UNIVERSITY OF PORT HARCOURT

THE TONIC FOR EMERGING SUSTAINABLE TECHNOLOGIES

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ORDER OF PROCEEDINGS

2.45 pm. Guests are seated

3.00pm. Academic Procession begins

The Procession shall enter the CBN Centre of Excellence auditorium, University Park, and the Congregation shall stand as the Procession enters the hall in the following order:

Academic Officer
Professors
Deans of Faculties/School
Dean, School of Graduate Studies
Provost, College of Health Sciences
Lecturer
University Librarian
Registrar
Deputy Vice Chancellor Research and Development
Deputy Vice Chancellor Academic
Deputy Vice Chancellor Administration
Vice Chancellor

After the Vice Chancellor has ascended the dais, the Congregation shall remain standing for the University of Port Harcourt Anthem.

The Congregation shall thereafter resume their seats.

THE VICE CHANCELLOR'S OPENING REMARKS.

The Registrar shall rise, cap, invite the Vice Chancellor to make his opening remarks and introduce the Lecturer.
The Lecturer shall remain standing during the Introduction.

THE INAUGURAL LECTURE

The Lecturer shall step on the rostrum, cap and deliver his Inaugural Lecture. After the lecture, he shall step towards the Vice Chancellor, cap and deliver a copy of the Inaugural Lecture to the Vice Chancellor and resume his seat. The Vice Chancellor shall present the document to the Registrar.

CLOSING

The Registrar shall rise, cap and invite the Vice Chancellor to make his Closing Remarks.

The Vice Chancellor's Closing Remarks.

The Vice Chancellor shall then rise, cap and make his Closing Remarks. The Congregation shall rise for the University of Port Harcourt Anthem and remain standing as the Academic [Honour] Procession retreats in the following order:

Vice Chancellor
Deputy Vice Chancellor Administration
Deputy Vice Chancellor Academic
Deputy Vice Chancellor Research and Development
Registrar
University Librarian
Lecturer
Provost, College of Health Sciences
Dean, School of Graduate Studies
Deans of Faculties/School
Professors
Academic Officer

PROTOCOLS

- The Vice-Chancellor
- Previous Vice Chancellors
- Deputy Vice Chancellors [Admin., Acad. and Research Development]
- Previous Deputy Vice-Chancellors
- Members of the Governing Council
- Principal Officers of the University
- Provost, College of Health Sciences
- Dean, School of Graduate Studies
- Deans of Faculties
- Heads of Departments
- Distinguished Professors
- Directors of Institutes and Centres
- Visiting Academics and Colleagues
- Esteemed Administrative/Technical Staff
- Captains of Industry
- Cherished Friends and Guests
- Unique Students of UNIPORT
- Members of the Press
- Distinguished Ladies and Gentlemen.

DEDICATION

This inaugural lecture is wholeheartedly dedicated to the Almighty God, who makes all things beautiful in His time (Ecclesiastes 3:11). It is also lovingly devoted to my treasured wife, Barr. Rhoda T. Briggs, and our wonderful children—Prosper, Excel, Blossom, and Greatness T. A. Briggs—whose unwavering love and support have been a constant source of strength and inspiration.

ACKNOWLEDGEMENTS

Throughout my journey, many individuals who were instrumental in my progress—guided by the hand of God—played pivotal roles in my growth and success. While I cannot mention everyone by name, I remain profoundly grateful for the support, mentorship, and generosity I received along the way.

I owe special thanks to my parents, the late Dr Alasin G. T. Briggs and Madam Blessing A. Briggs (of blessed memories), for their unwavering commitment to providing me with the best education possible. I am especially indebted to my mother, whose constant encouragement and belief in my potential inspired me to pursue postgraduate studies—a step that ultimately set me on the path to a fulfilling career in academia.

I am deeply grateful to the 9th Vice Chancellor of the University of Port Harcourt, Professor Owunari Abraham Georgewill, for graciously granting me the opportunity and approval to deliver this inaugural lecture. His exemplary leadership, marked by vision and outstanding qualities, continues to drive the university toward greater achievements and enduring excellence.

I extend my deepest gratitude to the esteemed principal officers of the university: Professor Chukwudi Onyeaso (Deputy Vice Chancellor, Administration), Professor Rosemary Ogu (Deputy Vice Chancellor, Academics), Professor Angela Frank-Briggs (Deputy Vice-Chancellor, Research & Development), Dr Gloria Chindah (Registrar), Dr

Godspower W. Obah (Bursar), and Professor Helen Emasealu (University Librarian). May the Almighty God continue to bless, strengthen, and guide you all in Jesus' mighty name.

I extend my heartfelt gratitude to my cherished family, Da Tobin Dakeitolumari Membere Briggs, for their unwavering support and boundless love. I am also deeply appreciative of the Krukrubo family, with special recognition to the Janewari Krukrubo’s family for their exceptional kindness and assistance. Most especially, I honour late Madam Rose J. Krukrubo, my late mother's elder sister, whose wisdom and care have been truly invaluable.

I sincerely appreciate my beloved siblings, Mrs. Lolo Agina Obu, Charles A. Briggs, Matilda Otonye, Mrs. Auntie Ikhioye, and Alaye A. Briggs—for their unwavering support and profound presence in my life. Their love and encouragement have been truly invaluable.

I wish to express my heartfelt appreciation to the former Vice Chancellors of this distinguished institution, with whom I had the honour of working closely, for their invaluable support and contributions to my professional journey. I begin with Prof. Don Baridam, the 6th Vice Chancellor, who appointed me to the university’s staff on October 22, 2008. I am especially grateful to Prof. Joseph A. Ajienka, the 7th Vice Chancellor, for placing his trust in me as the pioneer Coordinator of the Department of Mechatronics Engineering in 2013 and later promoting me to serve as Acting Head of the Department. I also extend my sincere thanks for the opportunity to serve as Deputy Director of the Intellectual Property and Technology Transfer Office (IPTTO), where I had the privilege of working under Prof. Samuel W. Ibodje, whose mentorship greatly enriched my understanding of strategic academic administration

I extend my sincere gratitude to Prof. Ndowa E.S. Lale (8th Vice-Chancellor) for appointing me as the Acting Head of Mechatronics Engineering in 2016, as well as the Acting Director of IPTTO in 2015, and later the Acting Director of the Offshore Technology Institute (OTI) in 2017. My heartfelt appreciation also goes to Prof. Stephen A. Okodudu (former Acting Vice Chancellor), whom God used mightily to clear the obstacles and challenges on my path, ultimately enabling my promotion to the rank of professor. I pray earnestly that God will bless and richly reward them both.

I am deeply grateful to all my primary and secondary school teachers for their invaluable contributions to my education. Special thanks go to Mr Okuru of Township State Primary School, Moscow Road, Port Harcourt, as well as Auntie Best and Auntie Tariah, the Headmistress of Pabod Model Primary School. I must also acknowledge Mr K.D. Smith, who imparted the vital lesson of punctuality in examination settings, alongside Mr. Pedro and Mr. Alaibe, my dedicated woodwork and metalwork instructors. I appreciate all the teachers, prefects, and friends at Government Comprehensive Secondary School, whose support shaped my journey. I will always remain grateful to them. Furthermore, I say huge thanks to members of PMPS OLD STUDENTS and COBA for the atmosphere in which we can connect again and discuss the great memories we had together.

I am profoundly grateful to my esteemed professional and industry partners for their steadfast support and collaboration during my tenure as Director of the Offshore Technology Institute. I offer special appreciation to Gabriel Ugburo, Jonathan Ogbekhilu, and Tayo Akinkunmi of TechnipFMC; Chinedu Maduakoh and Jami Oyan of Topline Engineering Limited; and Sylvester Iroghama, CEO/MD of Iro-Vester Engineering Limited. I also extend my sincere thanks to the dedicated management and staff of the Nigerian Content Development and Monitoring Board (NCDMB), Shell Nigeria Exploration and Production Company (SNEPCo), and Aveon Offshore Limited. Your invaluable contributions have significantly impacted the institute's progress and impact.

I extend my sincere appreciation to my esteemed professional associations for their invaluable support and contributions: the Council for the Registration of Engineering in Nigeria (COREN), the Nigerian Society of Engineers (NSE), the Institute of Industrial and Systems Engineers (IISE), Advance Higher Education UK, and Institute of Non-Destructive Testing, Nigeria (INDTN). Their commitment to excellence has been instrumental in my journey.

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The late Prof. C. O. C. Oko was instrumental in shaping my academic discipline from my undergraduate years through my postgraduate studies. His guidance as both my professor and colleague in the Department of Mechanical Engineering at the University of Port Harcourt laid the foundation for my scholarly pursuits.

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Prof. Ibisime Etela, Prof. J. P. Kpolovie, Prof. G. Otto, Prof. Andrew A. Obafemi, Prof. Nath Abraham, Prof. Matthew Wegwu, Prof. K. A. Anele, Prof. Prince. C Mmom, Prof. N. Peter-Side, Prof. G.O. Avwiri, Prof. Olufemi. M. Adesope, Prof. Kilani, Dr Mrs Ataga, Dr Mrs Charles Ganville, Dr Nmencha Alex, Dr Ibinabo Young Matthew Esq., Mrs Matilda Nnodim, Prof Collins Wizor, Prof U. J. Nowgu, Dr. Ovunda Ihunwo, Prof. C. C. Chukueggu, Dr. Gift Worlu, and others.

The entire staff of the Department of Mechanical Engineering, University of Port Harcourt is hereby appreciated for giving me the opportunity to work with them: Prof. Ojapah, M. M., Prof. Diemuodeke, E. O., Professor Ossia, C.V, Dr. Lawson-Jack, S., Prof. Shadrack, M. U. Dr. Big-Alabo, A., Dr. Saturday, E. G., Dr. Ofodu, J.C., Dr. Aikhuele, D.O., Dr. Ezekwem, C., Dr. Ebieto, C. E., Dr.Nnorom, O., Dr. (Mrs) Abraham-Igwemoh, J.E., Engr. Eseonu, O. M., Engr. Torbira, M.S., Engr. James, R.V., Mr. Ameme, C., and Mrs Nwogu, Franklin Jeneibiwari. I also do appreciate my students from far and near- undergraduate and postgraduate students alike. My mentees and role models are appreciated.

