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Artificial Intelligence (AI) in Engineering Research: An Ethics Perspective

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Abstract

Whilst history shares that engineering is a discipline practised in a social context with engineering projects contributing to the well-being of communities around the world, academic engineering research is the lifeblood and future of any academic tradition and discipline and none more so than for engineering. The importance of academic, engineering research and its direct impact on our daily life cannot be underestimated but what is providing cause for concern amongst engineering ethicists, is the computer technology used by engineers to interpret, analyse and communicate their results from their academic research.Whilst we can marvel at the design and utility of Brunel's Clifton Suspension Bridge a first of its kind in Victorian times, have perhaps personally enjoyed the thrill of flying supersonic on Concorde, daily drive a car built by robots and make continual use of a laptop in our professional and personal life; we can equally appreciate the ground-breaking engineering research carried out by those involved in the Manhattan project and the way in which it was used to bring about an end to World War Two and the engineering research that led to landing a man safely on the moon in 1969. However, in so doing, perhaps what we have failed to consider is the level of direct human involvement in these engineering examples. Historically, academic engineering research has been facilitated by human interest and the need through direct application of engineering breakthroughs to improve daily life. Such engineering innovation has undeniably been the direct result of human effort, intellect, foresight and vision with technology playing a supporting role, rather than a leading role. This paper examines the ethics of undertaking academic engineering research in contemporary times and the challenge artificial intelligence (AI) presents to the critical need to maintain academic excellence and intellectual and research integrity in the pedagogy and output of this academic discipline through human interest, abilities and facilitation.

Keywords

Intellectual integrity, engineering, research integrity, academic excellence, Artificial Intelligence (AI).

1. Introduction

Albert Einstein (2023) perhaps the greatest scientist of the twentieth century is reported to have said; *"The human spirit must prevail over technology"* which for many concurs with the sentiments of Schwab (2016) who suggests;

> *"The big challenge for most societies will be how to absorb and accommodate the new modernity, whilst embracing the nourishing aspects of our traditional value systems. (2016:97)*

It is perhaps this sentiment veiled in moral philosophy that strikes a chord in the hearts of engineering academics as we look at the future of academic excellence and intellectual and research integrity in our discipline, both arguably battling on the front-line of technology and its associated ethics. To this end, many contemporary engineering researchers find themselves at the intersection of the legitimation of technology and the extent of the digital resources now available to them and the ethical dilemmas even ethical conflicts that can arise with regards to how and when to use them during their academic research.

In light of this, we are facing a situation in which engineering academics are facing ethical challenges already foreseen by Enriquez (2020) when he suggested that;

> *"Technology changes ethics, it challenges old beliefs, it upends institutions that do not grow and change"* (2020:6)

This paper examines how engineering academics can maintain academic excellence while ensuring research and intellectual integrity in the age of artificial intelligence (AI) This is required so that engineering researchers can undertake and share their findings and discoveries with peers, publishers and the world at large.

2. Objectives and Approach

In trying to successfully untangle the key elements of the question posed by this paper which speaks to the ethics surrounding the use of AI in engineering research, the optimal course is arguably to deconstruct the three key components that need to be considered namely;

1. Academic excellence
2. Intellectual and research integrity
3. Artificial intelligence (AI)

These three constituent parts will in turn be shaped into the key objectives of this paper which are to;
-Explain the meaning of ethics within the context of academic research.
-Explain the meaning of both academia and academic excellence.
-Interrogate the meaning and application of intellectual and research integrity by engineering researchers.
-Outline the use of AI in engineering research.
-Outline the impact the use of AI can have with regards to the research journey and intellectual and research integrity of research produced by engineering researchers.
These objectives are explored and discussed based on the relevant/appropriate literature.

3. Literature Review

3.1 Philosophy & Ethics

The etymology of the word philosophy speaks to a 'love of wisdom' and its history as an academic tradition stretches back to Classical times. Moral philosophy or ethics has been described and understood as applied philosophy and it is for this reason, that it has transcended time and continues to shape both the human life and the human condition in both professional and personal capacities.

Balckburn (2002) provides a definition for moral reason that suits the remit of this paper. He proposes that;
"Philosophy is certainly not alone in its engagement with the ethical climate. But its reflections contain distinctive ambition. The ambition is to understand the springs of motivation, reason and feeling that move us. It is to understand the networks of rules or 'norms' that sustain our lives. The ambition is often one of finding system in the apparent jumble of principles and goals that we respect, or say we do" (2002:5)

From this, it is straightforward to see how the subject of engineering research and the importance of academic excellence and intellectual and research integrity is challenged in the age of AI, 'as principles and goals' that have formerly been the mainstay of engineering research are actively being challenged. It will be the aim of this paper to dispense with the 'apparent jumble' surrounding academic engineering research, in favour of clear 'goals' to which future engineering research should comply if academic excellence and research and academic integrity are to be maintained.

