Using industry standard tools to set up students for success

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Defining student success post-graduation is complex, taking many forms. Some are more quantitative, such as degree completion rates and assessment grades. Others are more qualitative but no less important, including developing healthy relationships, personal growth and development, and new skills gained both in and out of the classroom. The ultimate test of student success is how well a student is able to adapt to their new environment upon graduation, whether it be industry, graduate school, research, or entrepreneurial.

Despite the complexity, identifying activities that directly contribute to setting up students for success after graduation is crucial in higher education. The Institute of Engineering and Technology reports that up to half of engineering students graduate without enough of the technical or interpersonal skills required by potential employers. This could be contributing to the fact that between 30% to 50% of engineering students end up in careers outside of their field. Therefore, one of these defined activities can be ensuring that students are exposed to and are familiar with the skills and software tools they are likely to encounter post-graduation.

With the growing intricacies of engineering challenges, incorporating simulation techniques has become increasingly vital. With companies looking to reduce costs, time and materials to innovate and solve problems simulation is essential.

The Academic team at Ansys works collaboratively with academics across the world to help them update their curriculum to include the industry standard simulation tools that students are likely to encounter after graduating. This paper presents the Ansys Funded Curriculum Program, started in 2022, with a goal of lowering the barriers to implementation of simulation-based courses by providing grants through a competitive proposal process.

Within the first two years of implementation, the impact of the program has been evident. Over 80% of students believed that the tools would be useful to them in their future careers, they also agreed that the tools had helped them to better understand the course material. This paper will discuss insights into the program's design, including key partnerships, statistical outcomes and some success stories.

Keywords: FEA, CFD, engineering simulation, engineering education, funded curriculum, university programs, faculty development, student outcomes

1. Motivation: Increasing student preparedness for workforce

Student success is complex to define, with multiple factors such as school performance and engaging in field-related extracurricular activities influencing the final metric. One detail that is often cited as a key factor is post-graduation or career success[1], [2]. But research looking into the preparedness of early post-grads has raised some concerns, with the Institute of Engineering and Technology reporting that up to half of engineering students graduate without enough of the technical or interpersonal skills required by potential employers[3]. This leaves three groups in a tough situation: companies looking to hire who need to quickly upskill new employees[4], Higher Education Institutions (HEIs) who have to rapidly adjust

curriculums to meet the ever changing demands[5], and, most importantly, new graduates who must take on the burden of feeling inadequate upon starting their careers [6], [7]. These young professionals have identified both professional skills[5], [8], [9], such as teamwork and project management, and technical skills[4], [6], [8], [10], such as real-world problem solving and increased software knowledge, as areas they found needed rapid upskilling upon entering the workforce. With this information and clear motivation, what are some strategies to try and increase preparedness and retention of young engineers?

Like student success, strategies to increase preparedness and retention are diverse, with several avenues to explore. Experiences outside of the classroom, such as participation in engineering clubs/societies and co-curricular design projects, have been shown to have a high impact on retention [11]. There are also efforts to increase engagement of students within the classroom, such as through active learning and real-world examples[12], [13], [14], [15], [16].

For this work, we specifically wanted to explore avenues for industry supporting academia in preparing their graduates. There is already work being done by industry to support extracurricular activities[17], [18]. Instead, we shift our focus to within the classroom, specifically trying to help address the challenge of adapting curriculum quickly to address industry needs[5].

2. Background: The Ansys Academic Program

Ansys is an engineering simulation software company that has been in business for over 50 years. Currently, it is ranked #1 in simulation in terms of having the broadest, deepest, and most accurate engineering simulation product portfolio.

With this broad portfolio, we have firsthand awareness of how simulation and other software tools are influencing the engineering workplace globally. We have also seen the increased impact that simulation software skills have on new graduates' career prospects.

The Academic Program team recognises that effective engineering education is a multifaceted endeavour. 80% of the team have degrees or advanced degrees in engineering fields, which brings a deep understanding of the connections between academia and industry in driving student success. We also have an appreciation of how fundamentals taught in engineering curriculum allow for students to understand and properly utilize the results from simulation and materials selection software.