The entire Registry staff is greatly appreciated, especially the staff of the Personnel Office (Academic) for all the documentation, especially during my professorial assessment.
My in-laws have been a wonderful lot and deserve special thanks for rallying to assist my family in time of need. Prof Iyeopu Minakiri Siminialayi (former Deputy Vice-Chancellor, Research & Development), thank you for your support.
I extend my heartfelt gratitude to Obiri Uniport, a vibrant community of progressive, like-minded individuals. My special appreciation goes to the extraordinary Leader for Life,

Prof. Okechuku Onuchuku, DSSRS (Acting Vice-Chancellor, Ignatius Ajuru University of Education), and the extraordinary Chairman for Life, Dr. Williams W. Wodi. I also acknowledge all the extraordinary members—both for life and beyond—for their unwavering support, camaraderie, and steadfast presence throughout my journey. Thank you for always being there for me.

I extend my profound gratitude to the Director of the College of Continuing Education (CCE), University of Port Harcourt, Prof. Love Akonye, along with the College Secretary, the College Accountant, the Chief Accountant, the Principal and staff of the University of Port Harcourt International Secondary School (UISS), and indeed, the entire staff of CCE. Your unwavering support and cordial cooperation have greatly enriched my tenure as Chairman of the CCE Board of Governors. May the Almighty God bless you all abundantly, in the Mighty Name of Jesus Christ. Amen.

I am sincerely grateful to the following individuals who have played significant roles in my academic journey. Professor Fidelis Abam, Professor of Energy and Power Engineering at the University of Calabar, has truly been a brother from another mother—an unwavering confidant and cherished friend. My heartfelt appreciation also goes to Mr. Isaac Moses and Mr. Uzoma Nwosu, dear brothers and loyal companions who have remained steadfast over the years. To Princewill Fiberesima (fondly known as Sule), my childhood friend, I fondly recall our days on Bende Street and at Number Three Field, all in Port Harcourt Township—what unforgettable memories we created together. Your friendship remains deeply treasured.

My Christian family, the Nigerian Christian Graduate Fellowship, helped to cushion my life so that the rough, bumpy ride of this world was minimal. I would like to thank Prof Femi Shaka, the President of the Full Gospel Businessmen's Fellowship International (FGBFI), the Eminent Persons Chapter, Uniport. Where the happiest people on earth meet. Who ensured that the secretary of the fellowship? I appreciate other esteemed members of EXCO and members of the fellowship, indeed **HIS BANNER OVER US IS LOVE.**

Special gratitude to my spiritual fathers, mentors, and leaders: Pastor E.A. Adeboye (General Overseer, The Redeemed Christian Church of God (RCCG)). Pastor Belemina Obunge (Formal Head RCCG Rivers family), Pastor Adesoji Oni (Pastor in charge of Region 5), Pastor Solomon Marega (Assistant Regional Pastor in charge of Region 35), Pastor Godwin Osuagwu (Assistant Regional Pastor in charge of Region 5), Pastor Peter Thomas, Pastor Andrew Gbasimoriye, Pastor Shola Otitoju, Pastor (Mrs) D. U. Okorie, Pastor Oyetunde Adeoye Johnson, Pastor Akinola Adewole, and Pastor Vincent Ebube. I appreciate all the pastors at Rivers Province 9 of the Redeemed Christian Church of God, members of Ebenezer and Seed of Praise and Beautiful Land parishes. Whose relationships as my pastors have been a blessing to my family and me.

I sincerely thank the committee that reviews my inaugural lecture material and presentation slides. What a great job by this inaugural lecture review committee. God bless you all.

Finally, to my caring, enduring, patient, understanding, and lovely wife, and sweetheart, Rhoda T. Briggs - you are the best and will remain so for me – I love you forever. My children: Prosper T. Briggs, Excel T. Briggs, Bossom T. Briggs, and Greatness T. Briggs. They made the home very conducive for me to work, even in my very busy itineraries. God Almighty bless you all richly in Jesus Christ's mighty name.

I have been truly blessed by the kindness and support of countless individuals who have played a part in shaping my journey in life. Although I may not be able to recall every name at this moment, I ask for your understanding. Please know that my heartfelt gratitude extends to every one of you.
Your contributions have not gone unnoticed, and I sincerely appreciate you all.

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1.0 Introduction

An Inaugural Lecture serves as a distinguished platform for a newly appointed professor to present the core of their discipline, share their contributions, reflect on academic and human challenges, and offer insights into future directions. While accessibility is the aim, certain technical terms may be necessary to convey the depth of expertise. I appreciate your patience and understanding should any aspects of this lecture become highly specialised or less engaging during the lecture.
Vice Chancellor, I sincerely thank you for granting me this opportunity. Undertaking this assignment brings me great joy and a deep sense of fulfilment. Upon its completion, I will gratefully declare, like the Holy Scripture: *"He has made everything beautiful in its time"* (Ecclesiastes 3:11).

The Faculty of Engineering's first inaugural lecture was delivered in 2000 by the late Professor Chy Ikoku of the Department of Petroleum and Gas Engineering, titled *"Petroleum: Mankind's Best Friend."* Since then, others have followed from the same department, as well as from Civil and Environmental Engineering and Electrical and Electronics Engineering. This lecture marks the third inaugural lecture from the Department of Mechanical Engineering, the first being delivered by Profwaaor E. K. Obiskor (the first Head of Department) and second by Professor J. U. Okoli in 2012. I trust that this moment will serve as a catalyst, setting the ball rolling not only for our department but also for inspiring my colleagues across the faculty to rise to the occasion and showcase their expertise. Together, we can enrich the university and, indeed, contribute meaningfully to the advancement of our nation.

Mr Vice-Chancellor, I am a professor of Industrial Engineering. I am proud to be the second individual in the Department of Mechanical Engineering to earn a PhD in Industrial Engineering, the first being Professor Ongoebi M. O. Etebu in 1997. Notably, I am the first graduate of this department to attain the rank of professor and to have the honour of delivering an inaugural lecture today—the first graduate (B.Eng) of the faculty to become the Dean of the Faculty.

As a boy in primary school, my parents often asked what I wanted to become when I grew up. I always answered, "an engineer," even though I had no idea then that engineering included various specialised fields. In my first year of secondary school, I became friends with a classmate who often brought intriguing mechanical prototypes—like link mechanisms and cast soap moulds—for classroom demonstrations. Fascinated, I asked where he got them, and he told me they were made by his father. When I learned that his father was a mechanical engineer, I was deeply inspired. It was at that moment that I made a clear decision: I would pursue mechanical engineering at the university. I wanted to create, design, and innovate just like the man I had come to admire through his son's eyes.

When it came time to fill out my Joint Admissions and Matriculation Board (JAMB) form, I boldly selected Mechanical Engineering as my first, second, and third choice. Despite advice from my parents and friends to consider alternative courses as a backup, I remained resolute—it was Mechanical Engineering or nothing. My determination paid off, and I was ultimately admitted to study Mechanical

Engineering at the University of Port Harcourt, fulfilling a long-held dream.

A pivotal moment in my academic journey came during my third year when we were required to take semester examinations alongside fifth-year students. This unusual arrangement occurred due to a shortage of lecturers, which delayed the teaching of fluid mechanics until the final year for the older cohort. During those joint classes, I formed a connection with one of the top-performing fifth-year students, who opened my eyes to the diverse specialisations within Mechanical Engineering, ranging from thermo-energy and fluid mechanics to materials, production/maintenance, and industrial engineering. When he asked about my area of interest, I confidently shared my fascination with industrial engineering. That interest deepened after I met the late Dr. M. T. Lily (later became a professor), a remarkable mentor who later became a professor and earned his PhD in Industrial Engineering from the University of Liverpool, UK, in 1983. His influence played a significant role in shaping my journey toward becoming a professor in Industrial Engineering.

Vice-Chancellor, Sir, Industrial engineering is emerging as one of the few glamorous professions that will be counted on to solve complex problems in the highly technological world of the future.

We are seeing rapid advances in the use of automation, artificial intelligence (AI), and other forms of high technology in factories and production systems worldwide.

Designing a factory of the future is a challenging and complex task—one that requires knowledge of fundamental sciences, engineering science, behavioural science, computer and information sciences, economics, and a broad array of topics concerning the basic principles of production.

Industrial Engineering (I.E.) curricula are designed to prepare students to meet the challenges of the future. Many I.E. graduates will, indeed, design modern manufacturing facilities. Others will elect to design healthcare delivery systems, transportation systems, or other systems that provide service rather than manufactured products.

The demand for I.E.'s is strong and growing each year. The demand for I.E.'s greatly exceeds the supply. This demand/supply imbalance is greater for I.E. than for any other engineering or science discipline and is projected to exist for many years in the future.

1.1 Purpose of the Inaugural Lecture

As a Professor of Industrial and Systems Engineering, the purpose of my Inaugural Lecture is not only to reflect on my academic journey but also to present the body of research and applied contributions that have shaped my path to this professorial rank. Over the years, my work has focused on solving real-world problems through the integration of systems thinking, operations research, human-centred design, and emerging technologies. From optimising manufacturing and production processes and developing intelligent scheduling systems to improving healthcare delivery and resource allocation in public institutions and organisations, my research has consistently aimed at increasing efficiency, reducing waste, and enhancing organisational performance. These studies, often carried out in collaboration with students, colleagues, industry partners and policy stakeholders, have resulted in practical solutions and scholarly outputs that address both local and global challenges. This Inaugural Lecture serves as a platform to share these findings, demonstrate the relevance of Industrial and Systems Engineering in today's world, and highlight the societal value of rigorous, ethically grounded, and impact-driven research. It is also a call to students, colleagues, and decision-makers to embrace the systems approach as we shape sustainable, resilient, and future-ready organisations and communities.

1.2 The Engineering Process

The development of various engineering branches has led to a clear understanding of what engineers do—mechanical engineers improve engines, electronics engineers design better devices, and so on. While other professions also solve problems and analyse data, what truly distinguishes engineers is their focus on designing systems. Although architects also design, they often rely on engineers for structural and technical components, particularly without an engineering background. Thus, system design is considered a defining characteristic of engineering.

Design involves creativity but also relies on principles and structure. In engineering, design is closely linked to the concept of synthesis, which refers to combining elements into a new or improved whole. This contrasts with analysis, which involves breaking systems down into components to understand how they work. Engineering requires both processes. For instance, analysing a beam means determining its capacity, often yielding a single correct answer. However, designing a beam to carry a specific load involves multiple possible solutions, depending on materials, shapes, and constraints.

