is ethical direction finder, because with great technological power comes great responsibility. As engineers impel the frontiers of likelihood, they confront progressively multifaceted ethical predicaments. From self-directed vehicle decision-making in inescapable crash circumstances to the inferences of bioengineering and chromosomal editing, circumnavigating these predicaments necessitates a caring and moral style, guided by recognized frameworks.

#### 4.3.4 Prospect of Novel Technology in Modernize world

The prospects of sustainable engineering rely on assimilating circular economy prototypes, evolving renewable energy storeroom, and endorsing climate-buoyant facilities universally. Though engineering is a movement, it's also a inevitability. By concentrating on long-term environmental well-being, these machineries play a crucial part in modeling a cleaner, highly conscientious, and energy-proficient sphere. Space exploration serves as one of the prospect of engineering. With striving plans to inhabit Mars as well as reconnoiter the universe, engineers are at the leading position in creating technologies that backs

these endeavors [29-31]. From designing and constructing rockets that has capability of interstellar travel to forming sustainable habitations in outer space, engineers are indispensable to pushing the precincts of human investigation [32 & 33].

Another major compelling facet of the engineering future is within the scope of sustainability. Due to climate change and diminishing resources, engineers are tasked with ascertaining novel resolutions for ensuring sustainable future [34-37, 42]. Renewable energy origins, for instances airstream and solar power, have seeing momentous expansions as a result of engineering discoveries. Engineers are driving towards exploiting the efficacy of these technologies to make them more manageable and inexpensive for the general inhabitants. Additional critical sector that engineering is poised to modernize is transportation. The upswing of self-directed vehicles has the prospect of transforming the means we travel and commute. Engineers are creating trailblazing sensor machineries and AI algorithms to allow safe and proficient self-driving cars. These innovations not only lessen traffic bottleneck and discharges but also enhance approachability for individuals with mobility defies [38-40]. Similarly, the growing complication of tasks is another key impediment. As technology progresses, engineers are expected to tackle sophisticated systems with copious interdependencies. This necessitates a multi-disciplinary technique, with collaboration within engineers across different fields to attain all-inclusive solutions. Linking the crack between diverse fields and efficiently handling interdisciplinary tasks will be substantial issues in the nearest future [41-45, 48].

#### 4.5 Stratagems for a Prospect-Proof Novel Engineering

To circumnavigate the future magnificently, engineers must embrace cutting-edge strategies and prioritize unceasing education. Because continuous learning is not optional, but a vital tool. An UdeMy appraisal discloses that a reeling 71% of engineers accept that lifetime education is fundamental for career progress. This obligation to up-skilling and staying well-informed of the newest advancements is vital for future accomplishment [2, 46-48]. Furthermore, embracing a sustainable attitude serves dual purpose, namely, a strategic and an ethical choice.

#### 5. Conclusions

As technology advances, so must the engineers. Because an engineer's future needs is not only technical expertise but also soft abilities such as communication, critical thinking, and flexibility. The prospect of engineering enfolds great talent and capability; hence engineers must push boundaries through innovation technology and modern engineering for better tomorrow. Engineering at contemporary times depends on advanced techniques and devices such as quicker designs, smarter methods, and enhanced policymaking across many fields, that make it different from traditional means.

Nevertheless, they also confront challenges like the rising intricacy of projects, data safety concerns, struggle to change, a scarcity of skilled experts, costly initial investment, ethical apprehensions, integration matters, talents gaps, and resource constrictions. By tackling these situations confrontationally and capitalizing on novelties, fortified cyber-security, up-skilling squads, adopting modern engineering principles and investing in climbable instruments, engineers can keep on shaping a sustainable and flourishing future for humankind.