The Ansys Academic Program has several initiatives (not an exhaustive list):

- **Free student software**
  To lower the barrier to entry for students who want to learn simulation, Ansys provides access to a host of simulation tools (with some functional restrictions) for free.

- **Student team engagement**
  Ansys supports student-led competitive design teams by providing access to *industry level* software at no-cost as well as extensive training materials.

- **Teaching and learning resources development**
  The Ansys Academic program has a team dedicated to creating teaching resources in collaboration with academic experts and engineers. These sit alongside a large library of self-paced learning resources that are free to access.

- **Research partnerships**
  Ansys partners with universities and research institutions to contribute to publicly funded research programs. These collaborations aim to advance national and international research priorities in many areas such as aerospace, defence, healthcare and energy.

- **Funded Curriculum Program**
  Ansys invests in tomorrow's engineers by contributing grants to academic institutions that integrate its simulation tools into undergraduate curricula in new and innovative ways.

3. The Ansys Funded Curriculum Program

The Ansys Funded Curriculum Program was launched in 2022. The funding aims to address some of the challenges associated with creating new or updating existing courses that seek to bridge the skills gap in engineering education. Specifically, the funding supports the inclusion of industry-standard simulation tools in the curriculum.

Ansys has a long-standing history of working closely with academic institutions. We have engaged with lecturers at several universities to understand their visions for teaching and the challenges they face in keeping the curriculum up to date with industry demands. Some of these engagements have led to the development of teaching resources mentioned above: working with academic experts to create the teaching materials they believe will be most beneficial in their courses.

In addition, we have collaborated on an ad hoc basis to create entire master's-level courses to ensure students are fully versed in simulation. These courses are run and maintained by the universities, with support from Ansys engineers. The success of these endeavors has driven a desire to broaden the reach, scope, and impact of these collaborations.

To facilitate this expanded horizon, the Funded Curriculum Program was designed to be an openly accessible yet comprehensive selection process, with proposal submissions solicited from universities worldwide.

- **Calls and submissions:**
  The call for proposals occurs twice a year; the call is publicised at conferences, on LinkedIn, and on the company website. The guidelines state that the courses being proposed must either be completely new or significantly revised to now include simulation. Typically, each call has a focus or theme, for instance: courses in Sustainability or Biomedical Engineering or Electrical Engineering.

  Each submission should include:
  - The CV of the lead academic.

- The proposed course(s) description (rationale, year of study, number of students, etc)
- How the incorporation of these tools will enhance the course.
- A brief description of how the funds will used, if granted.

- **Review:**
  The Academic team is responsible for reviewing all proposals that meet the eligibility requirements. To minimize and mitigate bias in the review process, each proposal is evaluated by at least three team members who have no direct connection to the university or academic submitting the application.

  Proposals are scored based on several criteria, including:
  - The quality of the writing: Is the proposal written to a high standard?
  - The expertise of the lead academic: Is there evidence that they have sufficient experience with the proposed simulation tools?
  - Interdepartmental collaboration: Does the proposal foster collaboration between engineering departments, breaking down silos?
  - Relevance to industry needs: Does the proposal address a gap in the curriculum identified as important by industry stakeholders?

  In addition to these criteria, priority is given to courses aimed at the first and second years of undergraduate study. Introducing simulation early in the curriculum provides the benefit of enhancing students' understanding of fundamental physical concepts. Visualizing phenomena such as fluid flow, stress distribution in a beam, or the electric field distribution in a circuit reinforces theoretical instruction and broadens the scope of experiments that can be explored in the laboratory. Furthermore, incorporating simulation into the curriculum early on allows students to develop these skills over the entire duration of their academic careers, rather than only in their final year, as is often the case.

- **Project management:**
  Each successful proposal is considered a ‘project.’ A member of the Ansys academic team acts a project manager and works closely with the university throughout the development of the curriculum and the delivery of new course(s). This typically begins with a kick-off meeting, during which the deliverables and timelines are agreed upon and documented. Deliverables typically include:

  - Delivery of the new course(s) and collection of student feedback
  - Creation and dissemination of educational resources to support the course(s)
  - Sharing of course outcomes and feedback through papers, conferences, webinars, etc.