The engineering process is therefore iterative, involving continuous back-and-forth between synthesis (design) and analysis (evaluation). One analysis leads to a proposed design, which then prompts further analysis. This cycle continues until a satisfactory solution is found. The term "acceptable" is emphasised over "optimal," as practical engineering solutions often balance various trade-offs under certain assumptions. This process is fundamental across all engineering disciplines, including industrial, civil, mechanical, electrical, and chemical engineering (Turner et al., 1987).

1.3 Engineering is a Profession

Professions such as medicine, law, teaching, and engineering share key traits: a specialised body of knowledge, internship-like training, a self-regulating code of ethics, and a commitment to serve society. Smith (1969) emphasises these attributes, adding that true professionals also pursue lifelong learning and prioritise public service. While definitions may vary, there is broad agreement that professionalism carries serious responsibilities and high expectations from society (Kemper, 1975).

1.4 Professional Ethics

Engineers often make decisions that significantly impact society, such as ensuring user safety, protecting the environment, and influencing communities through design.

While they are sometimes blamed for issues like pollution and overcrowding, these are unintended byproducts of meeting societal demands. Engineers carry the responsibility of balancing public welfare with economic and technical constraints. For instance, a perfectly safe car would be impractical due to its cost and weight. Engineers must navigate ethical dilemmas, weighing client interests against public safety. Despite these challenges, the engineering profession maintains a strong reputation for ethical conduct and its commitment to societal well-being through thoughtful, responsible decision-making.

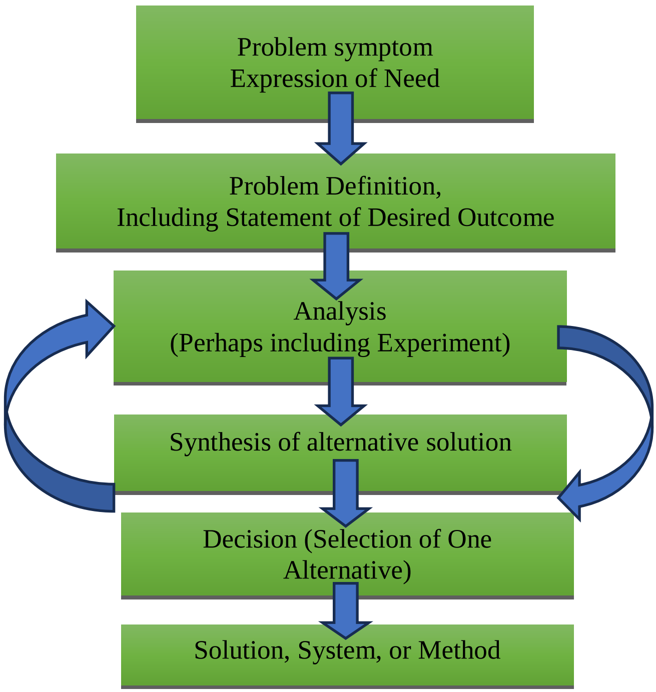

Figure 1: Basic Engineering Process

1.5 Definition of Industrial Engineering

The following formal definition of industrial engineering has been adopted by the IIE:

Industrial Engineering is concerned with the design, improvement, and installation of integrated systems of people, materials, information, equipment, and energy. It draws upon specialised knowledge and skill in the mathematical, physical, and social sciences, together with the principles and methods of engineering analysis and design, to specify. predict and evaluate the results that can be obtained from such systems.

As used in this context, the term industrial is intended to be interpreted in the most general way. Although the term industrial is often associated with manufacturing organisations, here it is intended to apply to any organisation. The basic principles of industrial engineering are being applied widely in agriculture, hospitals, banks, government organisations, and so forth.

If you read the definition again. Think about any large factory that you have seen in which thousands of workers, hundreds of machines, a large variety of materials, and millions of naira must be combined in the most productive, cost-effective manner. Think about a large city that also requires thousands of workers, hundreds of vehicles and other machinery, materials, and millions of naira to deliver services required by the public. Imagine how much more effectively the city could be run if the principles of industrial engineering were applied.

2.0 Industrial and Systems Engineering Profession Impact of Related Developments

This section of the lecture effectively traces the historical development, contemporary relevance, and multidimensional responsibilities of Industrial and Systems Engineering. With its interdisciplinary and multidisciplinary roots, system-wide vision, and emphasis on measurable impact, ISE stands out as a profession essential to sustainable development, global competitiveness, and organisational excellence. The synthesis of human, technical, and computational elements within ISE uniquely equips its practitioners to meet the pressing challenges of the 21st century. The section offers a comprehensive and insightful review of the evolution, relevance, and functional depth of Industrial and Systems Engineering (ISE), capturing its academic and practical significance

2.1. Evolution and Influence of Operations Research (OR)

The origins of ISE are closely tied to the emergence of Operations Research (OR) during World War II, and OR introduced a scientific, interdisciplinary approach to solving complex military problems using mathematical models, statistics, and behavioural sciences. Following the war, these techniques were applied to industry, commerce, and education, becoming an integral part of industrial engineering programs and shaping both curricula and professional practice.

ISE departments began incorporating OR into their structures, offering graduate programs and sometimes rebranding to include OR in their departmental titles. The OR approach emphasised tasked-force-driven problem-solving, interdisciplinary and multidisciplinary collaboration, and quantitative analysis—traits that now define the modern ISE profession.

2.2. Impact of Digital Computers

Digital computing has profoundly transformed ISE by enabling the analysis and control of large-scale, complex systems. Computers have facilitated simulation models, optimisation, real-time monitoring, and control, thus allowing industrial engineers to develop and manage highly efficient systems. Tools such as CAD/CAM have revolutionised system design and manufacturing.

ISE professionals leveraged computing technologies to improve productivity and flexibility, including the design of integrated networks for data sharing, remote access, and production control. These advancements elevated the role of ISE from manufacturing-centric to enterprise-wide, touching logistics, robotics, and IT infrastructures.

2.3. Application in Service Industries

Initially applied in manufacturing, ISE practices have spread into service sectors—particularly healthcare and government. Hospitals adopted ISE tools for inventory control, scheduling, and waste reduction. Similarly, government institutions use ISE to design control systems, optimise resource allocation, and improve operational efficiency. ISE's relevance in these areas shows the discipline's adaptability and expanding influence in non-traditional domains, underlining its universal application.

2.4. Integration with Other Disciplines

ISE evolved from traditional engineering disciplines like mechanical, electrical, and chemical engineering. It also draws from non-engineering fields such as psychology, management philosophy, operations research, computer science, and statistics. This interdisciplinary and multidisciplinary (as shown in Figure 2) foundation gives ISE its unique systems perspective and problem-solving capability

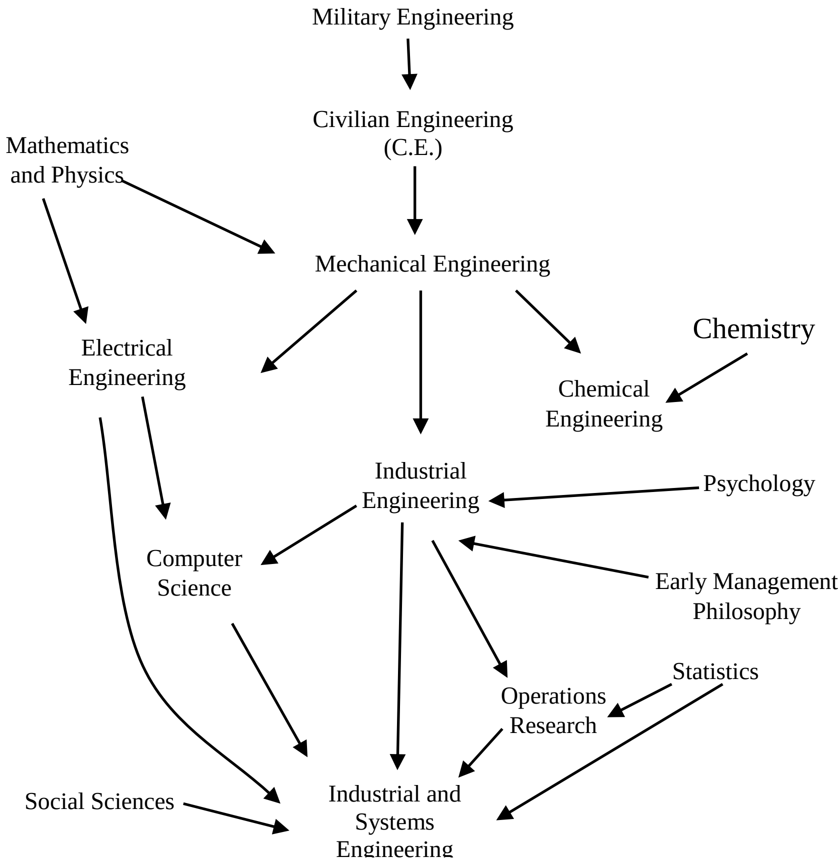

Figure 2: Relationship of Industrial Engineering to Other Engineering

2.5. Future Challenges and Sustainability

This sub-section addresses future-facing challenges such as finite natural resources, environmental constraints, and the need for sustainable practices. Engineers are now expected to design systems that balance efficiency with ecological responsibility. Product reliability, safety, and environmental compatibility have become critical concerns.

Moreover, the global productivity race demands continuous improvement and innovation. While American industry once led the world, increasing competition from Asia and Europe necessitates a resurgence in technology investment, automation, and quality improvement. ISE has a crucial role in driving this new wave of industrial transformation.

2.6. Industrial and Systems Engineering Design

Unlike mechanical or electrical engineers who work with physical artefacts, ISEs design entire systems—ranging from human activity systems (e.g., workplace layouts) to management control systems (e.g., planning, reporting, forecasting). This macro-level systems thinking allows ISEs to influence overall organisational effectiveness.

Design activities include defining workflows, structuring data systems, ensuring safety, and optimising layouts. While complex and often underrepresented in traditional labs, these tasks form the backbone of operational excellence.

2.7. Educational Challenges in ISE

Because production systems are large and human-centred, they cannot be easily replicated in labs. ISE education relies on symbolic, conceptual, and increasingly computer-based models. Though effective, these methods limit student engagement in hands-on design activities. The lecture advocates for developing new educational methods that better simulate real-world design complexity and encourage active participation.

