Artificial intelligence: is it the end of work or can education respond?

David Guile

In the recent Imperial College/LSE symposium on '*Artificial Intelligence* (really on Chat GPT) *and the Knowledge Economy*', one recurring theme in the presentations and questions from the floor was, perhaps unsurprisingly, 'Is this the end of work?' Why? Well, primarily because presenters and participants followed the tendency in famous 'AI and end of work' reports, such as the ones from Oxford Martin College (2013) and the Brookings Institute (2019), to match, albeit in slightly different ways, AI's assumed functionality to aspects of job roles, and then read off from any clear fit that the entire job was at risk of being replaced by AI. Clearly, the adoption of AI might be cited as the reason for the loss of jobs, as the recent announcement from BT indicated. But there are problems associated with the 'read off' approach, and there is another way of looking at the implications of AI for work.

This alternative perspective has been presented by Daugherty and Wilson (2018) in their book *Human + Machine: Reimagining Work in the Age of AI*. They argue that one consequence of the debate about AI and work being constructed around a focus either on tasks that are performed by humans or on tasks performed by machines, is that an important range of activities has been lost from sight, ie hybrid activities where humans and machines closely collaborate. Instead of asking 'How might AI impact on jobs?', Daugherty and Wilson ask 'How might AI result in new jobs or new roles?' To do so, they distinguish between three types of work activity: human-only activity (such as 'leading', 'empathising', 'creating' and 'judging'); machine-only activity (such as 'transacting', 'iterating', 'predicting' and 'adapting'); and human and machine hybrid activities. They sub-divide the last of these into two categories: activities where humans complement machines (such as 'training', 'explaining', 'sustaining'); and activities where AI gives humans what they refer to as 'superpowers' (such as 'amplifying', 'interacting' and 'embodying').

Based on this distinction about different types of human-plus-machine hybrid activities, Daugherty and Wilson make the following inter-connected argument. Firstly, the new jobs that will grow from the human-machine partnerships are happening in what they call 'the missing middle' - in other words, in new ways of working that are largely missing from today's debate. Secondly, the emerging human/machine hybrid activities will require a new type of skill - *fusion skills*.

They define these as follows:

- '*rehumanising time*' - devoting more time to conduct creative research to address pressing problems;
- '*responsible normalising*' - the act of responsibly shaping the purpose and perception of human-machine interaction as it relates to individuals, businesses and societies;
- '*judgement-integration*' - the judgement-based ability to decide a course of action when a machine is uncertain what to do;
- '*intelligent interrogation*' - knowing how best to ask questions of AI across levels of abstraction, to get the insights you and others need;
- '*bot-based empowerment*' - working well with AI agents to extend human capabilities and create 'superpowers' in business processes and professional careers;
- '*holistic (mental and physical) melding*' - humans creating working mental models of how machines work and learn, and machines capturing user-performance data to update their interactions;
- '*reciprocal apprenticing*' - performing tasks alongside AI agents so people can learn new skills, and on-the-job training for people so they can work well within AI-enhanced processes;
- '*relentless reimagining*' - the rigorous discipline of creating new processes and business models from scratch, rather than simply automating old processes.

Fusion skills, unlike the familiar digital skills, that merely constitute a series of additions to existing interpersonal and technical skill (such as data analytics), are based on the possibility of new types of human/machine interaction. Furthermore,

Traditional single subject degree	Fusion skill	Integrated/interdisciplinary degree
Identify ways in which AI might enable staff and students to secure an improved work-life balance	*Rehumanising time*	Identify ways in which AI might enable staff and students to secure an improved work-life bal;ance
Agree philosophy, pedagogy and assessment to add AI into modules	*Responsible normalising*	Agree philosophy, pedagogy and assessment to incorporate AI into project/problem-based activity
Include examples of machine 'failure' or 'worrying' results in modules	*Judgement-integration*	Embed into project/problem-based activity examples of machine 'failure' or 'worrying' results, and provide students with opportunities to decide appropriate response
Include in modules examples of how experts have asked questions of AI, across increasing levels of abstraction	*Intelligent interrogation*	Embed into project/problem-based activity opportunities for students to learn how to ask questions of AI, across increasing levels of abstraction throughout their degree
Include in some modules oppportunities for students to work with AI to extend their capabilities	*Bot-based empowerment*	Embed into project/problem-based activity opportunities for students to work with AI to develop AI capacity and understand how AI solutions cut across engineering specialisms
Include examples of how AI works and learns to capture user-performance data to update its interactions	*Holistic melding*	Embed into project/problem-based activity opportunities for students to create mental models of how AI works and learns, and to work with examples of how AI has captured user-performance data to update its interactions, to understand the difference AI learning has made in the engineering field
Include case studies of how engineers are working alongside AI so students understand the skills they will need to develop when working in engineering research or professional contexts	*Reciprocal apprenticing*	Embed into project/problem-based activity opportunities for students to perform tasks alongside AI agents so they can learn new skills and begin to work within AI-enhanced processes
Include case studies of how new processes are developed from scratch in engineering research or professional contexts	*Relentless imagining*	Embed into project/problem-based activity opportunities for students to gain experience of new processes being developed from scratch
Discipline-specific understanding with practical awareness	**Outcome**	**Holistic conceptual understanding and practical experience**