3.2 Academia and the Academic

The Collins (2023) dictionary defines academic as;

> *"...describing work or school, college or university that places emphasis on studying and reasoning rather than on practical or technical skills".*

Whilst this definition is for use in current times, there are obvious connotations with the word academic and academia and the much vaunted 'Academy' founded by Plato on the outskirts of Athens in 387 BCE for the express purpose of providing his followers and students with confirmation of his notion that knowledge could be gained and sought through observation. It was not just the result of inner reflection.

Considered to be the first 'university' in the Western world, the curriculum of the Academy, consisted of philosophy, science and mathematics, and subjects taught extended to astronomy, politics and ethics. As is apparent by the scope of this ancient curriculum, both practical and technical skills were required by students, particularly those undertaking studies in what we now know as 'hard' sciences, so the definition of academic as provided by Collins can be seen to be inadequate in both ancient and
contemporary times where practical and technical skills are paramount in academic disciplines involving 'hard sciences' such as engineering.

Aristotle (Plato's pupil) also set up his own university called the 'Lyceum' in 335 BCE whose focus, aside from the curriculum established by Plato, was what we now call 'co-operative research'. Aristotle's library at the Lyceum provided the source and references for the assigned research projects undertaken by students and formed the basis of what has now become a fundamental pillar in modern academic studies both for the student in terms of gaining universal recognition for their studies by the awarding of a degree and the career academic in terms of collegial recognition and the rationale and support for their academic promotion. Additionally, contemporary tertiary institutions actively encourage research activity by their academic staff, as both the amount and quality of their research output, directly impacts the institution's local and international rankings. In short, research is central to the professional life of every academic and the academic institutions they serve.

3.3 The Engineering Research Approach: Academic Excellence

In undertaking research, there is broadly speaking two main approaches namely positivism and interpretivism (Ulz 2023) Engineers invariably use the positivist model/approach that employs quantitative methods, rationality and induction and has been defined by Leedy & Ormrod (2015) as an approach that believes that;
"...with appropriate measurements tools, scientists can objectively uncover absolute, undeniable truths about cause -and -effect relationships within the physical world and human experience" (2015:25).

The use of this approach speaks to the academic discipline's acknowledgement and use of the three types of knowledge identified in Greek philosophy namely; epistemé, techné and phronesis.

Jonsen and Toulmin (1988, 58-59) describe 'epistemé' knowledge as the; *"theoretical comprehension of abstract arguments in the sciences"* whilst 'techné' knowledge is defined by them as a *"...practical command of general craft techniques"*. The final type of knowledge recognised by the Greeks is 'phronesis' or 'practical wisdom' which arguably very often acts as an arbiter for engineering research in which the impossible and impractical in research is countered by its engineering application, resulting in the possible and practical. Such is the engineering researcher's academic skill set.

Such research undertaken by engineers draws upon observation, analysis, logic and mathematics and draws its strength from empiricism and the principle of 'verifiability' and 'predictability'. A definition of academic research that encompasses both the classical understanding of knowledge and the pragmatic approach to experimentation outlined above that accompanies contemporary engineering research has been provided by Speak Ai (2023) who suggest that;

> *"Academic research is the systematic process of collecting and analyzing (sic) information in order to increase our understanding of a particular topic or issue. It is used by academics, postgraduate students, and professionals to answer questions, build on existing knowledge, and generate new ideas. Academic research is a long-term, rigorous process that requires an organized, methodical approach."*

The work of Lester and Lester (2015:21-22) concurs with this definition, but the authors also suggest there are seven important criteria associated with academic research, whose purpose with regards to improving the skills of the engineering researcher is to;

1. Teach methods of discovery.
2. Teach Investigative skills.
3. Develop inquiry-based techniques.
4. To build career skills.
5. Teach critical thinking.
6. Teach logic.
7. Teach the basic ingredients of argument.

Such is the substance, goals and principles of academic research and the skills it is expected to develop in academics. From this it is proposed, comes academic excellence.

In focusing on scientific academic research, Pickering (1993) somewhat boldly asserts that; *"...from science comes prediction; from prediction comes action"* (1993:566) and whilst as an ethicist, the author would challenge this assertion on the basis the recognition of 'values' can also be a certain spur to action, Pickering's words 'ring true' for many discoveries arising from and within engineering research. This is especially evident in the fourth industrial revolution (4IR) in which we are seeing a rapid adoption of technology with its resultant 'action' in and for contemporary life.