#### Author Contributions

**LOA:** Conceptualization, **LOA** and **EUP:** Resources, **EUP:** Data curation, **LOA** and **EUP:** Methodology, **LOA** and **EUP:** Formal Analysis, **EUP:** Project administration, **EUP:** Investigation, **LOA:** Formal Analysis, **LOA:** Project administration, **LOA:** Funding acquisition, **LOA** and **EUP:** Software; **EUP:** Supervision, **EUP:** Validation, **LOA:** Visualization, **LOA:** Writing – original draft, **EUP:** Writing – review & editing.

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The data supporting the outcome of this research work has been reported in this manuscript.

#### Conflicts of Interest

“The authors declare no conflicts of interest.”

#### References

1. D. Ahmed, “Senses, experiences, emotions, memories: artificial intelligence as a design instead of for a design in contemporary Japan,” *Intelligent Buildings International*, vol. 14, no. 2, pp. 133–150, 2020. <https://doi.org/10.1080/17508975.2020.1764327>
2. K. A Kumar, “Advancements and Challenges in Modern Civil Engineering: Towards a Sustainable Future,” *IJRAR*, vol 1, no. 3, pp. 1-8, 2016.
3. H. Hui, L. Junjie, J. Lili, H. Ren, “The Future of Environmental Engineering Technology: A Disruptive Innovation Perspective,” *Engineering*, vol 21, no. 1, pp. 153-160, 2024.
4. S. R. Zulaykho, “Innovative technologies in engineering research: Enhancing skills for modern challenges,” *AIP Conf. Proc.*, vol. 3304, no. 1, pp. 3-10, 2025. <https://doi.org/10.1063/5.0269697>
5. E. Wen, “Is artificial intelligence creative?” *The American Journal of Student Research*, vol. 2, no. 3, pp. 105–111, 2024. <https://doi.org/10.70251/hyjr2348.23105111>
6. F. A. Sattar, “The Future of Mechanical Engineering: Trends and Technologies in Machine and Equipment Development,” *International Journal of Multiphysics*, vol. 18, no. 4, pp. 10-18, 2024.
7. O. Miliou, C. Angeli, “Design principles for internet skills education: results from a design-based research study in higher education,” *SN Social Sciences*, vol 2, no. 9, pp. 169-179, 2022. <https://doi.org/10.1007/s43545-022-00428-2>
8. Z. Gao and L. Lin, “The intelligent integration of interactive installation art based on artificial intelligence and wireless network communication,” *Wireless Communications and Mobile Computing*, vol. 2021, Art. no. 3123317, pp. 1–12, 2021. <https://doi.org/10.1155/2021/3123317>

