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Article

Modernising the Control Curriculum and Delivery to Meet 21st Century Needs

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Abstract: This paper focuses on the changes in tertiary education to reflect the changes in both technology and advances in the control field. It is necessary for educators to continually update both the content and delivery of control related topics to prepare graduates for the future. This paper is separated into two different foci. The first part looks at advances in technology alongside the changing needs of society and reviews how the control community is responding to these changes. The second part focuses more on learning resources and reviews some of the freely available tools that are available to students and professors to help students better understand both the topic and its importance to society.

Keywords: control education; student engagement; authentic delivery; global challenges

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1. Introduction

The control community has numerous significant challenges, many of which are well captured in the recent comprehensive control 2030 report [1] (e.g., climate change, migration, healthcare, smart infrastructure, etc.). An observation that is repeated in this report is that the control community is well placed to make substantial contributions to a number of societal challenges that the world is facing [2]. This is because the breadth and rigour of the control and systems tools the community has and is developing are often precisely what is needed to give insights into these challenging problems [1]. We, as a community, need to exploit our skills to ensure we can contribute effectively to improving the lives of the future inhabitants of this world.

The Special Issue on *"Recent Developments in Automatic Control and Systems Engineering"* [3], of which this paper is a part, has invited authors to summarise the state of the art in a variety of core control disciplines; however, the focus of most of the papers has of course been largely technical. Nevertheless, in order to prepare for the future, the community also needs to nurture future control researchers and leaders. How do we inspire undergraduate students in our care to take an avid interest in control-related issues? Unless we can inspire students to undertake PhDs and further their academic studies, we will not be providing the work force required to tackle future societal challenges. It is also self-evident that control has applications across a huge spectrum of application areas, e.g., refs. [4–7], and this needs to be reflected in our control curriculum. Consequently, the prime purpose of this paper, and why it sits naturally within the Special Issue on control, is to give a narrower focus to some of these issues and specifically to summarise existing good practice in tertiary education with a focus on control education. This paper focuses on the teaching of undergraduates, i.e., how do we inspire them to take any interest in the control methodologies and approaches and thus choose advanced options in later years, thereby equipping themselves to contribute to tackling some of these challenges.

The control community has undertaken regular reviews of curriculum content [8–12] throughout recent decades. The most recent one [9] was different in that it deliberately set out to canvas views from the entire global control community [13,14]. One notable aspect is the conclusion that there should be less emphasis on rigour and depth and more emphasis on engaging students. If we fail to engage students adequately, there is little chance they will select higher-level courses that have more depth and provide a foundation for significant contributions to real societal problems. Of course, this observation is at odds with what might be considered the more commonplace first course in control that has been used widely across the globe where the emphasis was more likely to be mathematically focused.

A separate strand of studies goes beyond control and is applicable to all of engineering, i.e., how are courses delivered [15–18]? There are whole communities focused on this issue (e.g., European Society for Engineering Education, American Society for Engineering Education) and it would be difficult to capture all that work concisely. Unsurprisingly, a large amount of work is also being performed within the control community [13,14] and there are too many papers and works to list individually. A core and unsurprising point is that education needs to move with the times: just because a delivery technique was popular and effective in 1980 or 1990 does not mean it is still appropriate. We, as educators, need to recognise that modern students have had a different upbringing. Thus, the way they engage with learning has changed. Moreover, the changes in technology [15,19–23] provide huge opportunities to improve the educational environment.

This paper will thus focus on both delivery and control curriculum and will summarise some of the core proposals and developments in the community. Section 2 will look at some philosophical points, Section 3 will focus on hardware and laboratory developments, Section 4 will focus on the potential for virtual environments, and this paper will then finish with a Section 6.

2. Design of a Control Curriculum for the 21st Century

A core conclusion in the survey paper [9] was the need to de-emphasise tedious number crunching and replace this with experiences which enable students to engage with

1. Why are control and feedback important?
2. How does feedback make an important difference to practical scenarios?

Such points require some deep thinking about what constitutes an ideal course in control. This section briefly summarises some of the best practice for education in the 21st century. Later sections will provide more focused case studies.