2.8. Typical Responsibilities of an ISE

ISE professionals perform a wide array of functions across product design, process optimisation, production planning, personnel management, cost control, system analysis, and organisational design. Examples include: - Selecting materials and designing optimal workflows - Forecasting demand and managing inventory - Scheduling operations and improving methods - Designing incentive systems and ensuring workplace safety - Developing information systems and budgeting tools. No single engineer performs all tasks. Specialisation is common, but a solid foundational understanding of each area is integral to ISE training.

2.9. Organisational Role of ISE

The positioning of ISE within an organisation varies. In some firms, it reports directly to operations; in others, it is a standalone managerial department. Larger ISE departments are structured by function, with clear groupings that align with organisational goals. Regardless of structure, the department's contributions significantly impact efficiency, quality, and competitiveness.

2.10. Measuring ISE Effectiveness

ISE performance is measured through predefined, quantifiable goals. These can be ongoing (e.g., reducing labour hours or in-process inventory) or project-based (e.g., equipment upgrades or layout changes). Periodic comparisons between actual performance and targets guide improvement strategies and validate the department's value.

3.0 Understanding Systems and Feedback

The lecture explores system theory, defining systems as interconnected components working toward a common goal. It differentiates between natural and man-made systems, static and dynamic, physical and abstract, and open versus closed systems.

ISE heavily employs feedback control—gathering performance data, comparing it to desired outcomes, and initiating corrective actions. This mechanism is vital for both human activity systems (e.g., factory workflows) and management control systems (e.g., production planning). Closed-loop systems allow for adaptation and improvement; a principle embedded in every ISE function. The key concept to the successful operation of a management control system is that of feedback. This process is illustrated in Figure 3 for a typical production process.

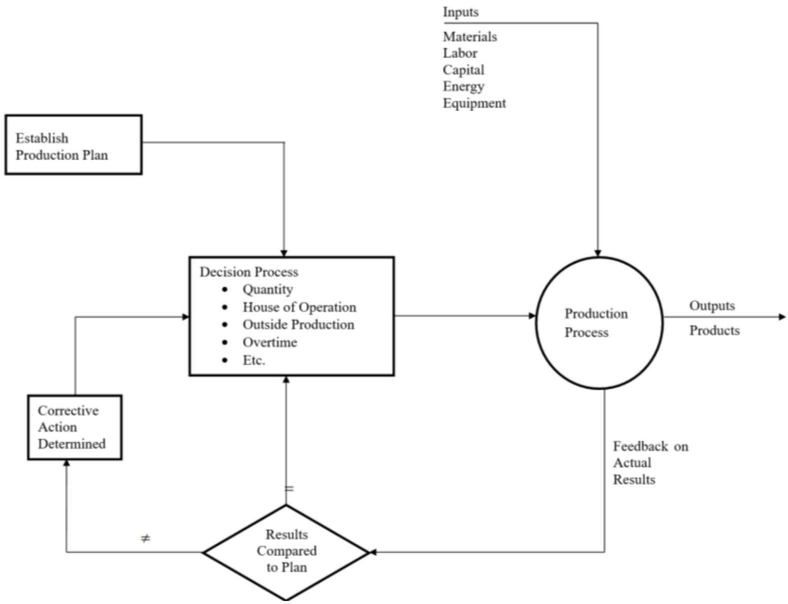

Figure 3: Feedback-control system for production

4.0 The Tonic for Emerging Sustainable Technologies

The theme of this inaugural lecture is "The Tonic for Emerging Sustainable Technologies," which focuses on how ISE plays a critical role in advancing emerging sustainable technologies, with respect to the principles and practices that drive the development and implementation of these technologies.

The term "tonic" implies that Industrial and Systems Engineering (ISE) is a key enabler or solution for addressing challenges in sustainable technologies. ISE provides the necessary tools, methodologies, and innovations to enhance sustainability in emerging technologies. In the following ways:

i. ISE serves as a remedy or enabler for the successful adoption and penetration of sustainable technologies.

ii. By applying systems thinking, optimisation techniques, and data-driven decision-making, ISE ensures that sustainable technologies are not only effective but also economically viable and scalable.
iii. Reduce waste and environmental footprint
iv. Optimize supply chains for sustainability
v. Enhance the economic viability of sustainable solutions

4.1. Advancements in Sustainable Manufacturing Supply Chain Modelling

Wofuru-Nyenke, Briggs, and Aikhuele (2023) carried out a study on advancements in sustainable manufacturing and supply chain modelling, focusing on optimising resources, reducing waste, and improving efficiency. We highlighted key challenges such as environmental impact, energy consumption, and cost management while exploring innovative solutions like circular economy models, digitalisation, and AI-driven decision-making. The role of data analytics, life cycle assessment, and lean manufacturing principles in enhancing sustainability is emphasised. Additionally, the study addresses resilience in supply chains and the need for strategic collaboration among industries to achieve long-term sustainability goals. These insights provide a comprehensive framework for integrating sustainability into industrial and manufacturing practices.

4.2 Predicting demand in a bottled water supply chain using classical time series forecasting models

Wofuru-Nyenkea and Briggs (2022) carried out classical time series forecasting methods for predicting demand in a bottled water supply chain. The weighted moving average showed the highest accuracy with the lowest Mean Absolute Deviation

(MAD) of 1,987, while exponential smoothing had the least accuracy (MAD of 2,483). This research aids supply chain analysts in selecting effective demand forecasting models.

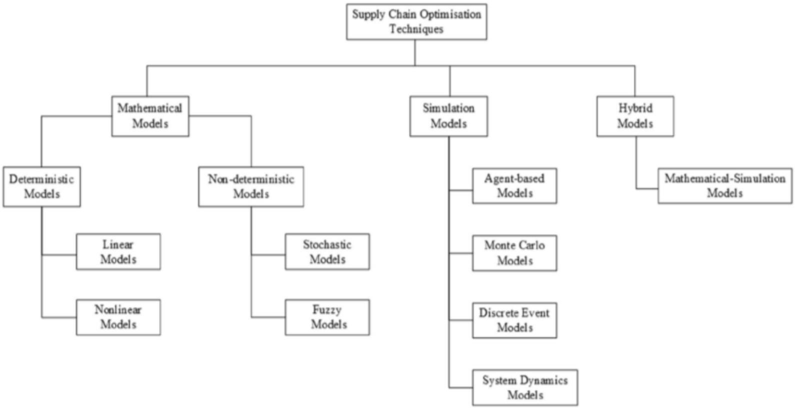

Figure 4: Classifications and Subcategories of Manufacturing Supply Chain Models

ISE contributions to sustain technologies involved in these projects (sections 4.1 and 4.2) are:

i. Sustainable Supply Chain Optimisation: ISE utilises mathematical modelling, data analytics, and simulation to enhance the efficiency of sustainable supply chains, reducing waste and emissions.

ii. Resource Efficiency: Industrial engineers apply lean and green manufacturing techniques to optimise energy use, minimise raw material waste, and improve overall sustainability in production processes. This aligns with ISE techniques like Lean Six Sigma and circular economy strategies.

iii. Sustainable Product Design: Systems engineering approaches, such as life cycle assessment (LCA), ensure that new technologies and products are designed with sustainability from inception.

iv. Resilience in Manufacturing: The project highlights sustainability challenges in manufacturing, which ISE addresses by developing predictive models and robust systems to handle disruptions in the supply chain.

v. Decision Support Systems: ISE professionally develops AI-driven decision-making tools that integrate sustainability metrics, helping industries transition to eco-friendly operations.

4.3 Power Situation and Renewable Energy Potentials in Nigeria: A case for Integrated Multi-generation technology

My team and I explored the current power situation and examined the role of renewable energy in mitigating energy shortages. It highlighted several challenges, including unreliable electricity supply, dependence on fossil fuels, and increasing energy demand. The study emphasised the importance of diversifying energy sources through solar, wind, and hydropower. Furthermore, it advocated for policy reforms, infrastructure investment, and strategic integration of renewable energy to strengthen energy security, promote sustainability, and support economic development (Owebor et al., 2021).

4.4. Multi-criteria optimisation of integrated power systems for low-environmental impact

We examine integrated power systems as a solution for reducing environmental impact. It emphasises combining renewable energy sources, energy storage, and smart grid technologies to enhance efficiency and minimise emissions.

The research study discusses the benefits of system integration in achieving sustainability, resilience, and energy security. The outcome of the project highlights the importance of planning, technology selection, and policy support to develop low-impact power systems suitable for future energy demands (Owebor et al., 2022).

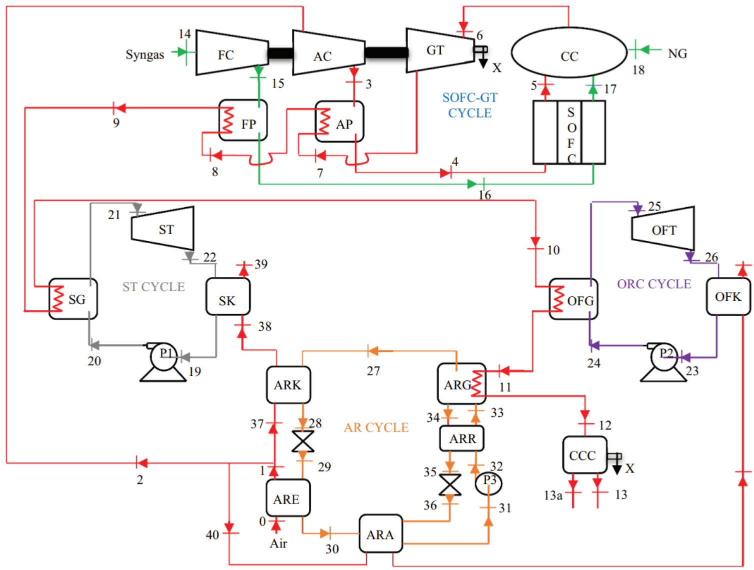

Figure 5: Power Plant Diagram of a combined Solid Oxide Fuel Cell, Gas, Steam, Organic Rankine and Absorption Refrigeration Cycles, Carbon Capture (CCC is carbon capture and Storage)

My VC here is the Industrial and Systems Engineers (ISE) roles in these projects:

i. Power System Optimisation**:** ISEs developed models to optimise the generation, distribution, and consumption of power, ensuring reliability and cost-effectiveness.