However, what must not be forgotten, is that irrespective of the research approach used and data interpreted and metrics analysed, the pedagogy and process of academic research is the same for both engineers and their scientific and quantitative research and those undertaking their evaluative and qualitative research in the humanities. For both research types, a systematic investigation follows rigorous predictable and consistent steps to study material facts and sources in order to reach a new understanding of existing information/knowledge or to discover new information and the resulting knowledge.

As such, in academia, emphasis is upon academic excellence in terms of the method of investigation, the assessment of the facts uncovered by the researcher and the quality of the research that is eventually presented and published. In other words, academic

research is premised on the condition of it being an example of academic excellence, not just owing to its content but the process and methodology undertaken by the researcher and subsequent endorsement hopefully provided by peer reviews and publishers.

3.4 The Engineering Research Approach: Intellectual and Research Integrity

The Latin etymology of the word 'integrity' speaks to 'wholeness' and has been expanded upon by Beck (2021) to mean *'whole and undivided'* and arises from *"...a deep sense of truth"* (2021, xvii.) which by implication suggests honesty. Beck (2021) further surmises that; *"Integrity is the cure for unhappiness"* (2021, xvii) and whilst the author would not choose to embrace integrity as the sole means for banishing unhappiness, integrity is one of the Aristotelian (1961) moral virtues and as such is proposed to be an acquired 'excellence' that when practised leads to eudaimonia or 'ultimate happiness'. Such 'ultimate happiness' or 'well-being' has been interpreted as vital to the 'good life' by philosophers and classical moral philosophy proposes it is something that every individual pursues as they seek the inherent need to 'flourish' and in so doing experience and achieve a sense of 'well-being'. Academics are no different.

Virtue ethics is a normative and consequential, ethical approach, that is character based and although predicated on the individual, is not without a sense of and use for the collective. Initially proposed as a self-help guide for future statesmen, the Aristotelian virtue ethics approach has transcended time and can be equally interpreted for the purposes of this paper as providing an important understanding for 'guiding' the individual engineering researcher to acquire virtues such as integrity and thereby exhibit virtuous behaviour. Equally, virtue ethics can 'guide' the collective engineering research community through their acquisition of moral and intellectual virtue(s). This engineering research collective includes not just the individual engineering researcher, but their respective academic institutions, academic peers and publishers of academic research papers and books, all of whom seek a continued sense of 'well-being' and 'flourishing' through the constant pursuit and attainment of academic excellence through the virtue of integrity.

However, 'integrity' is not the only moral virtue required by an engineering researcher if academic excellence is to be achieved. Virtues such as academic rigour, tenacity, inspiration, competency, perseverance, patience and courage are all equally important if academic excellence in engineering research is to be established, encouraged and expressed by the engineering researcher alongside the notion and reality of 'truth'. All such virtues assist the engineering researcher in the process and methodology of their research which via their research journey helps to create both context and meaning for their research project and their results. Of note, is that none of the moral virtues mentioned above are present in AI technology, which is machine-based and in its current design and application, is without the capabilities of moral or emotional intelligence, humour, or the notion of integrity. In short machines lack a conscience or moral compass unlike their human counterparts and thereby there is an absence of an understanding or notion of what is 'right'; 'wrong'; 'good' or 'bad' in accompanying activities. In other words, put simply, machines demonstrate a clear

absence of ethics and those machines and programmes that fall within the ambit of AI are not immune to this circumstance.

3.5 The Engineering Research Approach: Artificial Intelligence (AI)

As shown earlier, academic research in engineering can be seen to be at the forefront of new discoveries and knowledge for this academic discipline and if we were to use the metaphor of a road journey for the pedagogy of the engineering research method and process, we could arguably identify four key pit stops in the research process. (See Figure 1)

1. The search for academic sources
2. The assessment of academic sources
3. Conducting experiments, reviewing theories, collaboration, coding, imaging and writing-up research.
4. Submitting research for peer review and to publishers for publication.

Yellow Flag = Pit Stop 1

Green Flag = Pit Stop 2

Blue Flag = Pit Stop 3

Red Flag = Pit Stop 4

Figure 1. The Academic Research Journey with 4 Pit-Stops (Tartila.Adobe Stock Images)

Interestingly, at each of these 'pit stops' lies an opportunity for the engineering researcher to interface with AI both directly and indirectly.