  The academic team member serves as both a point of contact and, if necessary, a technical resource. Regular meetings are scheduled to ensure the project stays on track and to address any issues that arise. These meetings also provide an opportunity to provide support, exchange ideas and feedback as the courses and resources are developed and delivered.

Some time constraints are placed on the projects: for instance, the first course (if there are more than one) must be delivered within one year from the project kick off. After that, the project is tracked until all the proposed courses are delivered, any related teaching resources have been reviewed and (as much as possible) feedback from students has been received.

It is essential that all stakeholders (students, academics, and the company) have a positive experience. To support this, two surveys are distributed:

Academic Feedback Survey: This survey collects feedback from the academics and aims to understand:

- Were they satisfied with the support provided by the company?
- Did they receive sufficient resources from the company to create the planned courses?
- Were they satisfied with the selection and communication process?

Student Feedback Survey: This survey is shared with students who participated in the new courses. The questions and results from this survey are discussed in the next section.

Since the program started, the company has successfully collaborated with 47 universities in 19 countries (Figure 1). The proposed courses span 12 engineering and science disciplines (Figure 2) and utilize 22 different tools.

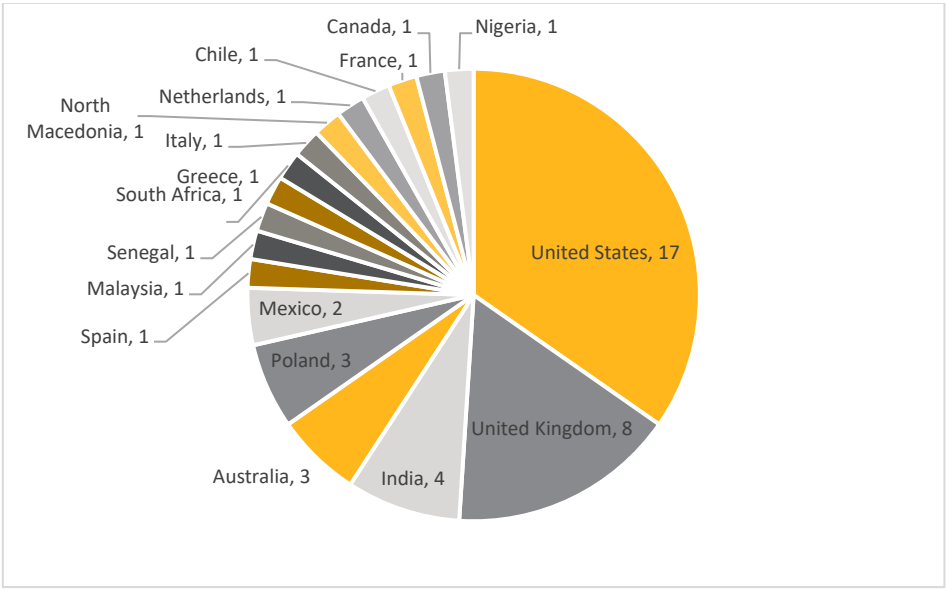

Figure 1: Breakdown of grants awarded by country

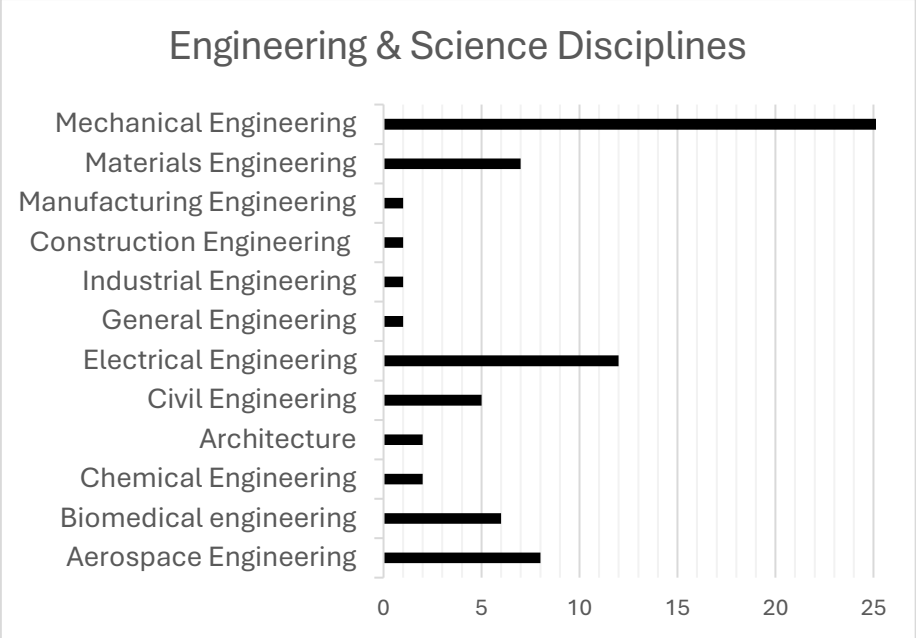

Figure 2: Breakdown of grants awarded by discipline.

Tool	Application
1. ACP	Structural analysis of layered composites
2. CFX	Simulating flow in turbomachinery applications (e.g. fans, pumps, turbines and compressors
3. Design Modeler	3D CAD modelling
4. Discovery	Early-stage CAD design with multiphysics simulation.
5. Granta EduPack	Material selection and sustainability assessment
6. Fluent	Computational fluid dynamics (CFD) for fluid flow, heat transfer, and chemical reactions
7. HFSS	High-frequency electromagnetic simulation for antennas, RF components, and wireless systems
8. Icepak	Thermal management for electronics, including cooling and airflow optimization.
9. LS Dyna	Finite element analysis (FEA) for crash simulations, metal forming, and other dynamic events
10. Lumerical	Photonic and optical device simulation, including integrated circuits, waveguides, and sensors