This analysis system performs and suggests improvements to reduce transmission losses.

ii. Integration of Renewable Energy: ISEs help in planning and integrating renewable energy sources (solar, wind, hydro) into existing power grids. This assesses capacity, designs efficient systems, and manages the variability of renewables using forecasting and control algorithms.

iii. Energy Policy and Planning: ISEs use systems thinking to evaluate national or regional energy strategies. This contributes to policy design by simulating the long-term impact of adopting renewable technologies, helping stakeholders make informed decisions.

iv. Sustainable Industrial Energy Use: ISEs identify energy-intensive processes in industries and recommend lean and green manufacturing methods to reduce consumption and emissions.

v. Data Analytics & Decision Support: By leveraging big data and machine learning, ISEs create dashboards and decision-support tools to monitor power systems in real time, predict failures, and guide maintenance or upgrades.

vi. Supply Chain and Infrastructure Planning: ISEs aid in designing resilient and sustainable supply chains for renewable energy infrastructure—like solar panels and wind turbines—ensuring timely availability and minimal environmental impact.

vii. Sustainability and Life Cycle Analysis: ISEs conduct life cycle assessments (LCA) of integrated energy systems to quantify environmental impacts, identify hotspots, and support the selection of cleaner technologies.

viii. Operations Research and Decision Support**:** Using simulation and optimisation models, ISEs assist in selecting the best configurations for power systems, balancing environmental, economic, and technical trade-offs.

4.5. The Combustion and Interchangeability of Natural Gas on Domestic Burners

I explore the interchangeability of natural gas and liquefied petroleum gas (LPG) for domestic burners, emphasising that chemical composition, along with heating values and specific gravities, significantly influences compatibility. Key parameters like the Wobbe Number, combustion potential, and yellow tip index were analysed to define the conditions for efficient interchangeability. Results showed that natural gas can substitute LPG without burner adjustments if supplied at twice the pressure of bottled LPG and above hydrocarbon and water dew points to enhance combustion quality (Briggs, 2014). The findings provide a framework for ensuring seamless substitution in domestic settings while maintaining safety and efficiency standards. The Industrial and Systems Engineers (ISE) impact on this project are:

i. Fuel System Modelling and Optimisation: ISE models the combustion processes of alternative gaseous fuels to optimise performance, energy output, and environmental impact.

ii. Sustainable Energy System Integration: ISE supports the integration of natural gas into existing Liquefied

Petroleum Gas (LPG) on domestic burners through systems analysis and transition planning.

iii. Data Analytics and Quality Control**:** ISEs use statistical tools and AI to monitor combustion characteristics, ensure fuel interchangeability, and maintain system reliability and safety.

iv. Process Improvement and Emission Reduction: By applying Lean Six Sigma and process engineering methods, ISE helps improve combustion efficiency and reduce emissions from alternative fuels.

v. Supply Chain and Infrastructure Planning: ISE designs supply chains for sourcing, processing, and delivering natural gas, ensuring cost-effectiveness and minimal environmental footprint.

vi. **Policy and Strategic Decision Support:** ISE provides decision-making frameworks and economic assessments to evaluate the feasibility and impact of adopting natural gas at scale.

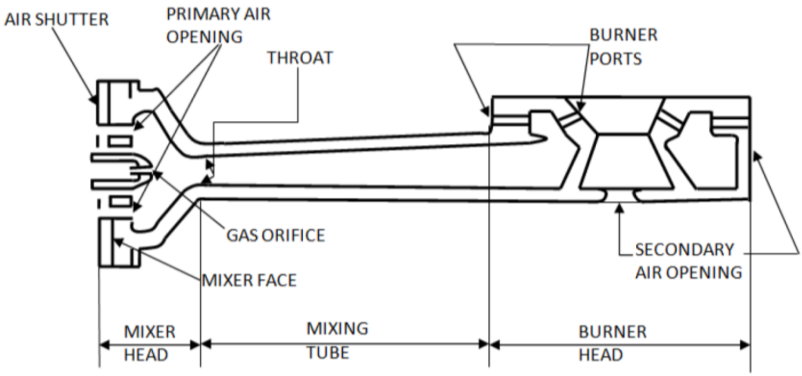

Figure 6: Parts of an Atmospheric Gas Burner

4.6 Determination of the Suitability of Groundnut Oil as a Hydraulic Fluid

Briggs and Victor (2014) conducted a study to evaluate groundnut oil's potential as a sustainable hydraulic fluid alternative. It analyses properties like viscosity, flash point, density, and corrosion resistance compared to conventional oils. Results indicate that groundnut oil meets several key performance criteria, making it a viable, biodegradable option for hydraulic systems. The research promotes eco-friendly practices by highlighting renewable, plant-based oils as substitutes for petroleum-based hydraulic fluids. The Industrial and Systems Engineering (ISE) impact in this study:

i. Process Design and Optimisation: ISE designs and optimises testing and refinement processes for evaluating groundnut oil's performance as a hydraulic fluid, ensuring cost-effective and efficient methods.

ii. Experimental Design and Quality Assurance: Using statistical tools like Design of Experiments (DOE) and Statistical Process Control (SPC), ISEs ensure the repeatability and reliability of performance tests on groundnut oil.

iii. Sustainability and Eco-Efficiency: ISE assesses the environmental impact and life cycle of using groundnut oil in hydraulic systems, promoting renewable and biodegradable alternatives to petroleum-based fluids.

iv. Supply Chain and Resource Management: ISE contributes to establishing a sustainable supply chain for groundnut oil, from sourcing and processing to distribution for industrial use.

v. System Integration: ISE evaluates how groundnut oil-based fluids can be integrated into existing hydraulic systems with minimal modification and operational disruption.

vi. Feasibility & Economic Evaluation: ISE applies cost-benefit analysis and decision-making models to assess the financial viability of replacing conventional hydraulic fluids with groundnut oil.

4.7. Applicability of Heuristic Approach in Planning and Scheduling a Project

This study explores how heuristic methods can improve project planning and scheduling. It highlights their ability to handle complex, dynamic variables more efficiently than traditional techniques (Briggs et al., 2013). The study demonstrates how heuristics optimise task sequencing, resource allocation, and time management. By applying these intelligent rules of thumb, project managers can enhance decision-making, reduce delays, and increase overall project efficiency, especially in uncertain or constrained environments.

The Industrial and Systems Engineers (ISE) in this model are:
i. Project Planning and Scheduling: ISE specialises in operations research and uses heuristic and exact methods (e.g., critical path method, PERT, genetic algorithms) to develop efficient project schedules that minimise time and cost.

ii. Heuristic Algorithm Development: ISE is skilled in developing and applying heuristic approaches to solve complex, NP-hard problems in scheduling, resource allocation, and project sequencing, where traditional methods fall short.

iii. Performance Measurement and Optimisation: They establish KPIs and feedback loops to monitor project execution, enabling continuous improvement through simulation, modelling, and process refinement.

iv. Systems Thinking: ISE applies systems thinking to align multiple project elements—tasks, resources, constraints, and goals—within a unified framework, improving coordination and risk management.

v. Tool Development and Automation: They design or deploy digital tools and software to automate scheduling and tracking, increasing productivity and reducing manual errors in complex projects.

vi. Decision Support Systems: ISE creates models and dashboards that help project managers make data-driven decisions, especially in dynamic and uncertain environments.

4.8. Geographic information systems (GIS) approach for assessing the biomass energy potential and identification of appropriate biomass conversion technologies in Nigeria

My team and I embark on a project to review renewable energy technologies in Nigeria, emphasising the transition to sustainable power sources, such as solar, wind, and biomass. It examines technological, financial, and policy challenges hampering widespread adoption. Strategies such as hybrid systems, localised energy solutions, and regional cooperation are recommended. The study advocates for investment in innovation, infrastructure, and training to enhance energy access, reduce carbon emissions, and support economic growth across the continent (Ukoba et al., 2023). The impact of this project by Industrial and Systems Engineering (ISE) is:

i. Design and Integration of Renewable Energy Systems: ISE applies systems thinking to design and optimise renewable energy systems—integrating solar, wind, and biomass for efficiency, scalability, and local adaptability.

ii. Modelling, Simulation, and Optimisation: ISE uses tools like simulation modelling and operations research to evaluate and improve the performance of hybrid and off-grid energy solutions.

iii. Supply Chain Management: ISE streamlines the supply chains for renewable energy technologies—from production to deployment—ensuring timely delivery and cost-effectiveness in resource-constrained settings.

iv. Sustainable Development Planning: ISE applies life cycle assessment (LCA) and environmental impact analyses to ensure that renewable energy projects align with sustainability goals.

v. Policy and Strategic Decision Support: ISE uses decision support systems and cost-benefit analysis to assist governments and organisations in making evidence-based energy investment and policy choices.

vi. Capacity Building and Training Systems: ISE designs education, workforce development, and training programs to build local expertise in renewable energy operations and maintenance.

4.9. Fatigue Analysis of Steel Jacket Platform in Shallow Water Depth in the Gulf of Guinea

Adeyemi and Briggs (2020) investigated the fatigue performance of a steel offshore platform situated at a 22-meter water depth. The research, conducted using Bentley SACS software, employed both spectral and deterministic analyses based on wave data collected over seven years. It assessed the fatigue life of various structural joints and piles using industry standards and safety factors. The spectral analysis revealed that many jacket joints failed to meet the target fatigue life of 250 years, while deterministic analysis showed limited compliance. However, all piles, both above and below the mud line, exceeded the 500-year fatigue life requirement. The study emphasised that spectral analysis offers a more detailed fatigue evaluation and recommended strengthening or replacing deficient joints. The research underscores the importance of fatigue assessment in ensuring the structural integrity and longevity of offshore platforms exposed to harsh environmental loads.

This work reflects how ISE research enhances offshore engineering by integrating system-level thinking, computational modelling, data analytics, and life-cycle optimisation to improve the performance, safety, and sustainability of critical infrastructure.

4.10. Modelling the Effects of Steel Catenary Riser (SCR) Wall Thickness on Its Structural and Fatigue Performances for Wave-Induced Load

We (Dapa et al., 2019) investigated the impact of varying wall thickness on the structural and fatigue performance of Steel Catenary Risers (SCRs) subjected to wave-induced loads in deepwater West Africa. Using the ORCAFLEX® software and guided by Det Norske Veritas (DNV) standards, four SCR models with identical internal diameters but different wall thicknesses were analysed under eight wave load cases based on the Ochi-Hubble spectrum. Static and dynamic analyses revealed that increasing wall thickness led to improved fatigue life along the riser's arc length but resulted in decreased flexibility and higher top tension at the Hang-Off Point (HOP). Consequently, fatigue life at the HOP dropped below the DNV's minimum design requirement of 200 years. The study concluded that increasing wall thickness compromises fatigue performance at critical points, rendering it an ineffective strategy for wave-induced fatigue mitigation. The findings underscore the need for balanced design approaches that consider both structural stiffness and fatigue resilience.