9. D. H. R. Ríos, "Proposal for the strengthening of student nurseries of a scientific and technological nature. Case study: seedbeds, department of Meta, Colombia," *Revista Vinculos: Ciencia, tecnología y sociedad*, vol. 21, no. 1, pp. 30-38, 2024.
10. N. L. Rane, "Potential role and challenges of ChatGPT and similar generative artificial intelligence in architectural engineering," *International Journal of Artificial Intelligence and Machine Learning*, vol. 4, no. 1, pp. 22-47, 2024. <https://doi.org/10.51483/ijaiml.4.1.2024.22-47>
11. M. Alaa, "Artificial intelligence: Explainability, ethical issues and bias," *Annals of Robotics and Automation*, pp. 34-37, 2021. <https://doi.org/10.17352/ara.000011>
12. R. Belk, "Ethical issues in service robotics and artificial intelligence," *The Service Industries Journal*, vol. 41, no. 13-14, pp. 860-876, 2020. <https://doi.org/10.1080/02642069.2020.1727892>
13. A. Bandyopadhyay, V. Vu, Q. Tran, M. Qi, L.T. Vu, "Applications of artificial intelligence and IoT technologies in smart manufacturing," *Frontiers in Mechanical Engineering*, vol. 9, no. 1, pp. 116-123, 2023. <https://doi.org/10.3389/fmech.2023.1160923>
14. M. M. Mariani, I. Machado, V. Magrelli, and Y. K. Dwivedi, "Artificial intelligence in innovation research: A systematic review, conceptual framework, and future research directions," *Technovation*, Art. no. 102623, 2022. <https://doi.org/10.1016/j.technovation.2022.102623>
15. I. Rojek, J. Kopowski, D. Mikołajewski, "Optimization with artificial intelligence in additive manufacturing: A systematic review," *Journal of the Brazilian Society of Mechanical Sciences and Engineering*, vol. 45, no. 1, pp. 2053-2061, 2023. <https://doi.org/10.1007/s40430-023-2053-7>
16. L. Gang, L. Rui, Y. Ding-Hao, "A framework for developing a machine learning-based finite element model for structural analysis," *Computers & Structures*, vol. 307, no. 2, pp. 5-13, 2025. <https://doi.org/10.1016/j.compstruc.2024.107617>
17. G. N. Gubal, "On the existence of weak local in time solutions in the form of a cumulant expansion for a chain of Bogolyubov's equations of a one-dimensional symmetric particle system," *Journal of Mathematical Sciences*, vol. 199, no. 6, pp. 654-666, 2014.
18. Y. Yang, X. Xia, D. Lo, and J. Grundy, "A survey on deep learning for software engineering," *ACM Computing Surveys (CSUR)*, vol. 54, no. 10s, pp. 1-73, 2022. <https://doi.org/10.1145/3505243>
19. L. Layman and R. Vetter, "Generative Artificial Intelligence and the Future of Software Testing," in *Computer*, vol. 57, no. 1, pp. 27-32, Jan. 2024. <https://doi.org/10.1109/MC.2023.3306998>
20. C. Maware, R. Muvunzi, T. Machingura, I. Daniyan, "Examining the progress in additive manufacturing in supporting lean, green, and sustainable manufacturing: A systematic review," *Applied Sciences*, vol. 14, no. 14, pp. 6041-6050, 2024. <https://doi.org/10.3390/app14146041>
21. C. Schmidleithner, D. M. Kalaskar, "Additive manufacturing: Recent trends, applications, and future outlooks," *Progress in Additive Manufacturing*, vol. 1, no. 2, pp. 1-10, 2023. <https://doi.org/10.1007/s40964-023-00258-8>
22. W. Yan, J. Qin, S. Wang, "Recent advances of AI for sustainable smart manufacturing," *Autonomous Intelligent Systems*, vol. 1, no. 2, pp. 10-19, 2024. <https://link.springer.com>
23. D. Mikołajewski, J. Kopowski, "Optimization with artificial intelligence in additive manufacturing: A systematic review," *Journal of the Brazilian Society of Mechanical Sciences and Engineering*, vol. 45, no. 1, 2023. <https://doi.org/10.1007/s40430-023-2053-7>