11. Maxwell	Electromagnetic field simulation for low-frequency applications like motors, transformers, and actuators
12. Material Designer	Model and analyse microstructures and derive homogenized material properties.
13. Medini	Functional safety analysis and risk management for automotive and aerospace systems
14. OptisLang	Optimization and sensitivity analysis for engineering design
15. Rocky	Particle dynamics simulation for granular materials and bulk material handling

16. RedHawk	Power integrity and thermal analysis for integrated circuit (IC) design
17. SCADE	Model-based system design and software development for embedded systems
18. Sherlock	Reliability analysis and prediction for electronics
19. STK	System modeling and simulation for space systems, satellites, and mission analysis
20. Thermal Desktop	Thermal analysis and modeling for spacecraft and other complex systems
21. Twin Builder	Simulation and optimization of digital twins for system-level performance and predictive maintenance
22. Zemax	Optical design and analysis for lenses, imaging systems, and optical components

Table 1: List of simulation tools used in the funded courses, and their applications.

4. Feedback from students

As part of the program, reviews and feedback are collected from the students who have participated in these courses. The aim is to evaluate their access to and proficiency with these tools, as well as the perceived relevance of these tools for other courses and future careers.

The student feedback survey results were anonymous. The only identifiers were the name of the university and the name of the course. The students on these courses represent a diverse range. The students were from Years 1 to 4 of study, and a few at the master's level. Examples of course topics include Fundamentals of Aerodynamics, Machine Component Design, Material Selection for Sustainability, and Electronics Thermal Management.

The questions asked are listed here:

- Ansys software improved my understanding of the course material.
- There were adequate resources available for me to learn effectively.
- I now know how to use Ansys software for future projects.
- I believe that the Ansys software will be useful in my future career.
- What did you like most about this course?
- What improvements would you like to see in this course?

Students were asked to rank their responses to the above questions from 1= Strongly disagree to 5: Strongly agree.

As of January 2025, we have received responses from 231 students from 9 universities studying 10 different courses.