This research work makes significant contributions to Industrial and Systems Engineering (ISE) research in the evaluation of Steel Catenary Risers (SCRs) under wave-induced loading conditions. It was noted that the study adopted a systematic modelling and simulation approach using ORCAFLEX® software—an application of core ISE competencies in systems modelling, computational analysis, and design optimisation. The work emphasised the integration of performance evaluation, design criteria, and fatigue analysis within a structured methodology aligned with international standards (DNV), showcasing the role of ISE in ensuring reliability and compliance in offshore structural systems.

Furthermore, the research demonstrated the application of life-cycle assessment principles, a key ISE focus area, by assessing the long-term fatigue performance of risers under various wall thickness scenarios. The analysis of structural trade-offs between wall stiffness, flexibility, and fatigue life illustrated the systemic thinking characteristic of ISE, where design decisions are evaluated for their holistic impact on performance, safety, and cost. The study thus highlighted ISE's essential role in optimising complex offshore engineering systems.

4.11. Policy pathways for renewable and sustainable energy utilisation in rural coastline communities in the Niger Delta zone of Nigeria

Diemuodeke and Briggs (2018) examined the barriers to sustainable energy access in rural coastal communities of the Niger Delta and proposed policy pathways to enhance the adoption of renewable energy technologies (RETs). It was reported that challenges such as poor policy frameworks, inadequate technical expertise, limited financing, socio-cultural resistance, and weak political commitment hinder energy development in the region. The paper outlined eleven practical policy solutions, including subsidised energy costs, aggressive awareness campaigns, establishment of RET training and research and development (R&D) centres, and creation of renewable energy regulatory and finance institutions. Key stakeholders identified—government, local communities, Non-Governmental Organisations (NGOs), Niger Delta Development Commission (NDDC), and oil companies—were recommended to collaborate in implementing sustainable energy strategies. The study emphasised the critical role of energy access in achieving socio-economic development, climate resilience, and the Sustainable Development Goals (SDGs). It concluded that without strong political will and coordinated stakeholder

engagement, rural electrification in the Niger Delta would remain elusive despite the region's renewable energy potential.
This research work reported notable contributions of Industrial and Systems Engineering (ISE) research in addressing the complex energy challenges facing rural coastline communities in the Niger Delta. It highlighted how systems engineering approaches were applied to identify, categorise, and analyse the multifaceted barriers—ranging from technical and institutional to socio-economic and political—affecting the deployment of renewable energy technologies (RETs). Through structured problem definition, stakeholder mapping, and policy design, the research adopted a holistic ISE framework to propose effective and integrated policy pathways for sustainable energy access.

Moreover, the study utilised systems thinking to align energy interventions with local realities, enabling the development of adaptive, scalable, and stakeholder-inclusive solutions. The emphasis on data synthesis, process optimisation, and stakeholder coordination reflected core ISE principles aimed at ensuring efficiency, resilience, and long-term sustainability of energy systems. Ultimately, the research demonstrated how Industrial and Systems Engineering provides strategic tools for designing, managing, and improving complex socio-technical systems such as rural energy infrastructure.

4.12. TEA-LP (DFID and Carbon Trust) grant (100,000 pounds) for the development of a **curriculum on the Master's in Energy Access and Renewable Energy Technology programme.**

We (Briggs and Diemuodekea, 2024) developed a curriculum for the Master's in Energy Access and Renewable Energy

Technology programme that focuses on advancing Education for Sustainable Development (ESD) through innovative and adaptive approaches. It incorporates SDGs, research outcomes, and a Digital Skills Module to prepare students for global challenges. Using Triple Helix Plus+ Pedagogy, the programme offers degree certificates and certifications, ensuring graduates are globally competitive. Its goals include creating top-quality human resources to strengthen local content in the renewable energy industry and delivering cutting-edge training for professionals. The philosophy emphasises producing technopreneurs committed to sustainable, environmentally friendly solutions in their professional practices.

The impact

The programme started in 2021, with two cohorts of students completing the programme. The students from the MSc Energy Access and Renewable Energy Technology have two start-up companies in the energy access sector, which is primarily due to the Entrepreneurship and Management course. One of the start-up companies is Tovero Energy (https://toveroenergy.com/), with the following services: energy planning, energy audit, energy advisory, mini-grid design, clean cooking solutions, energy systems design and development, and energy education and advocacy (Diemuodekea *et al.,* 2019). Three companies from the MSc Energy Access and Renewable Energy Technologies programme are in the process of registering their companies with the Nigerian Corporate Affairs Commission (CAC). Furthermore, the program has given birth to a full-bloom institute known as the University of Port Harcourt Energy Technology Institute.

Plate 1: group photograph of participants of stakeholders’ workshop

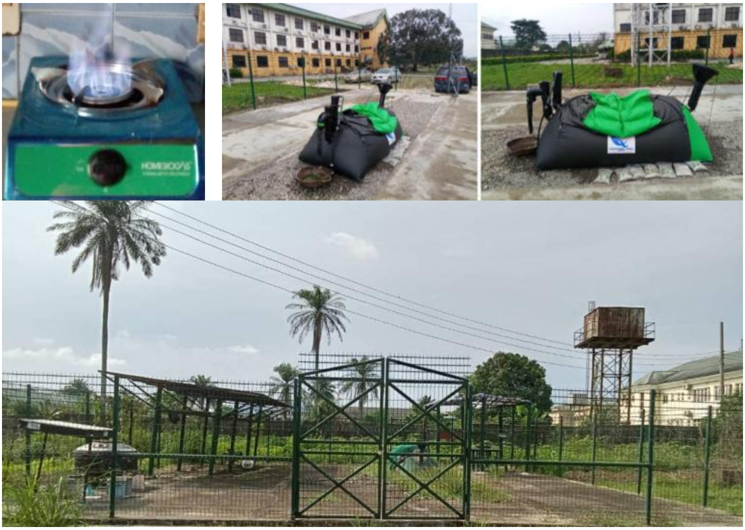

Plate 2: Green Energy Farm

4.13. Design and Construction of a Mobile Biogas Digester with an improvised gas volume measuring device

As part of an initiative to promote sustainable energy and innovation, we designed and developed a 0.5 cubic meter mobile biogas digester capable of supplying clean energy to multiple small-scale agro-processing and artisanal units. The biogas system successfully powers a 15-litre essential oil extractor, a 700 kg capacity fish dryer with an oil collector, an organic manure pelletizer, and a 54 cubic feet gas-fired kiln for ceramics. This solution directly addresses environmental concerns by mitigating greenhouse gas emissions and reducing dependency on firewood, thereby contributing to the fight against deforestation.

This project was supported by the Partnership for Skills in Applied Sciences, Engineering, and Technology (PASET) Regional Scholarship and Innovation Fund (Rsif). It was made possible through the academic and advisory support of Professor Onyewuchi Akaranta and Professor Ibisime Etela. The overarching objective is to bridge critical gaps in Nigeria's university-based research ecosystem and establish the university as a leading hub for entrepreneurial research and technology commercialization.

Plate 3: Mobile Biogas Digester with an improvised gas volume measuring device

4.14. Keytric: Energy management device

We developed KEYTRIC, a novel energy management device, designed to manage energy consumption rates and the safety of property. Its modular architecture allows compatibility with various hardware applications. The object of this invention is to provide a system that will cut down electricity bills for consumers. This device provides an easier, affordable, and simple way of switching off a room or building's electricity supply. It further provides an automatic way of switching off the electricity supply rather than using the knife switch, which the user might not always remember; the electricity will automatically switch off once the door is locked. The design, operation, and application scenarios of KEYTRIC emphasise its potential in both consumer and industrial markets. The Industrial and Systems Engineering (ISE) impact in this project is:

i. System Design and Integration: ISE apply systems engineering to integrate sensors and locking mechanisms into a unified, efficient device architecture.

ii. Process Optimisation: streamlining the manufacturing and assembly processes to ensure high-quality production with minimal waste and cost.

iii. Human Factors and Usability Engineering: ISE ensure the device is user-friendly, ergonomically designed, and meets the needs of diverse users through human-centred design principles.

iv. Reliability and Safety Engineering: We analyse system reliability and risk, ensuring that KEYTRIC operates safely and effectively under varied conditions.

v. Scalability and Deployment Planning: ISE plan for large-scale deployment, including logistics, inventory management, and installation support for consumer and industrial markets.

vi. Data Analysis and Decision Support: ISE use data analytics to assess usage patterns and system performance, guiding continuous improvement and updates to the technology.

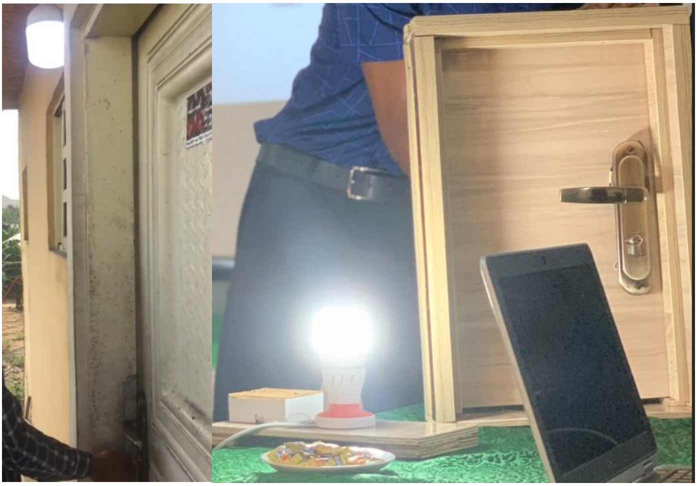

Plate 4: Keytirc Device Demonstrations

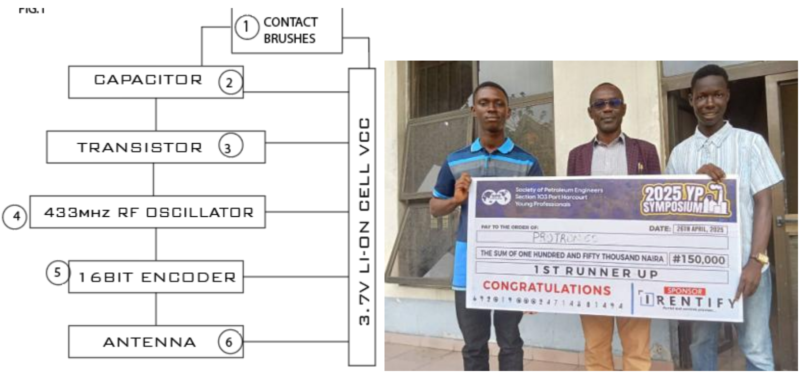

Figure 7: Keytric Schematic Diagram and Award from 2025 YP Symposium

4.15. Designed and developed a solar-powered electric rickshaw (popularly called Tricycle)

We designed and developed a solar-powered electric rickshaw, integrating innovative components for efficiency and sustainability. The vehicle features a 100W electric motor, a 60V PWM motor controller, and an 18Ah lead-acid battery pack, securely mounted on a tricycle chassis. A 100W solar panel and 40A charge controller enhance energy capture. Planned improvements include a traffic indicator, a digital battery level display, and a charging status indicator. Additionally, this study will evaluate maximum range and speed, ensuring optimal performance. The project underscores advancements in clean energy transportation, aiming to refine electric mobility solutions while maintaining functionality and efficiency.