2.1. Reducing the Emphasis on Mathematics

A historical first course in control felt like a mathematics course due to the use of Laplace transforms, complex numbers, logarithms, ODEs and more. It is perhaps not surprising to hear a repeated comment from numerous international colleagues across many years that a large number of students completed such control courses without any real appreciation of what a feedback loop represented, nor why it was important. Instead, they had learned a number of mechanical mathematical procedures to solve some standard exam type problems. These insights were essentially repeated in the results of the global survey [9]. The obvious solution to this issue is to change the emphasis and ensure that the focus is moved to

- Why are control and feedback important?
- Industrial case studies showing control and feedback loops in action.
- What is feedback?

Once students are sufficiently engaged and motivated, then they will be more receptive to learning the mathematical tools and techniques required to analyse, evaluate and design the feedback compensators needed. Moreover, irrespective of this observation, the more rigorous mathematics can be delayed to a second course.

It was also noted [9,20,24] that computer tools are now widely available. Thus, it makes no sense for students to spend excessive time completing computation and plotting by hand, especially where such operations are largely mundane and boring. By all means, get students to understand the mathematical steps and how to plot, but thereafter encourage the use of appropriate computer tools for such computations and thus free up more time for students to the spend on illustration, evaluation and design. There is a lot to be said for providing students with access to appropriate computer tools during end-of-year exams, such that it enables the assessment to be focused on problem solving and interpretation rather than mundane computations and number crunching, which are better suited to school-level assessments.

2.2. Core Content

While it is recognised that there will always be local differences due to the overall curriculum design, it was accepted [9] that a first course should cover the following principles and themes:

1. The importance of control and feedback.
2. An understanding of system behaviours.
3. Some practice in designing simple control loops to influence behaviours with a focus on PID.
4. Industrial case studies and laboratories, which reflect the discipline of the course (chemical, electrical, aerospace, etc.).
5. Use of software (e.g., [25–29]) to alleviate a tedious number of crunching requirements.
6. Good quality visualisation, for example, virtual laboratories, to support engagement with core concepts.

Many had a preference for frequency domain and Laplace and others for state space; however, to some extent, these are secondary issues. The amount of more advanced and/or focused material that could or should be introduced will depend on the size of the module. However, generally, it was felt that more advanced and mathematical approaches should be delayed to a second course.

2.3. Breadth of Illustrations

In order to motivate students, they need to be convinced that a topic is useful. Thus, it would be commonplace to use a wide range of examples to inspire engineers and from a wide range of disciplines to emphasis the breadth of applying control, e.g., [4–7,30,31]. Although such an introduction may not cover a wide breadth of control approaches, using a range of examples facilitates the step into conversations about what control approaches we might need. Certainly, a good ending to a first course, following a discussion on PID, can start looking at questions such as *what if PID is not good enough?* It would be great to collate good videos and online illustrations which allow lecturing staff to motivate their students to consider taking more advanced courses in control related topics; this is something the worldwide community is trying to facilitate, e.g., [32].

2.4. Interactive Lectures and Lecture Flipping

It is not appropriate in this paper to spend too long on the concepts of lecture flipping [33–36] as these are generic and thus not specific to control. However, they should certainly be mentioned briefly. There is some focused evidence in the control community (e.g., [37], Section 5) that flipped learning approaches can improve student engagement and learning. Thus, one should consider this as an option, at least for some aspects of course delivery. However, it is equally recognised that some students do not engage well with this approach and can become quite unhappy.

On a similar level, the need to ensure that contact time with students is interactive is also well publicised and emphasised in Blooms taxonomy [38]. How teaching staff enable this would encompass describing several other papers. Thus, we will just mention lecture polling systems (e.g., Mentimeter, Wooclap, Pointsolutions, etc.) which are now easy to adopt. Modern software works through websites and mobile apps. Thus, apart from the license cost, they are simple to use. These are excellent tools for encouraging students to engage actively with problem solving and group work within contact sessions. They also provide useful insights into teaching staff on areas where students are struggling and need more support.

2.5. Group Work, Assignments and Problem Solving

Anecdotally, at least, most teaching staff would accept that if you assess student primarily via an exam, then they will focus on what is required to do well in the exam. This often reduces to learning or rather memorising set formulae and approaches to determine the correct mathematical values for standard problems. Unfortunately, such students often fail to see the big picture and thus never grasp what feedback loops are really about.

