The Price of Progress? Assessing the Impact of Artificial Intelligence on Systems Engineering Education

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Abstract

The advent of Artificial Intelligence (AI), especially Generative AI (GAI), could have both advantages and disadvantages for the education sector. In a positive sense, GAI allows faster more comprehensive searching for information and may facilitate the development of models and concepts at a higher tempo. In a negative sense, however, AI generated content, which might pass as the work of a human, could be submitted by unscrupulous individuals as their own work. This threat to original insight and thought is a challenge to the integrity of educational qualifications. Beyond content generation, however, GAI could pose more existential questions for the andragogical process and provision of education. In the field of Systems Engineering (SE) education has, to date, focused on the application of concepts, principles, modelling techniques and related ideas to finding the best possible solution to problem situations in engineering and business. The advent of GAI could have the effect of changing this paradigm; does such technology confer SE ability on those with the ability only to construct the cleverest "prompts"? Can GAI under the right circumstances be used to determine the most appropriate models and approach to solution development and, if so, will higher-order functions be lifted from the human "operator"? If so, where does the human add value in the subject? In the light of these questions, will GAI fundamentally affect how SE should be taught? This paper assesses these questions and proposes andragogical ideas for the constructive use of GAI techniques in SE education.

Keywords: artificial intelligence, systems engineering, education

Introduction

The impact of Artificial Intelligence (AI) is a subject which is of interest or concern to all of us in education to some degree, whether it be positive anticipation of the teaching benefits that AI might offer or it is concern for the potential impact on our students' cognitive abilities.

In our own subject of Systems Engineering (SE), we consider that AI will be used in aspects of practice and of education, but we consider that as SE is so dependent on novel ideas and innovative solutions, an overreliance on AI might result in limited creativity—it might result in new arrangements of existing elements to update an existing solution rather than finding a radical new solution or even identifying a new root cause of the original problem.

To understand why that might be, it is necessary to understand a bit more about our subject and Systems Engineering is not a name that does us any favours. In fact, it may well put many people off. Certainly, the subject deals with *systems* but *engineering* in our case is in the broadest sense of the word—"purposefully designing or arranging" might well describe what we do and that can be applied to all manner of systems from huge governmental systems down to hard product-systems. We are in the business of problem solving; of "engineering" some form of solution to satisfy a user's need.

Importantly, SE is a pan-disciplinary approach; Systems Engineers seek to bring together teams with a range of skills to solve the problem at hand. As SE rises from a number of disciplines, it has inherited its characteristics from a number of forebears. Some of that heritage is use of graphical methods to articulate ideas about the system we are investigating. Again, this is a creative activity and the impacts of that we shall consider later.

Overall, SE is an explorative and creative activity with a large human component, and these factors might well be key to how AI is able to be used to best effect.

In addressing the potential implications of AI for SE education, this paper will: identify why the rise of AI might present a problem for education in general and Higher Education (HE) in particular; look at the particular nature of SE education and consider whether there are specific issues as a result; consider the nature of masters level education and the challenges posed by AI for higher order thinking at this level; conclude by considering the specific threats and opportunities raised by AI in SE education. A precis of this paper, in this same structure was delivered as a recorded presentation in the European Conference on Education in London 9–13 July 2026.

Genesis of the Problem

Whilst at the start our study, we concerned ourselves with the challenges facing SE education, even the most cursory exploration of the problem space shows that AI is not only an issue for SE nor only for the education sector—it is something which is impacting every aspect of life in the developed world.

There is an idea in systems theory that a change in one part of a system causes change in all other parts of the system (Hall, 1956, as cited in Chestnut, 1967). This is an important idea as we also need to recognise that most systems are "open"—that is to say that they interact with their environments. We can easily see that this means that a change in business practice or students' "schema" of prior experience will have an impact on education and the "customer

need" that we need to fulfil. To understand the needs of our students, then, we need to consider both the motivations of the students in entering HE and also the expectations at entry, based on their prior interaction with the educational and wider societal *(system) environment*.