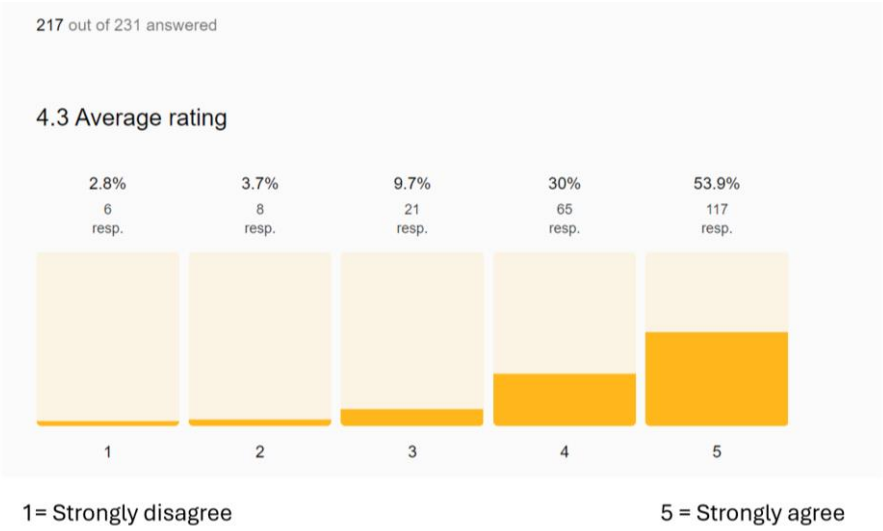

Figure 3: Student survey results for 'Ansys software improved my understanding of the course materials'

A vital rationale for including simulation in the engineering curriculum is to support the learning of both basic and advanced engineering concepts. 83.9% of students agreed that simulation software aided their learning.

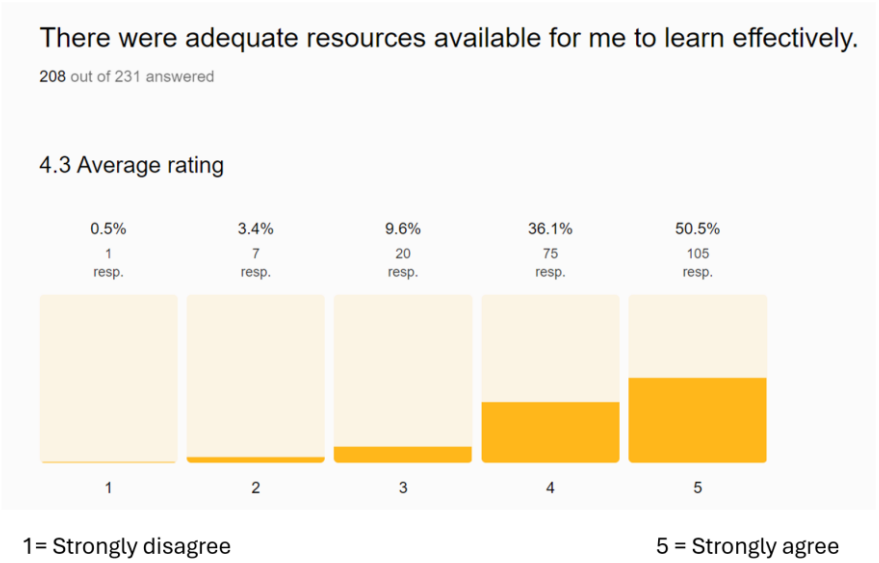

Figure 4: Student survey results for 'There were adequate resources for me to learn effectively.'

The funded curriculum program supports academics in creating their own teaching resources. They are also encouraged to use any of the hundreds of free teaching and learning resources on the company website to complement their teaching.