In the authors' experiences (e.g., [39–41]), students only really fully appreciate control when they have an intensive assignment that forces them to engage with more open-ended problems requiring some deep thinking and engagement with real issues/hardware. In a similar way, there is ample evidence that group work encourages most students to inspire each other, teach each other and ultimately learn more by engaging with a topic at a much deeper level.

2.6. Making Use of Technology

A core observation is that the conventional model of lectures and exams was created in the distant past when this was the only practical way to pass information from the teacher to the student. However, with the advent of computers and the internet, access to information, notes, videos and so on is essentially free and immediate. Consequently, the role of a lecture should no longer be the simple passing of information; that is not necessary. It is important that university lecturers modernise their delivery [15,16,42–44] to exploit technology sensibly as this can, for example,

1. Improve the learning experience of learners.
2. Give more flexibility to learners in which resources they use to learn from.
3. Improve efficiency and thus save money.
4. Match student expectations of a modern education.
5. Enable automated feedback processes which both drive and aid learning.

2.7. Modern Approaches to Teaching and Engagement

The control community [14] is always looking for opportunities to investigate new ways of educating both students and the public more widely about control and its importance. Some of these methodologies will slowly seep into good educational practice. Thus, it is sensible to try and keep abreast of such developments. Some recent ideas are

1. The advent calendar [45] quiz, which is available free online.
2. The use of animated cartoons [46]; the current project is in process and will release results in 2025.
3. Methodologies and processes for categorisation of questions into topics and difficulty to help systematic development and assessment of student learning [47].

2.8. Summary

There is clear evidence of a need for change from both the survey standpoint [9] and with regard to multiple colleagues across the world reporting on conversations with and the competence of their students. The historical delivery of control courses, i.e., didactic lectures and a focus on mathematical computations and exams, was not achieving what was needed. Consequently, many students were disengaged and understood too little. In turn, this meant they were not selecting higher-level courses. The engineering community at large has been developing good practice, which makes use of the modern educational environment, and we should be exploiting this. The remaining part of this paper will focus on a few areas of accepted good practice that can be deployed in control courses.

3. The Use of Hardware Laboratories in the Control Curriculum

As a summary article on good practice, it makes sense to spend some time focusing on the use of hardware or laboratories.

3.1. Main Stream Hardware Options

To some extent, there is not much of real interest to pass on when one considers conventional university laboratories. There are a small number of international suppliers of hardware appropriate for teaching control topics at a university level that routinely attend international conferences to disseminate their wares. In general terms, and to avoid any issues of bias, these suppliers will not be named, but the author's view is that the equipment is largely excellent and well supported by high-quality teaching materials. Certainly, from the perspective of the author's institution, it is usually much more cost effective and efficient to make use of these sources rather than develop in house laboratories, partially because development and maintenance of in-house laboratories often takes substantial staff time and expertise. Moreover, there is a high risk to delivery if core individuals leave.

The biggest challenge for institutions is taking a holistic view of their entire engineering programme's needs, as it is often more efficient to service the whole curriculum, not just control, from a small number of suppliers, allowing consistency in software and generic technical support. Of course, the other major challenge is finance: a good quality kit is expensive. For institutions with large cohorts (say 200–400), there is a need for multiple copies of equipment to ensure that all students get sufficient access. In the author's institution, they aim for 50–70 of them, so that a single laboratory slot can deal with 100–150 students at once, as some kits are used by several cohorts (aerospace, electrical, chemical, etc.); clearly, this requires massive periodic investments and planning.

More expensive and specialist hardware that might be used for final-year options and purchased in low multiples requires local decision making to ensure the expenditure is focused on where there is maximum local benefit, for example, to support a unique selling point for the given institution.

Remark 1. *One successful approach to dealing with the high cost of hardware and to encourage sharing was the Diamond building in Sheffield [48]; this was a novel initiative within the UK at the time of construction. In essence, the laboratories for all the engineering departments are shared and serviced centrally, allowing space, equipment and delivery management to be utilised much more efficiently.*

3.2. Remote Laboratories

The global COVID pandemic forced many universities to move online almost overnight. Although platforms did exist for lectures and resource sharing, one of the biggest challenges was access to laboratories. Of course, virtual laboratories (more in Section 4) can fill some of the gap, but there is no substitute for engaging with actual hardware. In parallel, many universities struggle with limited space and resources, meaning that even students who are in attendance have less access to hardware than desirable.