There have been many societal changes in recent years and there has, in the UK, been a huge increase in the proportion of people going on to Higher Education. Uptake of university places rose in the UK by 174% between 2002 and 2002 (Carasso & Plume, 2023). This is mirrored around the world and "UNESCO's first Higher Education Global Trends Report shows that the number of students enrolled in higher education worldwide has more than doubled over the past two decades, reaching 269 million in 2024" (UNESCO, 2026). In the UK at least, this increased level of education at input to the workforce has created intense competition for jobs. As a result, students are looking for a direct improvement in employability as an outcome of studying for a degree.

Students come to HE already well experienced in the use of AI; they are what has been termed "digital natives". Staff in HE are, by comparison, more likely to be "digital immigrants". They are, by comparison, likely to be coming to AI and other new ways of working long after they learned their craft (Prensky, 2001). Staff are more likely to view education as valuable for its own sake, rather than as a means to get a job (Naylor et al., 2021) and in this context may view the use of AI as a threat to deeper learning rather than an enabler to acquisition of a workplace advantage. So, the prevailing debate on the use of AI in education might be: Have the changing needs of students and universities created a mismatch in expectations?

So, we have established a reasonable proposition that in a world which moves at pace and in which many consider that AI will always be available in the workplace, students are quite naturally focussing on outputs, not journeys. This is entirely understandable as almost every other aspect of daily life encourages students to "outsource" activities to AI assistance—from visually searching an item using the mobile phone camera to asking for rapid summaries of all manner of information which would previously have taken hours or days to research.

So, with the incredible capability that AI provides, and noting that there has been a widespread concern about its use in HE, are academics playing "King Cnut"—the ancient British king who tried to hold back to tide by force of his will (Henry of Huntingdon, 1996, orig. pub. 12th Century) and is forever cited as an illustration of futility. Are they setting themselves up as "Gatekeepers" when all can see that the tide of modernisation is about to sweep them away?

To put this in context and to avoid dying on a hill of their own making, academics need to consider what is important in education. Most recent concern in academia seems to have focussed on the ability of students to produce acceptable responses to assignments by using AI and, as a result failing to learn the material that those assignments were intended to assure. This neatly exposes the challenge faced here—teachers in HE are worrying about the continued ability of current assessment methods to *substantiate* learning as a result of a change in our *system* which has already occurred, rather than worrying about the bigger issues of getting students to learn or even whether the intended learning is still appropriate for students in the changed system.

At its worst, we could see this as a change in demand from our students; a desire to be trained for the workplace rather than being educated for a changeable future. But, if the system has been changed and pre-employment training is in fact what the intended beneficiaries of our service require, should we acquiesce? Alternatively, ought we to revisit education beyond

assessment and focus on teaching and learning and consider whether AI can assist there, and whether they will remain broadly applicable in a way that will see education in an unchanged set of disciplines or whether education might be more appropriate in some subjects or to a changed target audience.

Finally in considering the challenge posed to education in general (before considering SE specifically) it is worth considering the danger of adopting a parochial, even defensive viewpoint. There is of course, a temptation to see one's own subject as being special; uniquely complicated and exquisite. At this point we might do well to heed the admonishment in *How Big Things Get Done* by Flyvbjerg and Gardner (2023), in which they point out that "your project is not unique" and that if one looks hard enough, it will fit into a "class" of project from which lessons can be drawn. Bearing this in mind, it is probably true that there are points which can be read across between SE education and that in other subjects, if we can see common factors.

Systems Engineering Education

In understanding the SE educational offering across Europe and the US it is interesting to note that there are many domain-centric systems engineering courses and relatively few system-centric SE courses. By that I mean that there are lots of courses or courses which deal with systems of some specific type, for example Computer Systems Engineering rather than "pure" SE courses based on systems theory and specific techniques like Model Based Systems Engineering. As previously discussed, SE as a problem-solving discipline as opposed to traditional engineering.

Equally there are, in Europe at least, few bachelors' degrees in pure SE and more MSc programmes. Where there are BScs in Systems Engineering in the UK, they are in essence broad based "hard" engineering courses with a Systems "overlay", though with a 3-year full time or 4 year "Sandwich" course, there is plenty of time to cover SE content which has, 'til now been delivered as an MSc "top-up" to current practitioners. For the wider adoption of SE, then, this looks like a good thing, and those courses will face the same problems of protecting original thought and critical thinking in the same way that the "systems centric" courses do.