Plate 5: solar-powered electric rickshaw

4.16. Development of the University of Port Harcourt (UniPort) Technology Park (UTP) Business Policy

The University of Port Harcourt (UniPort) Technology Park (UTP) Business Policy was developed through the UP-ECOSIN project, funded by PASET's RSIF program under the Energy and Renewables theme. The grant supported strategic development, consultations, workshops, and professional reviews, ensuring the effective formulation of policies in collaboration with UTP management to strengthen the innovation ecosystem.

The University of Port Harcourt (UniPort) is dedicated to fostering innovation, commercialisation, and entrepreneurship through demand-driven research. As the Innovation Hub of the South-South region, UniPort promotes collaboration between universities, industry, and government, leveraging science, technology, and innovation (STI) to drive sustainable industrial development. To support this mission, the University of Port Harcourt Technology Park (UTP) was established to nurture innovative ideas, facilitate commercialisation, and protect intellectual property. The UTP operates within a structured business policy that outlines managerial, legal, and administrative frameworks for smooth implementation. Recognised as a regional innovation hub by TETFund, UniPort's policy ensures efficiency and high-performance innovation. The strategy guides emerging technologies, reinforcing UniPort’s commitment to supporting individuals and corporate entities in addressing societal needs. Through this structured approach, UniPort strengthens its role as a leader in research-driven entrepreneurship, fostering sustainable economic growth and technological advancement.

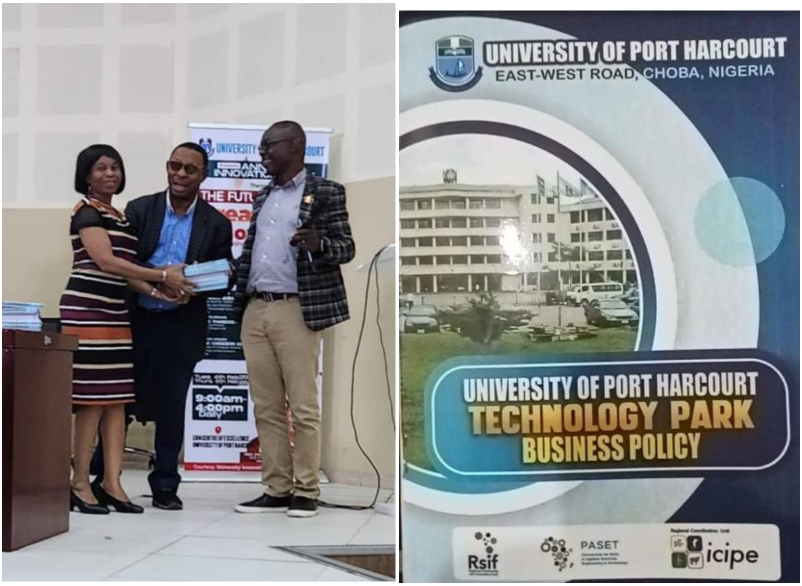

Plate 6: Handing over the Uniport Technology Park Business Policy to the University

4.17. Design and Fabrication of Pelletizing Machine

This project centres on the design and construction of a compact and efficient fish feed pelletizing machine aimed at addressing the challenges of feed accessibility in Nigerian aquaculture. Due to rising costs, limited availability of feed materials, and incompatibility of imported feeds with local fish species, small and medium-scale fish farmers struggle to obtain high-quality, affordable feed. To solve this, the study proposes a locally constructed, small-scale pelletizer capable of producing up to 100kg of feed per hour.

The machine is designed with simplicity and efficiency in mind, incorporating key components such as dual pressing rollers, a flat perforated die, a feeding hopper, gear bearings, and a power source—all mounted on a steel-framed skid. Feed mixtures are introduced through the hopper, pressed by rotating rollers against the die, and forced through perforations to form pellets. The roller-to-die gap can be adjusted to optimise pellet quality, and interchangeable die plates (2mm and 4mm) allow the production of pellets suitable for different stages of fish growth.

The primary aim of the project is to fabricate a functional, low-cost pelletizer using locally available materials, tailored for use with indigenous feed ingredients. Objectives include analysing existing machines, identifying performance limitations, and incorporating design improvements to enhance compatibility with local conditions.

This innovation is expected to support sustainable aquaculture by enabling farmers to produce high-quality, nutritionally balanced fish feed cost-effectively, reducing reliance on expensive imported options and improving overall productivity in the fish farming sector.

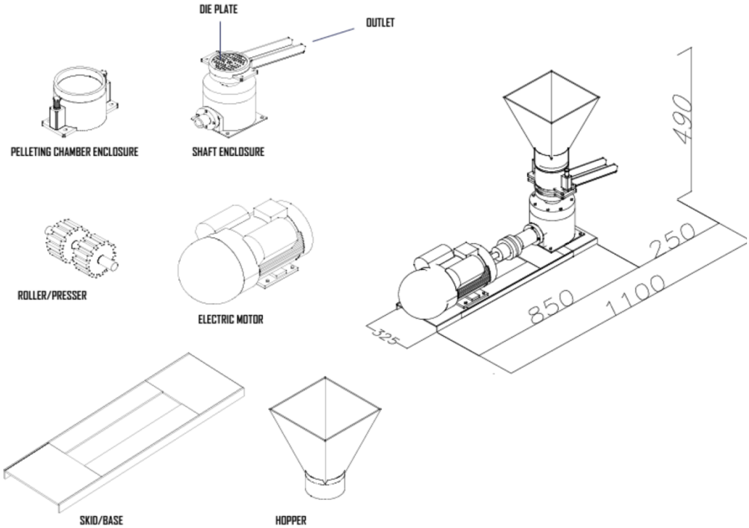

Figure 8: Engineering drawing of the Pelletizing Machine:

Plate 7: Pelletizing Machine

5.0 Academia and Industry Collaborations

Strategic collaborations between academia and industry harness the specialised expertise of Industrial and Systems Engineers (ISE) to bridge the gap between theoretical knowledge and practical application. ISE professionals bring a systems-thinking approach to solving complex industrial challenges, enabling academic institutions to tailor curricula, modernise laboratories, and simulate real-world environments. These partnerships enhance education by integrating process optimisation, data-driven decision-making, and sustainability principles into student training. As a result, graduates are equipped with industry-relevant skills, while industries benefit from innovative, efficient solutions designed through ISE methodologies—ultimately fostering mutual growth and addressing the evolving demands of the modern industrial landscape

Plate 8: Collaboration: Amtarol (OEM) and OTI-Uniport

5.1 Donation of Laboratory equipment and software worth more than $700,000

As a director in 2021, the Shell Nigeria Exploration and Production Company (SNEPCo), in collaboration with the Nigerian Content Development and Monitoring Board (NCDMB) and TechnipFMC, donated laboratory equipment worth over $700,000 to the Offshore Technology Institute (OTI) at the University of Port Harcourt. This generous contribution aims to establish a world-class laboratory that will provide graduates with globally recognised certifications alongside their university degrees. The facility is equipped with cutting-edge software packages, workbenches, and specialised tools designed to enhance students' knowledge in offshore technology, engineering design, and subsea structures. Additionally, a brand-new bus was provided to facilitate transportation for lectures, field trips, and industry visits, ensuring students gain practical exposure to real-world applications. This initiative underscores Shell's commitment to advancing education and fostering technological expertise in Nigeria's oil and gas sector.

Plate 9: First sets of the equipment supplied

Plate 10: Second Batch of the equipment supplied

Plate 11: Alternative Energy Learning and Pressure Process Control System

6.0 Conclusion

Industrial and Systems Engineering (ISE) stands at the forefront of emerging sustainable technologies, offering innovative solutions to complex challenges in manufacturing, energy, transportation, and various industries. As discussed throughout this inaugural lecture, the principles and methodologies of ISE provide a robust framework for optimising efficiency, reducing waste, and enhancing sustainability in modern systems.

The evolution of industrial engineering has been a dynamic journey, influenced by historical advancements, technological breakthroughs, and the increasing demand for efficient production and service delivery. From its roots in scientific management to its integration with operations research, digital computing, and systems engineering, ISE has continually adapted to meet the needs of industrial and societal transformations. Today, the discipline plays a pivotal role in driving sustainable development by integrating renewable energy solutions, optimising manufacturing processes, and ensuring resource efficiency across diverse sectors.

One of the key strengths of industrial and systems engineering is its interdisciplinary approach, blending fundamental sciences with engineering principles, economics, behavioural sciences, and computational tools. This holistic perspective enables engineers to design and improve complex systems that seamlessly integrate people, materials, information, equipment, and energy. The application of optimisation techniques, automation, data analytics, and artificial intelligence has further expanded the impact of industrial engineering in solving contemporary challenges.

In conclusion, industrial and systems engineering remains the tonic for emerging sustainable technologies, providing the methodologies, tools, and expertise necessary for transformative change. The contributions of ISE professionals will shape the trajectory of industrial development, ensuring a balanced approach that harmonises technological progress with environmental sustainability. As we look ahead, let us embrace the challenges and opportunities that lie before us, fostering innovation, collaboration, and strategic leadership to build a better, more sustainable world.