Whilst the use of certain AI programmes has served research well in the engineering field, especially in terms of coding, imaging, identifying plagiarism and reviewing lapses in grammar, spelling and other academic protocols; concern reigns with the advent of what is referred to as artificial generative intelligence (AGI) and the expanded use of natural language processing (NLP) and the use of interactive language-based models such as ChatGPT. The latter challenges not only the pedagogy of the research process but also the originality of the final research and the intellectual and research integrity of the researcher. When used, ChatGPT can negatively impact the relationship between the engineering researcher, their academic peers, their academic institution and their academic publisher. Indeed, it can even lead and extend into a situation in which academic excellence, and academic and research integrity have been put on notice pending a lack of trust and an agreed governance framework in both tertiary institutes and the publishing houses to identify the use of AGI. If an agreed governance framework could be agreed upon by all parties and enforced, then non-compliance by researchers could attract agreed penalties.

The acronym TESCREAL proposed by Torres (2023) stands for; Transhumanism; Extropianism; Singularitarianism; Cosmism; Rationalism; Effective Altruism and Longtermism, This goes a long way to helping explain the 'techno-utopian' vision of the future that programmers in Silicon Valley would have us adopt, but which seems to be at odds with our current pedagogy of academic research and academic excellence and our understanding of research ethics and the need to acquire Aristotelian virtue(s) in the research process. The broad-based use of a Utilitarian approach by the programmers and developers of AI, whereby the individual researcher (in the truest sense of the word) is marginalised in favour of the 'greater good', does not serve either academic excellence or research and intellectual integrity well. Indeed 'techo-ethics', a relatively new study within the discipline of moral philosophy, examines the relationship between machine and humans in terms of its benefits and shortcomings focused in the main around notions of; personhood, human dignity, and the broader issues of social and legal issues such as privacy, bullying and abuse. Needless to say, this approach has found fertile ground within the context of AGI which stands accused of possessing each of these shortcomings and not just when adopted within the context of academic research.

Ethicists have successfully argued the lack of beneficence arising from the use of ChatGPT in academic research which can be seen to actively challenge, and in some cases, even subvert both the notion and reality of academic excellence and research and intellectual integrity owing to its technical and language capabilities. In so doing, not only does it challenge the truth as it has been claimed by Ganesh (2023) that ChatGPT, "*...can generate coherent and engaging text on almost any topic"* (2023) but also the authenticity and the unique 'voice' of the engineering researcher that should accompany their final research product. Moreover ChatGPT, dispenses with the pedagogy long associated with academic research and through a series of short-cuts, aims to produce a final piece of research that if compared with previous research from the same engineering researcher undertaken before late 2022 can stand accused of possessing none of the 'human' nuances expected and associated with their final research product, nor encompass any of the virtues associated with the engineering researcher who successfully undertook such academic research.

3.6 The Use of Artificial Intelligence in The Research Process

It has been claimed that AI can arguably be seen to 'shadow' the human effort. This is evident in engineering research specifically when it comes to sorting, assessing, coding and reviewing both sources and the content of the final research paper.; essentially processes contained in pit-stops 1 and 2 of the engineering research journey.

To this end, it could be argued that AI software such as Grammarly, Mendeley, Zotero, EndNote, Coggle, Trinka and Turnitin, when used responsibly, can benefit both existing academic research pedagogy and the engineering researcher actively pursuing their research. In short in such instances, the responsible use of any or all of these AI models is best viewed as a time-saving resource for the engineering researcher that mirrors activities associated with human research activity which serves the method and process of their research well. In taking on the broader functions of improving accuracy and providing an accessible means of compliance with academic conventions and protocols, AI can also bring about a positive influence on the research process, particularly in areas such as plagiarism, collective brainstorming, referencing, citations and review.

However, it is when one comes to unique writing skills, imaging and coding abilities in pit-stop 3 of the engineering research journey that AGI such as ChatGPT creates a very real ethical dilemma/conflict in terms of directly challenging academic excellence and academic research and intellectual integrity.

ChatGPT employs 'natural language processing' (NLP) This manifests as an interactive large language-based model (LLM) that employs human interaction in the form of feedback. The dialogue format between user and AI Chatbot has been further entrenched using 'reinforcement learning from human feedback' (RLHF) which has provided an understanding between user and Chatbot that allows greater clarification to expose ambiguous queries and provide greater clarification between user and AI enabling increased accuracy of responses and a more acceptable end product. The result is an AI generated piece of research incorporating AI generated code, images, algorithmic bias and words that lacks researcher authenticity in addition to academic and intellectual integrity. Neither does AI generated research provide the researcher with insight, self-reflection or showcase critical thinking which are the expected by-products of the academic research process and resulting academic research.