Experience in Cranfield University—which runs one of the most established SE courses in the UK—many, if not most students come with workplace experience of SE. Those students also report that many of their contemporaries have no formal education in SE but have come across from allied disciplines (in line with our original "pan-disciplinary" definition). So, anecdotally, a significant proportion of SE practitioners have no formal *education* in SE, though may have had *training*, especially in the use of specific software tools.

Both in Europe and in the US, a surprising proportion of establishments delivering SE are linked to government and defence. This is, perhaps, unsurprising as SE theory developed largely in the aerospace and defence sectors. We do not perceive that this will impact how AI in SE education needs to be handled, but there are likely to be other educational anomalies of courses in Military Universities which would bear investigation, including easier control in start standards in the student body, for instance, though that is out of scope for our study.

Reading course descriptions from universities on websites shows many courses both in Europe and the US stress the practical aspects of their courses with "applied", "project", "group work" and "hands on" being common phrases. Another term which appears regularly is "innovative".

This is hardly surprising as the problem-solving nature of the discipline and in the common customer groups of aerospace, defence to some degree transport systems are all seeking to exploit cutting-edge technology in their engineered systems.

Importantly, SE involves a significant degree of analysis even to the point where the Systems Engineer defines for themselves what elements constitute the system—boundaries are not always defined in the real world and ruling elements in or out fundamentally affects the questions asked and the solutions offered. This is *creative* activity.

Finally, Systems Engineers often communicate their ideas visually—the syntax of the languages is clear, but the product, like writing, is a thinking process where ideas and diagrams are developed simultaneously. Again, this creation, often collaborative, is a cognitive process. The experience on Cranfield courses to date is that students have experimented with the use AI to generate SysML diagrams. But have had little success. The diagrams produced contain the elements specified in prompts, but the illustration of how the elements interact does not work, even when specified line-by-line. Of course this may improve over time, but the point previously made about writing, that thinking the text into being is a creative activity in itself, might equally be read across to drawing the SysML diagrams—getting a visually appealing result that we do not understand will still not get us closer to the truth.

Taking these factors together, we can see a building pattern of relationships with a dynamic human dimension, and a need to encourage and *practice creative thought*.

Artificial Intelligence and Masters' Level Education

There is no doubt that AI can answer questions quickly and *convincingly*. Those who possess a talent for "Prompt Engineering" can research topics quickly and effectively. This is now part of everyday life for most people involved in the field of HE. However, what has caused concern in many instances, is that convincing is not necessarily the same as correct and this raises the issue of trustworthiness. Applied to an extensive canon of knowledge AI can create valuable and accurate summaries of a subject area, saving a great deal of time. However, where the body of knowledge is less extensive results are less reliable and one known problem is "hallucination" which refers to generating imagined or incorrect content (Alqahtani et al., 2023).

AI tools offer promising formatting, style-checking and editing solutions. Used sparingly abilities can help a student to concentrate on their own research of the topic area and on critical analysis. However, overuse can be disadvantageous as the act of writing is inextricably linked with thinking (Hurley, 2026) and, by implication in an educational context, learning. Where the use of AI is intended by the student to lighten the burden of thinking, learning is likely to suffer and as Alqahtani et al. observed in their 2023 article "(Relying) on AI-generated text to start writing research outside of your expertise may limit your thought process…, potentially hindering your creativity and unique ideas". This same sentiment is echoed in creative industries and, reflecting on the impact on literature, Dr. Clementine Collet noted in her 2025 paper that AI had a place "simplifying non-creative tasks" or that it might be able "to do our admin tasks so that we can focus on the creative aspects of the industry" (Collet, 2025).

The speed of change will be hot and, in many cases has already happened. In the experience of the authors, AI adoption across the student body has been balanced across cohorts, with no particular business sectors seeming to lead or lag. Anecdotally, businesses which resisted AI

adoption in 2022/3 to prevent erosion of intellectual capital gave ground in less than a year and did not founder, as both customers and competitors were changing with them. The ability to use AI effectively is assumed in the student body and the acceptability of use in an educational setting, other than for written assignments, is assumed.

What we do not see changing in SE is the requirement for original thought to both conceive the system to be worked on and to identify novel solutions. This latter point is important as current AI works on trawling previously generated knowledge to apply a similar solution. In this case, finding novel solutions is not a possible use of current AI. This then is where SE finds its "class" (referring back to Flyvbjerg and Gardner's idea in para. 2, p. 4)—use of AI in practice and, therefore, most likely in education will be in common with creative industries (not just artistic ones) which rely on creating completely novel ideas for their ability to progress.