Daugherty and Wilson acknowledge that employers always have a choice with the implementation of any new technology. They can, in the case of AI, either use it to automate work processes and then live with the economic, social and political consequences of mass unemployment, or they can use AI as a resource to transform working, living and learning.

In the case of education, especially for anyone engaged in education after the end of compulsory schooling, the concept of fusion skills offers an opportunity to redesign programmes. Professor John Mitchell, Co-Director of the UCL Centre for Engineering Education (CEE) and I have illustrated this challenge by re-imagining the way in which engineering degrees might develop fusion skills.

Recognising that departments of engineering are likely to have different starting points - on the one hand, single subject degrees, on the other degrees characterised by integration between or interdisciplinary collaboration across engineering specialisms - we have highlighted challenges that each starting point will face, (without implying that one is necessarily better than the other).

From our perspective, integrated or interdisciplinary degrees are positioned to embed fusion skills more comprehensively into programmes of study than are single subject degrees, because both fusion skills and integrated degrees are concerned with relationships, on the one hand amongst engineers and on the other between humans and machines. In contrast, single subject degrees tend to prioritise offering students depth of knowledge in their chosen specialism. The table on page 22 illustrates the challenges each type of degree faces.

The scenarios in the table on p22 indicate what needs to happen. Both types of degree nevertheless face the challenge of how to contextualise fusion skills in curricula. Traditionally, the approach associated with single subject degrees is to add additional expert content, - in other words, know-that [as distinct from know-how Ed.] knowledge. This would involve AI experts who are already members of staff being invited to teach about their particular specialism, for example Deep Learning, Robotics, Virtual Reality etc, via existing or new modules, or, alternatively, new AI experts being recruited. This results, as the final row of the table indicates, in discipline-specific awareness about AI, with some practical awareness of how it might, in principle, be deployed in engineering workplaces. However, in integrated or inter-disciplinary programmes the approach to introducing new knowledge or skill tends to be rather different.

Here, the core unit is the course or programme team, so the first step is often to upskill that team by inviting experts in a field of new knowledge and skill to temporarily join the team, and for all parties to talk through how best to embed that new knowledge and skill into the existing repertoire of project-based activities that learners are expected to engage in.

Both approaches are, however, limited as regards the embedding of fusion skills because we are still discovering exactly how fusion skills manifest themselves in workplaces. The answer ideally lies in authenticity rather than simulation, and that may best be provided by industry partners. Take, for example, the fusion skill of '*relentless reimagining*' and its emphasis on creating new processes and business models from scratch. While this can be developed at a distance from industry, it is undoubtedly challenging to replicate in education the full and nuanced range of competing design requirements that interplay in the conception of a successful business process. The danger is that, without access to the realities of the workplace, even the projects delivered within an integrated degree will regress to the 'toy' problems that drove many educators away from single discipline projects in the first place.

This suggests that we need to reimagine education-industry partnership. For too long this has been stuck with the employability agenda. Of course, student employment will always be important. However, as we begin to approach the mid 21st century the critical questions are:

- what do fusion skills look like in practice in different workplace contexts?
- how are they learnt in those contexts?
- how far can both types of knowledge be acquired via short placements/internships, and how far will it be necessary to commission research on fusion skills?

These questions point, however, to a much bigger and bolder issue, namely the extent to which the development of fusion skills will necessitate a political reset - in other words, government, employers and educational institutions working together to strengthen knowledge exchange - the flow of people, ideas and technologies - between them in a way that orientates the market towards fairer outcomes, especially in AI, to advance shared goals, such as equality and sustainability, and to harness ongoing AI innovations to support the public - rather than a privatised - good.