Indeed, not one of the seven skills identified by Lester & Lester (2015) can be gained by an engineering researcher if their academic research is subverted by the use of AI in pit-stop 3 of the research process. Such skills are not required by a machine

'prompted' to 'fine tune' and perfect the final research product. Such skills are focussed towards the individual engineering researcher and their development in terms of academic excellence and their intellectual and research integrity.

4. Conclusion

It is perhaps to MacIntyre (2002) the contemporary philosopher who has revived the study of Aristotelian virtue that we
find ourselves intrinsically drawn when viewing contemporary dilemmas in academic research in engineering. Even more
so, when navigating the difficulties of marrying the integrity of the method and process of academic research alongside the abilities of contemporary technology and AI models in particular. MacIntyre exhorts;

> *"Each of us therefore has to choose both with whom we wish to be morally bound and by what ends, rules and virtues we wish to be guided." (2002:259).*

To this end, we have to ask; "Do academic engineering researchers wish to be 'bound' to a machine with an absence of virtue and morals, or do they choose to be virtuous and be bound by a sense of the unique and original as they undertake their research? We are also required to ask, "Do engineering researchers have a clear vision of the virtues, most notably personal and academic integrity, they want and need to acquire to achieve academic excellence?

Very often such questions are dependent on the the academic approach to research engineers decide to use as their research methodology. Zukaukas, Vveinhardt and Andriukaitiene (2018) in their paper; "Philosophy and Paradigm of Scientific Research" suggest there are three main approaches to academic research namely; the positivist approach; the pragmatist approach and lastly the realistic approach to research.

They define these as follows. Positivist research they propose disassociates itself from "personal values and works independently" whilst Pragmatist research "deals with facts and claims" and "the choice of practical results is important" whilst finally when defining the realistic approach to academic research they suggest it is; "based on positivist and interpretivist research philosophies" If so, do they have an equally clear vision of what 'rules' (governance) they are prepared to follow to produce research that highlights new discoveries and ethically expands our knowledge, whilst simultaneously often serving to define our understanding of existing knowledge?

The 'guide' referred to by MacIntyre (2002) is often in the guise of the Research Ethics committees in tertiary institutions who create and enforce the governance frameworks for the research undertaken by academics within their walls. These committees are currently experiencing severe challenges when attempting to create workable and relevant governance and compliance frameworks for academic research. The cause is the everchanging technological landscape that continues to produce hundreds of generative AI models with cognitive abilities. Not only can these models solve tasks and find solutions without human intervention, but alarmingly produce written research containing work, images and coding that has not been undertaken by the researcher, thus stifling and at worst dispensing with the need for academic, excellence and intellectual and research integrity for those who choose to use it. Moreover, technology almost always seems to be one step ahead of those hoping to unmask its use - such is the landscape that Research Ethics Committees are trying to navigate and harness; often with little success.

The development of research governance frameworks is both complex and time-consuming for those tasked with the job. The prospect of research assisted by technology is upon us. The task of research ethics committees in tertiary institutions is to sift through the capabilities of individual AI applications in an effort to decide which assists the academic researcher and which transgresses intellectual and research integrity and therein negatively impacts academic excellence.

However, as mentioned previously in this paper, AI models still lack the inspiration and competitive nature that often drives both academic engineering research and the engineering researcher to scale not just new heights in engineering – but to succeed. Neither does AI possess the courage and tenacity often associated with such research that can sometimes lead the academic researcher to not just breaking new academic ground but questioning existing engineering research and engineering research results. Moreover, intellectual virtues such as competency, intellectual rigour, and originality, bring a nuance and authenticity to academic research that will always be a mainstay of the academic effort and academic excellence in the discipline of engineering.

In short, it is hoped the virtue of academic integrity will continue to guide both the pedagogy of research and the engineering researcher. There will always be an inherent need for the engineering researcher to find their 'own voice' as they share their research with the academic community either in conferences or through publishing in academic journals. In the latter, peer review and publication help to establish an academic reputation for the researcher, built upon the trust, quality, truth and authenticity of the research presented; in other words - academic excellence through intellectual and research integrity. Establishing this relationship of trust between an engineering researcher, their peers, their academic institution and their publisher is dependent, as suggested, upon the Aristotelian virtues of honesty and truth which we know are the building blocks of integrity. These virtues provide engineering research with the opportunity to create and share new beginnings. New knowledge can be shared within the academic community and beyond, predicated upon them.

The future for governance frameworks of both tertiary institutes and academic publishers should arguably be fast-tracked and be synergistic to the extent that academic excellence can be quantified and intellectual and research integrity formalised in an ethics framework. This will preclude the indiscriminate use of generative AI models such as ChatGPT that stands accused of denying academic excellence and most importantly denying intellectual and academic integrity.

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Biography

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