In SE teaching practice at Cranfield University, we have not been immune to concerns regarding use of AI by students. Initially, we observed similarity in approach across class group essay submissions. Whilst an initial assumption might be conferring between student, a simple investigation revealed convergence as a potential indicator of Generative AI use—students using similar prompts (cued by the question as set) will generate very similar answers from the same available data—AI is working on simple probability, not original perspective. This is easily addressed with students by raising the issue that the similarity can be detected. However, this still leaves the question as to whether essay style assignments are tenable as the majority form of summative assessment. Furthermore, there is a potential cost impact of employing AI detection software, not least in the potential costs of dispute resolution.

In a similar vein, there have been instances of referencing which appeared to have facets of "Hallucination" mentioned earlier when addressing the potential use of AI in research. Imagined "References" combine known authors with credible titles, but attempting to follow links can lead to dead-ends or tangentially relevant material. Again, this issue is easily remedied by application to detailed marking and enforcement of the rules. However, it is worth consideration of whether the conflicting requirements of academic development and the students' desire for career enhancing skills are at odds here. In a time where there is no shortage of information and many students might consider that getting to an answer is more important than the journey in getting to it, perhaps the appetite for lengthy research is waning. In that case, perhaps there is a place for skills based short courses for students who prefer that approach, leaving only the more academically inquisitive to undertake long-form degrees. This is counter to the direction of HE in recent years but in a changed context and an era of cost pressure for students, perhaps change is inevitable.

This last point brings us back to the issue we identified when considering "mindset" at the beginning. In SE terms, the environment in which we are operating has changed (advent of ubiquitous AI) and the and our "capability" to achieve our goals (assessment to assure learning) has been degraded. As a result, we have options. Two obvious ones are to: a) reinforce the current assessment method to achieve assurance despite AI or b) to change assessment methods to favour deep understanding and changing our "study skills" teaching to encourage exploitation for the new and powerful AI toolset. It might be hoped that this would support development of a problem-solving mindset—the affective domain of SE learning.

It would be tempting to fall back on old assessment methods which defeat the use of AI; a return to examinations. This is, however, fraught with issues and recent Cranfield experience

is that students are resistant and this to the point of protesting to staff that exams, even supported with access to the students own physical (hard copy) notes were unrealistic in the modern era, where open access to online search will always be available. Add to that the observation that exams are not well suited to the higher orders of Bloom's Taxonomy (Bloom, 1956), and traditional exams may not be the panacea that one might have hoped.

Another option is oral exams or Vivas. Cranfield University currently use these on some courses, though no longer in SE. There are issues with the time taken to conduct significant oral exams, but Vivas to support a written submission are a viable option. Importantly, they address the observation that students who use AI for *writing* often have poor recollection of their argument and are unable to quote their own submissions directly. A viva could, therefore, be a way of detecting use of AI in creating the original, written assignment. Much more than this, however, and what we as educators might more properly be interested in, preparation for a viva might encourage the deeper learning we are trying to foster. However, such a change is significant and comes at cost—both financially and on a human level and such a change would need proper consideration.

What we have concentrated on thus far has largely been teaching and assessment. If we are able to design assessment so that it focusses on understanding and an ability employ ideas in creative ways in real time, then we could incentivise students to use AI to learn rather than answer. As far back as 2023, there was academic consideration of using AI as an interactive tutor, led by the learner (Limo et al., 2023). Anecdotally, students are now using freely available software to coach themselves through all manner of life's challenges—from job interviews to exams, so if this is being done without teachers input, the question might be whether educators need to direct or encourage this activity or whether that can be left to learners themselves. In any case, there is probably a need for staff training (back to "digital immigrants") and the best universities are already doing this (University of Oxford, 2025). One interesting recent development has been the advent of applications which can turn text into a virtual, interactive podcast (e.g. NotebookLM). This is interesting partly because it potentially puts learning into new parts of the learners' schedule and this, for some may improve the efficacy of learning. bespoke software has been developed. One final extension of this idea is that AI can now be used to assess answers given by a respondent, both written and oral—this is used regularly in all manner of "chat" applications. So, the potential exists to conduct automated assessment of vivas. Whilst this type of assessment might be able to detect correct answers to simple questions, the ability to explore genuinely novel thoughts would need to be explored before this idea would be safe for all but simple conversations (as in a self-tutoring application).