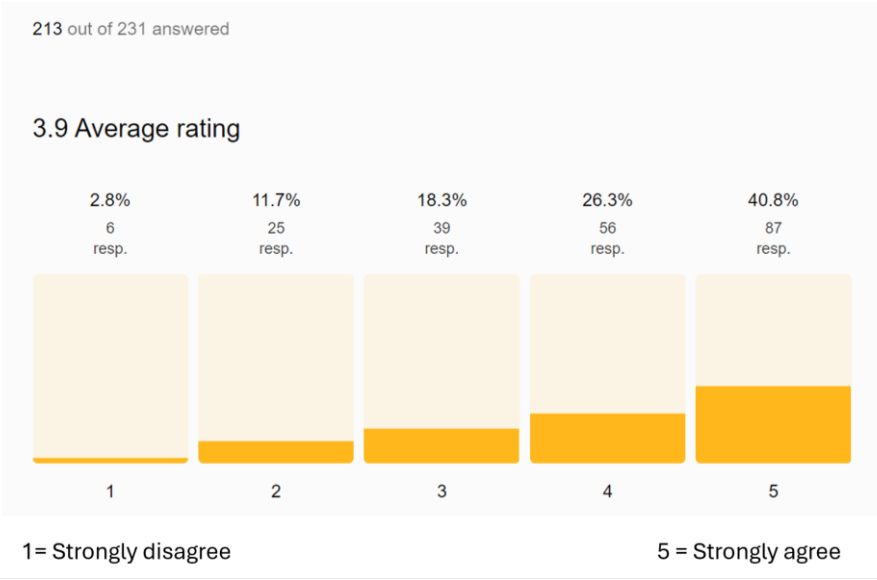

Figure 5: Student survey results for 'I now know how to use Ansys software for future projects.'

It was important to understand whether students felt that the skills they were developing, in setting up simulation problems, analysing the results and making design decisions based on the analysis were applicable to other projects or even courses. 67% of the students agreed or strongly agreed that these skills could be used in future projects. It should be noted that some of the students were taking these modules in their final year and therefore may not have agreed with the survey statement.

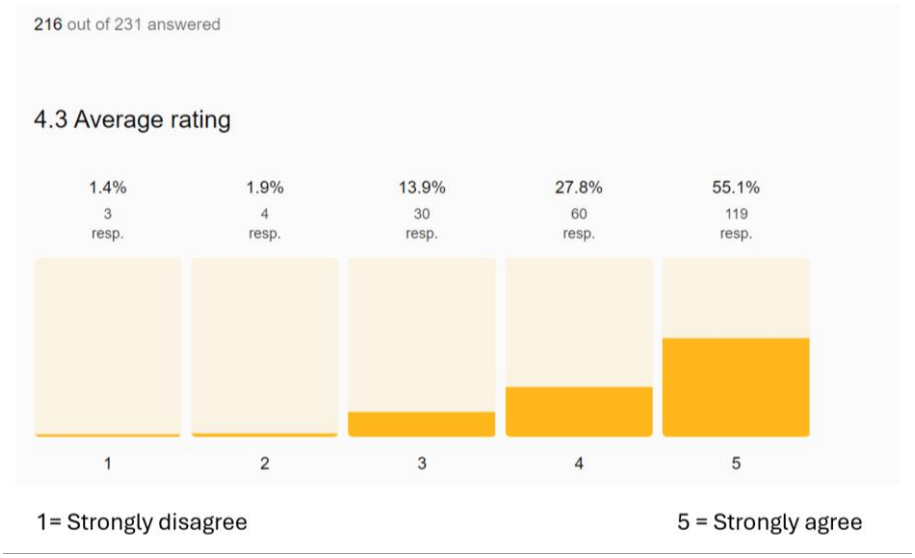

Figure 6: Student survey results for 'I believe that the Ansys software will be useful in my future career.'

82.9% of students agreed or strongly agreed that simulation would be useful after they graduated.

The results of the survey strongly suggest that the students consider these simulation tools to be instrumental in deepening their knowledge of engineering concepts as well as in developing useful skills.

The survey results strongly suggest that students believe exposure to and experience with simulation tools are critical to closing the skills gap between academia and industry, research or entrepreneurship. A number of reasons can be given for this:

- Students have gained a deeper understanding of core technical principles thereby boosting their confidence as engineers.

  "The course is interesting to me personally and deepens my understanding of aerodynamics and how it effects our everyday lives."

- The skills gained motivated students to unilaterally take on more complex problems and gain a level of mastery.

  "...gave me the real-world experience, comprehensive learning resources. It was a robust platform to learn and develop practical engineering simulation skills which will be valuable for our academic and professional careers. Through this i got opportunity to implement it in our project regarding space propulsion where we do numerical analysis."

- The knowledge that these tools, are in fact, the industry standard and this experience will make an easier transition into work.

  "I liked being able to simulate flow that I might have to do in my career."

  "The course provided an interactive session to deal with real life problems in a very friendly and easy to learn manner. Providing us with technological knowledge which will prove very beneficial for our academic and professional journey."