24. V. Q. Vu, M. Q. Tran, M. Q. L. T. Vu, "AI applications and IoT technologies in smart manufacturing," *Frontiers in Mechanical Engineering*, vol. 9, no. 3, pp. 8-17, 2023. <https://doi.org/10.3389/fmech.2023.1160923>
25. W. Zhang and Y. Jia, "Modern art interactive design based on artificial intelligence technology," *Scientific Programming*, vol. 2021, Art. no. 5223 034, pp. 1-12, 2021. <https://doi.org/10.1155/2021/5223034>
26. A. Spangenberg, N. Hobeika, F. Stehlin, J. P. Malval, "Additive manufacturing: Challenges, trends, and applications," *International Journal of Advanced Manufacturing Technology*, vol. 1, no. 3, 2024. <https://link.springer.com>
27. I. Rojek, J. Lewandowski, D. Mikołajewski, "Review of intelligence for additive and subtractive manufacturing: Current status and future prospects," *Micromachines*, vol. 14, no. 15, pp. 6730-6738, 2023. <https://doi.org/10.3390/app14156730>
28. O. I. Abiodun, A. Jantan, A. E. Omolara, K. V. Dada, N. A. Mohamed, and H. Arshad, "State-of-the-art in artificial neural network applications: A survey," *Heliyon*, vol. 4, no. 11, Art. no. e00938, 2018. <https://doi.org/10.1016/j.heliyon.2018.e00938>
29. L. Das, P. Anand, A. Anjum, M. Aarif, N. Maurya, A. Rana, "The Impact of Smart Homes on Energy Efficiency and Sustainability," in *2023 10th IEEE Uttar Pradesh Section International Conference on Electrical, Electronics and Computer Engineering (UPCON)*, vol. 10, no. 1, pp. 215-220, 2023.
30. K. Srithong, W. Limrattanaphattarakun, "Guidelines for Developing the Potential of Farmer Organizations for Sustainable Self-Reliance," vol. 12, no. 2, pp. 425-439, 2024.
31. Y. M. Abd Algani, O. J. M. Caro, L. M. R. Bravo, C. Kaur, M. S. Al Ansari, B. K. Bala, "Leaf disease identification and classification using optimized deep learning," *Measurement Sensors*, vol. 25, no. 2, pp. 643-651, 2023.
32. M. K. Mishra, K. Selvaraj, K. Santosh, M. Aarif, S. S. C. Mary, B. K. Bala, "The Impact of 5G Technology on Agile Project Management: A Cross-Industry Analysis," in *2024 5th International Conference on Intelligent Communication Technologies and Virtual Mobile Networks (ICICV)*, vol. 5, no. 1, pp. 119-126, 2024.
33. H. Hourani, A. Hammad and M. Lafi, "The Impact of Artificial Intelligence on Software Testing," *2019 IEEE Jordan International Joint Conference on Electrical Engineering and Information Technology (JEEIT)*, Amman, Jordan, 2019, pp. 565-570. <https://doi.org/10.1109/JEEIT.2019.8717439>
34. R. Lima, A. M. R. da Cruz and J. Ribeiro, "Artificial Intelligence Applied to Software Testing: A Literature Review," *2020 15th Iberian Conference on Information Systems and Technologies (CISTI)*, Seville, Spain, 2020, pp. 1-6. <https://doi.org/10.23919/CISTI49556.2020.9141124>
35. P. Soundarraj, M. Aarif, S. Gangadharan, S. R. Naqui, N. K. AssiHalaf and A. Salih Mahdi, "Smart Product Packing and IoT Marketing: Enhancing Customer Interaction," *2023 International Conference on Innovative Computing, Intelligent Communication and Smart Electrical Systems (ICES)*, Chennai, India, 2023, pp. 1-6. doi: 10.1109/ICES60034.2023.10465408
36. C. Ebert, D. Bajaj and M. Weyrich, "Testing Software Systems," in *IEEE Software*, vol. 39, no. 4, pp. 8-17, July-Aug. 2022. <https://doi.org/10.1109/MS.2022.3166755>
37. W. Villegas-Ch, J. García-Ortiz and S. Sánchez-Viteri, "Toward Intelligent Monitoring in IoT: AI Applications for Real-Time Analysis and Prediction," in *IEEE Access*, vol. 12, pp. 40368-40386, 2024. <https://doi.org/10.1109/ACCESS.2024.3376707>