It is wise to be cautious when setting boundaries for the use of AI, when we do not yet know where it will go but as with any other academic judgement, if a decision needs to be made, we will have to do that on the basis of available information and be able to justify that choice. We have established the creative nature of SE in finding novel solutions and have also discussed the key part that communication plays in effective SE—stakeholder engagement is fundamental in areas from capturing stakeholder needs, through negotiating a balance between conflicting requirements, to accepting solution systems which may still have limitations. Similarly modelling a system, as opposed to drawing the diagrams, is a creative contribution. There is more choice here than there might appear to the casual observer and this is where creative human contribution is essential. So, whilst we cannot say that no systems engineer will ever rely on AI to prompt ideas, we can say we will always teach that there is a need for a core human contribution. This is the art of SE, not the science.

Finally, and following from the point regarding the boundaries of AI, there is a growing question about the ability of AI to "think" for itself. Whilst this issue is beyond the scope of this paper, recently reported incidents do raise concerns for us in both the educational and operational spheres of SE. On 22 July 2026 it was reported that, according to Open AI (a leading company in the field), an AI "agent" which they were testing (effectively AI system which can operate autonomously once tasked by a human) escaped a controlled environment after finding a weakness and proceeded to attack "Hugging Face" (another AI company) in an attempt to complete its own assigned task (BBC, 2026). This does not imply creative thought, rather it shows an ability to apply an algorithm ruthlessly, but what is certainly does is raise the issue of trust in AI and that is a factor which will need to be weighed in future decisions about AI use in education.

Conclusion

So, critically, what have we learned regarding the impact of AI on SE education? There is definitely a place for AI in SE and in SE education. That extends across both teaching and learning and will support administration and research for both staff and learners. AI will be a transparent element of software tools (we can be sure of this as it is already present in the everyday software we all use every day; an AI summary is presented for almost every search we conduct) and an acceptance, even comfort, with this will be a prerequisite of working in the knowledge economy.

Noting the imperative to be inventive in SE, not simply reiterative, the key to ensuring creativity will be to maintain the human element in analysing/modelling systems. This is not protectionism—it is a recognition that AI relies on lessons drawn from the past and it is not good at original thought. Of course, one has to be alive to the fact that AI will develop beyond its current capability and also to be realistic in recognising that many aesthetic aspects of design by humans recycles previously used ideas, but in critical problem-solving issues there will always be a need for original thought—something that AI is not good at.

The moral panic that has gripped academia regarding the use of AI in summative assessment can be remedied by adjusting assessment methods to favour deep understanding and an ability to think critically in real time. We see the potential for traditional exams and vivas to check understanding of written submissions. Potential for AI support to assessed interviews must remain in abeyance for masters' education based on the requirement to assess critical thought, though it may well play a part at L6 and below. This links neatly to the next point as it relies on similar AI capabilities.

Exploitation of AI as a virtual tutor and learning partner should be encouraged. This will rely to a large extent on the students' abilities to build what works for them. We have seen, however, that they are digitally experienced before they come to us and will probably be more comfortable with this process than we are. It would not be unreasonable to assume, though, that there will be an increase in demand for digital learning support services and universities will need to plan for this.

Systems Engineers and those with similar approaches are well placed to help find innovative solutions for HE in this context. Many universities will have these skills within their staff and could usefully exploit this opportunity. This links neatly to a last point regarding the complex, adaptive nature of our problem—the changes that incorporation of AI into our activities bring will be pervasive, perhaps challenging and often surprising. Higher Education establishments

and HE itself are Complex Systems and the approach to making changes in response must be *Strategic*; we cannot expect simple changes with predictable outcomes. Interested parties will need to apply a rigorous approach to investigating the effects of changes, sensing and adjusting subsequent actions to guide the complex adaptive system of HE towards an optimum solution. This is a growing area of knowledge, and one in which the pace of change will require constant update. Further work will be required to explore its ongoing impact.

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Declaration of Generative AI and AI-Assisted Technologies in the Writing Process

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