When asked what could be improved about the course, a common theme was that of needing more time with the software:

> *"We thought of having one more semester for learning many things… but we know in 2 semesters we can't learnt everything which is vast but hope we get opportunity to work with ANSYS"*
>
> *"I would like this course to be more practical. Maybe we could spend more time from the planned weeks on learning the software… from the most simple things to more advanced and complicated tasks, because I think this software would be a lot useful especially for the future of one mechanical engineer (specifically those who are on EE and HEI fields at our Faculty)."*
>
> *"The course duration per week was a bit too short to carry out more projects in the class. This will help further improve the skills of the student at using the software."*

We aim to share this feedback with the academics to improve the next iteration of these courses.

5. Successful partnerships

In this section we'll discuss the outcomes from some of the successful partnerships in the program.

University of Newcastle, Australia (awarded October 2022)

The University of Newcastle is strategically revamping its engineering curriculum across multiple departments, covering multiple years of undergraduate studies, to better align with industry demands and adequately prepare its graduates for an engineering career.

Seven new and revamped courses were proposed in the Mechanical Engineering, Mechatronics Engineering and Aerospace systems for second, third and fourth years. The project team was composed of six academics supported by two teaching assistants.

Over the project duration, the team delivered each of the seven courses and created twenty-two new teaching resources to be used. The resources were also made available on the company's teaching resource website for open access.

As a result of the success of including simulation in the Mechanical Engineering department two of the resources were subsequently adopted into Medical Engineering courses as well.

"*The winning of the funding for Curriculum development has been a significant factor in revitalising our programs use of contemporary tools in a holistic way. [The software Integration] enables our students to explore deep fundamental and complex engineering problems and be aware that these problems do have solutions." Professor Bill McBride, Acting Head for the School of Engineering.*

Kings College London (awarded October 2024)

King's College London is one of the top universities in the UK for biomedical engineering; it has a close collaboration with some of the leading hospitals in the country.
Simulation had already been in use by healthcare technology researchers at the university and hospitals. However, they recognized the need to have students trained in these tools to develop the next generation of biomedical engineers.

Three new courses in Biomedical Engineering were proposed for students in their second and third years. The project team is composed of one academic, supported by one teaching assistant. This project is ongoing currently. The team has created one new resource so far, with the new courses due to be delivered in October this year. The inclusion of simulation in these courses inspired two other academics at the university to do the same in their courses, allowing more students to have access to industry-standard tools.

"The proposed design will therefore enhance these courses significantly, equipping our students with the necessary know-how to create innovation in medical technologies that addresses unmet clinical needs." Dr. Adelaide De Vecchi, School of Biomedical Engineering and Imaging Sciences, St Thomas' Hospital, King's College London.

6. Limitations and future work

The student surveys give us insights into how these courses have been received, their perceived work-readiness and potential success post-graduation. With over 80% of students agreeing that these skills will be useful for their career, does this match the industry view? The Institute of Engineering and Technology lists digital skills, such as 3D modelling and simulation of one of the top 5 skills in-demand skills for engineering graduates. Therefore, aligning the engineering curriculum to industry needs must indeed boost the success of students.

Future work for this program can be to track students after they graduate and discover how learning simulation has helped them. As the program is still in the first few years of implementation, that data is not yet available. We know this task will be challenging but believe the insight that could be gathered is well worth the effort.

7. Conclusion

Ensuring engineering graduate success is a complex challenge, with many factors at play. One area that has been identified as a key need by new graduates and industry alike is increased knowledge of software tools, such as simulation. To support the increase incorporation of these tools in engineering curriculum, the ANSYS Program has started the ANSYS Funded Curriculum Program. Kicked off in 2022, this program gives funding to faculty looking to incorporate simulation in their curriculum. Initial feedback shows this program is a success, with 47 grants being awarded across 19 countries. Students and faculty are both seeing positive benefits from incorporating these tools into the curriculum, with students citing better conceptual understanding and faculty adding highly valuable skills to their classes in a meaningful way. As this program is still young, there is room for continued improvement and further data to be gathered. However, we hope this work showcases how industry can support curriculum development to further ensure young engineers' success.

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