38. S. I. Khan, C. Kaur, M. S. Al Ansari, I. Muda, R. F. C. Borda, B. K. Bala, "Implementation of cloud based IoT technology in manufacturing industry for smart control of manufacturing process," *International Journal on Interactive Design and Manufacturing (IJIDeM)*, vol. 2, no. 3, 1-13, 2023.
39. Y. Wang, Y. Zhang, D. Tan, Y. Zhang, "Key technologies and development trends in advanced intelligent sawing equipments," *Chinese Journal of Mechanical Engineering*, vol. 34, no. 2, pp. 1-20, 2021.
40. D. Lo, "Trustworthy and Synergistic Artificial Intelligence for Software Engineering: Vision and Roadmaps," *2023 IEEE/ACM International Conference on Software Engineering: Future of Software Engineering (ICSE-FoSE)*, Melbourne, Australia, 2023, pp. 69-85. <https://doi.org/10.1109/ICSE-FoSE59343.2023.00010>
41. T. C. Nnodim, M. O. Arowolo, B. D. Agboola, R. O. Ogundokun, M. K. Abiodun, "Future trends in mechatronics," *IAES International Journal of Robotics and Automation*, vol. 1, no. 10, pp. 24-32, 2021.
42. C. Tao, J. Gao and T. Wang, "Testing and Quality Validation for AI Software-Perspectives, Issues, and Practices," in *IEEE Access*, vol. 7, pp. 120164-120175, 2019. <https://doi.org/10.1109/ACCESS.2019.2937107>
43. E. A. Usman, F. O. Ilojiana, V. I. Daudu, C. D. Umoh, A. A. Umoh, & K. I. Ibeke, "Mechanical engineering in automotive innovation: A review of electric vehicles and future trends," *International Journal of Science and Research Archive*, 11(1), 579-589, 2024.
44. M. Alcon, H. Tabani, J. Abella and F. J. Cazorla, "Enabling Unit Testing of Already-Integrated AI Software Systems: The Case of Apollo for Autonomous Driving," *2021 24th Euromicro Conference on Digital System Design (DSD)*, Palermo, Italy, 2021, pp. 426-433. <https://doi.org/10.1109/DSD53832.2021.00071>
45. A. A. Adediran, T. J. Erinle, J. B. Ajewole, S. J. Aliyu, "Revolutionizing Mechanical Engineering: CAD'S Evolution, Cloud Impact and Future Trends," *In 2024 International Conference on Science, Engineering and Business for Driving Sustainable Development Goals (SEB4SDG)*, vol. 1, no. 2, pp. 1-8, 2024.
46. S. F. Ali, "The Future of Mechanical Engineering: Trends and Technologies in Machine and Equipment Development," *International Journal of Multiphysics*, vol. 18, no. 4, pp. 1-8, 2024.
47. V. Q. Vu, M. Q. Tran, L. T. Vu, "Smart manufacturing: The fusion of robotics and AI in manufacturing," *Automation and Smart Manufacturing Technologies*, vol. 12, no. 4, pp. 102-119, 2023.
48. N. Siegmund, J. Dorn, M. Weber, C. Kaltenecker and S. Apel, "Green Configuration: Can Artificial Intelligence Help Reduce Energy Consumption of Configurable Software Systems?," in *Computer*, vol. 55, no. 3, pp. 74-81, March 2022. <https://doi.org/10.1109/MC.2021.3120048>
49. Y. Li, Z. Sun, S. Mangalathu, Y. Li, W. He, X. Xue, "Machine learning-based full-life-cycle seismic response assessment for in-service bridge piers: Comprehensive analysis of interpretability and seismic fragility," *Structures*, vol. 80, no. 2, pp. 4-12, 2025. <https://doi.org/10.1016/j.istruc.2025.110050>
50. H. Jia-Xuan, X. Zhao-Dong, H. Zhong-Wei, Z. Lian-Yu, L. Qiang-Qiang, D. Yao-Rong, M. Gabriele, "A novel multi-dimensional viscoelastic mitigation device: Shake table tests and numerical assessment of precast concrete sandwich wall panel structure," *Engineering Structures*, vol. 336, no. 4, pp. 7-16, 2025. <https://doi.org/10.1016/j.engstruct.2025.120388>
51. M. A. Stashenko, G. N. Gubal, "Existence theorems for the initial value problem for the bogolyubov chain of equations in the space of sequences of bounded functions," *Siberian Mathematical Journal*, vol. 47, no. 1, pp. 152-168, 2006.
52. Y. Chen, Z. Yao, P. Liu, Q. Hu, Y. Huang, L. Ping, F. Zhang, H. Tang, T. Wan, Y. Ping, B. Li, "A self-assembly nanoprodug for triple-negative breast cancer combined treatment by ferroptosis therapy and chemotherapy," *Acta Biomaterialia*, vol. 159, pp. 275-288, 2023. <https://doi.org/10.1016/j.actbio.2023.01.050>
53. T. P. Carvalho, A. A. Fabrizzio, M. N. Soares, R. Vita, R. P. Francisco, P. B. João, G. S. Alcalá, "A systematic literature review of machine learning methods applied to predictive maintenance," *Computers & Industrial Engineering*, vol. 137, no. 2, pp. 106-113, 2019. <https://doi.org/10.1016/j.cie.2019.106024>
54. C. Hennebold, K. Klöpfer, P. Lettenbauer, M. Huber, "Machine Learning based Cost Prediction for Product Development in Mechanical Engineering," *Procedia CIRP*, vol. 107, no. 4, pp. 264-269, 2022. <https://doi.org/10.1016/j.procir.2022.04.043>
55. A. Göpfert, J. M. Weinand, P. Kuckertz, D. Stolten, "Opportunities for large language models and discourse in engineering design," *Energy and AI*, vol. 17, no. 1, 2024, pp. 1-9. <https://doi.org/10.1016/j.egyai.2024.100383>
56. S. Yoo, N. Kang, "Explainable artificial intelligence for manufacturing cost estimation and machining feature visualization," *Expert Systems with Applications*, vol. 1, no. 2, pp. 10-19, 2021.
57. N. Yadav, N. Gupta, M. Aggarwal, A. Yadav, "Comparison of cosysmo model with different software cost estimation techniques," *2019 International Conference on Issues and Challenges in Intelligent Computing Techniques (ICICT)*, vol. 1, no. 1, pp. 1-5, 2019.
58. V. R. Ambrule, A. N. Bhirud, "Use of artificial neural network for pre design cost estimation of building projects," *Int. J. Recent Innovat. Trends Comput. Commun.*, vol. 5, no. 1, pp. 173-176, 2017.
59. I. Rojek, J. Kopowski, J. Lewandowski, D. Mikołajewski, "Use of machine learning to improve additive manufacturing processes," *Applied Sciences*, vol. 14, no. 15, pp. 6730-6739, 2024. <https://doi.org/10.3390/app14156730>