Some universities are set up as distance learning institutions. Thus, it is unsurprising that there are many good solutions for improving remote access to hardware, for example, [49–54]. However, there are several core challenges, as pointed out in Section 4.6 of [15], such as the following:

- An effective queuing or booking mechanism is needed; this may be non-trivial to facilitate. Poor access and/or long waiting times cause student frustration and disengagement.
- Reliability is critical, and there are multiple possible failure points. The monitoring and maintenance load on technical staff may be significant/expensive.

Hence, in summary, the expertise, cost and development time needed mean that this option will often not be pursued extensively by universities that most students are residing at. Moreover, better and more accessible resources inevitably require more development work and substantial software/hardware skills, which may not be available. Staff with limited resources/skills may consider it more pragmatic to default to less accessible or high-quality alternatives that are easier to manage (e.g., Section 4.3).

3.3. Take-Home Laboratories

The development of low-cost processors such as Raspberry Pi facilitated a significant change in what institutions could offer to their students [55]. It became possible to develop relatively cheap hardware (USD 30–100) that students could safely transport and use at home. This hardware could have multiple actuation possibilities and sensing, as well as relatively simple coding interfaces, which enabled students to focus on core learning outcomes rather than software engineering skills, as the hardware was small and simple; nevertheless, this real and exposes students to several real-life issues and scenarios that they may otherwise not have encountered while also peaking their interest.

Consequently, in recent years, there has been a rapid growth in the number of take-home laboratories available, for example, [40,56–63] (e.g., Figure 1). Most educational conferences linked to control will contain new examples, and there is strong evidence that these are popular with students and help reinforce deeper learning. Core advantages include the following:

1. Students have 24/7 access over an extended period.
2. Provides students with the space to carry out experiments for which there is insufficient time for in a timetabled session.
3. Students can ask *what if* questions and explore beyond the narrow remit of a laboratory sheet.
4. Good to support post-laboratory investigations requiring deeper evaluation and design.
5. Emphasises some real-life issues, such as noise, measurement delay, actuator constraints, non-linearity and more.
6. Effective design allows students to focus on core learning outcomes.
7. Affordable, enabling every student in the class to borrow one.

It would be wrong, however, not to point out some of the challenges of a take-home kit:

1. The dynamics will typically be relatively simple, which may limit the depth of learning outcomes that can be covered.
2. Where moving parts are included, regular breakages mean that maintenance and repair can be time-consuming and cause regular irritation for students. Having as few moving parts as possible is recommended.
3. Take-home kits with more interesting dynamics [58] that support final-year courses can be expensive to design and build. Moreover, much like remote laboratories, they are heavily reliant on strong technical support and expertise.

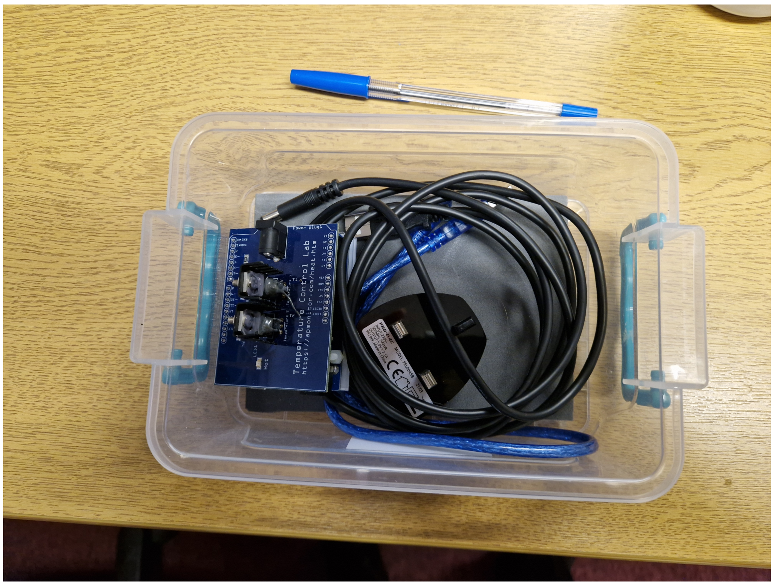


Figure 1. Example of a cheap take-home kit (two heaters) in a small sandwich box .