7.0. RECOMMENDATIONS

As we wrap up this inaugural lecture, it is essential to emphasise the responsibility of industrial and systems engineers in shaping a sustainable future. The principles of ISE provide the foundation for creating systems that not only drive economic growth but also prioritise environmental stewardship and social well-being. With this in mind, the following are key calls to action:

7.1. Recommendations For the Universities

i. The Nigerian Universities should expand their curriculum to integrate sustainability and emerging technologies by introducing a Bachelor of Engineering (B.Eng.) programme for Industrial and Systems Engineering programs.

ii. Partnerships between academia and industry should be strengthened to drive innovation and commercialisation of research outputs.

iii. Behavioural sciences should be integrated into industrial engineering processes to optimise human interactions with machines, automation, and workspaces.

iv. Training and skill development programs should focus on equipping engineers with expertise in sustainability-driven industrial solutions.
v. Decision support systems should be developed to guide policymakers and business leaders in implementing effective sustainability measures in order to leverage artificial intelligence and automation for efficiency

7.2 Recommendations for the ISE Professional Body

i. Industrial engineers should integrate AI-driven analytics to enhance decision-making and predictive maintenance in manufacturing systems.
ii. Industrial engineers should continue researching multi-generation energy systems to improve efficiency and reliability in energy transitions.
iii. Industrial and systems engineers should contribute to legislative discussions by providing technical expertise for national and international energy policies.

7.5 Recommendations for The Industries

i. Industries should adopt lean and green manufacturing techniques to reduce waste, improve energy efficiency, and optimise resource utilisation in order to promote sustainable manufacturing practices.
ii. Investment in circular economy models should be encouraged to minimise environmental impact and promote recycling and repurposing of materials.
iii. Hybrid energy systems that combine solar, wind, and bioenergy should be developed for industrial applications to reduce reliance on fossil fuels.

iv. Companies should implement data-driven decision models to enhance supply chain efficiency, reducing excess production and emissions.
v. Industries should invest in workplace ergonomics and safety measures to enhance employee well-being and productivity.
vi. AI and machine learning applications should be expanded to enhance predictive modelling, automation, and operational optimisation in industries.

7.4 Recommendations for the Governments:

i. Governments and stakeholders should invest in smart grid technologies to efficiently manage energy distribution and optimise renewable energy sources.
ii. Policymakers should create regulatory frameworks that encourage industries to adopt sustainable technologies and energy-efficient systems.
iii. Collaborative efforts among industries, academia, and policymakers should be fostered to improve the sustainable sourcing and distribution of materials.
iv. Governments should collaborate with industrial engineers to develop resilient infrastructures that adapt to climate change, population growth, and resource scarcity.
v. Urban planning should incorporate industrial and systems engineering principles to optimise transportation networks, waste management, and energy consumption in smart cities.
vi. Funding should be increased for research projects that focus on the application of ISE in renewable energy, manufacturing, and logistics.

7.5 Area of Current and Future Research

Looking ahead, Industrial and Systems Engineering will remain a powerful force for driving sustainable innovation. To stay at the forefront, future research should explore the transformative potential of artificial intelligence in reshaping industrial systems, while also addressing the pressing need for sustainable infrastructure and the development of smart cities. Embracing cutting-edge technologies—such as blockchain for secure and transparent operations, quantum computing for solving complex optimisation problems, and digital twins for real-time system modelling—will be essential. By integrating these advancements, researchers can unlock new possibilities for efficiency, resilience, and sustainability in an increasingly complex world.

Mr. Vice-Chancellor, Sir, permit me to end this inaugural lecture with these final words and respectfully hand over the lecture notes to you.

"Engineering is more than the art of building—it's the courage to imagine a better world, the drive to solve humanity's greatest challenges, and the commitment to turn vision into impact. Innovation finds its true power not in tools or technology but in the hearts and minds of those who dare to create lasting change."

Thank you all for your time and kind attention. May the Almighty God bless each of you abundantly and grant you a safe journey back to your respective homes.

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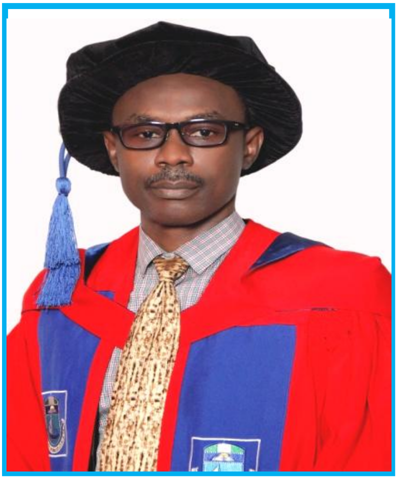

PROF. TOBINSON ALASIN BRIGGS

B.Eng, M.Eng (UPH), PGCert (Newcastle), Ph.D (UNN)
MNSE, COREN, MIISE

Birth and Education

Professor Tobinson Alasin Briggs, born July 6, 1970, hails from Abonnema in Akuku-Toru Local Government Area of Rivers State. He was born into the family of Alasin Gibson Tobin Briggs and Madam Blessing Alasin Briggs (née Ngozi Krukrubo). His early education began at Township State School and Pa Board Modern Primary School, followed by his secondary education at Government Comprehensive Secondary School, Borikiri, Port Harcourt.

Between 1990 and 1996, T. A. Briggs earned a B.Eng. in Mechanical Engineering from the University of Port Harcourt, followed by an M.Eng. in Mechanical Engineering from the same institution. His academic career began as an Assistant Lecturer with the Rivers State University of Science and

Technology (now Rivers State University), after which he pursued a Ph.D. degree at the University of Nigeria in 2006. In his quest for excellence in teaching and research, he furthered his studies, obtaining a Postgraduate Certificate in Advanced Studies in Academic Practice from the University of Newcastle, UK in 2011.

Professional Membership

Outside the university, Prof. T. A. Briggs is a Fellow of the Higher Education Academy (UK) and a member of several prestigious professional bodies, including the Nigerian Society of Engineers (NSE), the Council for the Regulation of Engineering in Nigeria (COREN), and the Institute of Industrial and Systems Engineers. He also serves on the COREN Engineering Regulation Monitoring and Enforcement (ERM&E) Sectoral Committee for the South-South region.

Administrative Experience and Services

Prof T. A. Briggs is the current Dean of the Faculty of Engineering, University of Port Harcourt and the Director of the University of Port Harcourt Technology Park.

- **2025 to Date:** Dean, Faculty of Engineering, University of Port Harcourt
- **2025 to 2025:** Chairman of the University of Port Harcourt College of Continuing Education (CCE).
- **2022 – 2023:** Chairman, University of Port Harcourt Degree Results Verification Committee
- **2017 – 2021:**
  - ✓ Acting Director, Offshore Technology Institute (O.T.I.), University of Port Harcourt

- ✓ Member, Students' Disciplinary and Related Matters Committee

- **2017 – 2019:** Senate Representative, University of Port Harcourt Staff Housing Loan Scheme Committee

- **2016:**
  - ✓ Member, School of Graduate Studies, PhD. Seminar Assessment Committee
  - ✓ Member, Faculty of Engineering Service Unit
  - ✓ Chairman, Committee on Renovation of Engineering Drawing Studio, Science & Engineering Workshop, and E-Library

- **2015:**
  - ✓ Secretary, Faculty Sub-Committee on Integration of Centres/Institutes with Departments

- **2014 – 2018:** Pioneer Head of Department, Mechatronic Engineering

- **2014 – 2016:** Member, University of Port Harcourt Research Ethics Committee

- **2014:**
  - ✓ Member of, the NUC Benchmark Implementation Committee for the Department of Mechanical Engineering
  - ✓ Member, of Mechanical Engineering Laboratories Decongestion Committee

- **2013 – 2016:** Assistant Director, Intellectual Property and Technology Transfer Office

- **2013 – 2015:**
  - ✓ Technical Assistant to the Provost, College of Engineering
  - ✓ Member, Committee on Research & Publications, College of Engineering

- ✓ Member, Board of Directors, CORDEC, University of Port Harcourt

- **2013 – 2014:** Pioneer Coordinator, Department of Mechatronic Engineering
- **2012 – 2014:** Member, of Faculty Committee on the Establishment of a Skill Acquisition Institute

Prof. Tobinson Alasin Briggs has authored numerous research papers in esteemed local and international journals and also serves as a peer reviewer. He is a professor assessor and external examiner for various institutions. He has mentored many graduate and postgraduate students who now hold leadership roles in academia, industry, and beyond, both in Nigeria and internationally.

Research and Collaborations

He contributed to the development of an MSc curriculum in Energy Access and Renewable Energy Technology under the Transforming Energy Access Learning Partnership (TEA-LP), funded by DFID and managed by Carbon Trust UK. Festo Automation also supported the Mechatronics Engineering programme with a robotic simulation arm valued at ₦7.5 million in 2015.

As Director in 2021, he facilitated a major donation of laboratory equipment worth over $700,000 from Shell Nigeria Exploration and Production Company (SNEPCo), in partnership with NCDMB and TechnipFMC, to the Offshore Technology Institute (OTI), University of Port Harcourt. This initiative aims to build a world-class lab, equipping graduates with globally recognised certifications.

He also partnered with PASET’s RSIF program in Energy and Renewables to support the development of UniPort’s

Technology Park Business Policy through the UP-ECOSIN project, funded by RSIF.

His core research as an Industrial and Systems Engineer focuses on optimising complex systems by integrating people, technology, and processes. He explores areas such as operations research, systems design, human factors, and sustainability to enhance productivity, efficiency, and decision-making in manufacturing, service delivery, and other organisational environments.

Family and Christian Life

He is a respected pastor in the Redeemed Christian Church of God (RCCG) and serves in the Technical Unit of the RCCG Rivers Family, where he helps organise training programs. Happily married to the elegant Barrister Rhoda T. Briggs, they are blessed with four well-raised and accomplished children: Prosper T. Briggs, Excel T. Briggs, Bossom T. Briggs, and Greatness T. Briggs.

Mr. Vice Chancellor, Sir, distinguished ladies, and gentlemen, it is my honour, privilege, and pleasure to present to you, our inaugural Lecturer an accomplished engineer, scholar, technocrat, capacity builder, consummate administrator, outstanding techno-innovator, caring and God fearing father, and dedicated husband, who has rendered positive service to this University and mankind - Professor Tobinson Alasin Briggs.

Prof. Owunari Abraham Georgewill
Vice Chancellor, University of Port Harcourt