## Biography



**Eruni Uku Philip** is an accomplished academic and an expert in the fields of chemical engineering and materials science. As Sub-Dean of Engineering and Head of Department in the Department of Chemical Engineering at the Federal University Otuoke, she has an impressive background in advanced materials synthesis, characterization, and processing. Dr. Eruni received her PhD in Chemical Engineering from Rivers State University of Science and Technology and is a member of both the Nigerian Society of Engineering and the Council for the Regulation of Engineering in Nigeria.

### Research Field

Eruni Uku Philip: Chemical Engineering, renewal energy, materials design, bio mediation and sustainable development,



**Lucia Omolayo Agashua** is a Lecturer at Federal University Otuoke, Bayelsa State Nigeria., Civil and Environmental Engineering Department. She completed her PhD in Civil and Environmental Engineering Department from Federal University of Technology Akure, Ondo State Nigeria, in the year 2024. Registered Engineer with the Council for the regulation of Engineers in Nigeria, Member of Nigerian society of Engineers, American Society of Engineers since 2009. Passionate team oriented that enjoying working with little or no supervision, has over 105 conferences papers and reputable journals publication indexing in scopus data base. She is a LiveDNA member and reviewer to various international journals such as Scientific African (Elsevier), American Journal of Civil Engineering, KCSE Journal of Civil Engineering (Springer) and so on. She currently serves on the Editorial Boards of numerous publications, including Science Futures and has been invited as a Keynote Speaker, Technical Committee Member, Session Chair, and Judge at international conferences.

### Research Field

Lucia Omolayo Agashua: Civil Engineering, Structural Engineering, Highway and Transportation Engineering, Green concrete, Water and Environmental Engineering, Waste management and Water Quality Assessment.