Some authors have proposed providing a detailed set of parts that students can purchase themselves to build their own devices at home. The author is less keen on this option, perhaps as a reflection of student expectations within the UK, where students would expect everything they need to be provided. If build skills are important, one can of course provide a *lab-in-a-box* which is also popular (e.g., [64,65]) and is similar in concept to the take-home kits. Again, there are numerous examples of this in the proceedings of the IFAC Advances in Control Education.

4. Virtual Laboratories to Support the Learning of Control

It will be clear from the previous two subsections that while access to real hardware is of course important, it is expensive and prone to limited availability. Consequently, university teachers have looked for other ways of enhancing the student learning experience and exposing students to real-life issues and contexts. In the recent twenty years or so, the power of both computers and the Internet has meant that the availability of simulation environments has become much better, with costs becoming much cheaper. In turn, this has led to a large number of educational developments exploiting this, for example, refs. [44,51,66–72]. Tools that are particularly accessible include a range of examples covering different topics, and they are free at the point of use and relatively straightforward to edit for those prepared to engage in learning the software environment, such as [27,71].

4.1. Concepts Behind Virtual Laboratories

Virtual laboratories or authentic simulation environments have the core advantages of

1. Scale, i.e., in principle, they can be accessed by a large number of students simultaneously. Thus, the teacher is not limited by numbers in how the resource is embedded into teaching.
2. Availability can, in principle, be 24/7 all year round, which helps students who need to timetable their studies around other constraints.
3. The engineering context and visual aspects should be transparent enough so that the student relates the learning and concepts directly to real applications.

There is huge variety in the type of resources available. However, in the author's experience, there has been a relatively limited uptake of the more expensive and high-quality options. In simple terms, most university budgets cannot justify large license fees for a simulation environment that has limited use across the whole curriculum, irrespective of how good the environment might be. Moreover, expensive variants tend to limit the affordable number of licenses and computers which will support the software, thus negating many of the advantages of virtual laboratories.

One can argue quite confidently that the variants which are most heavily used and publicised are those that are relatively simple, such as [70]. Moreover, they have the advantage of being *free at the point of use*, i.e., the authors create them for the benefit of the community and not for personal gain. The community is attempting to organise a list of useful resources through [32] so that interested teachers can quickly view what is available within the control area.

4.2. Using MATLAB to Create Virtual Laboratories

Module leaders like to tweak their module activities regularly. Hence, there are advantages of being able to author/edit their own virtual laboratories rather than being reliant on a costly or unavailable expert. There has been a number of papers over the recent decade discussing the use of MATLAB to facilitate such a wish (e.g., [19,73–75]). Reasons for using MATLAB could be considered controversial by some in the community who prefer to use free software. However,

1. It is widely used in the control community, so most academics will be familiar with the coding environment and thus be able to engage and edit resources quickly to meet local needs.
2. The download of toolboxes through the add-ons button is extremely easy and quick. Resources accessed through a toolbox can often be run through icons and links, without the need for coding skills.
3. MathWorks has recently made access to MATLAB free online, so even students without a license (https://uk.mathworks.com/products/matlab-online.html, accessed on 11 February 2025) can access and use MATLAB resources.
4. Central to this paper, the environment allows for quick and easy development and editing of interactive resources [19,74–78].
5. Most importantly, it is supported by a large and stable international company, which means there is a stronger likelihood that any effort put into resource production will have a good life time. Moreover, there are multiple files and toolboxes already available to support core requirements, removing the need for local developments.

4.3. The Control101 Toolbox

Given the arguments in the previous subsection, it is not surprising that the community identified control as a topic where a dedicated education resource focused on the MATLAB software would be useful. Following on from some of the observations in Section 2, the following priorities were identified:

1. Effective and fast animation (e.g., Figure 2) of core concepts within an engineering scenario that can be deployed both in lectures and for independent student learning. Within the animations, it should be possible to carry out testing and draw up illustrations of concepts, such as the following:
    - How does behaviour change when core parameters change?
    - What is the impact of different feedback choices?
    - How great is the impact of different types of non-linearity, uncertainty and disturbances?
2. Exemplars of code for performing straightforward but tedious number crunching (e.g., closed-loop poles, inverse Laplace, step responses, etc.).

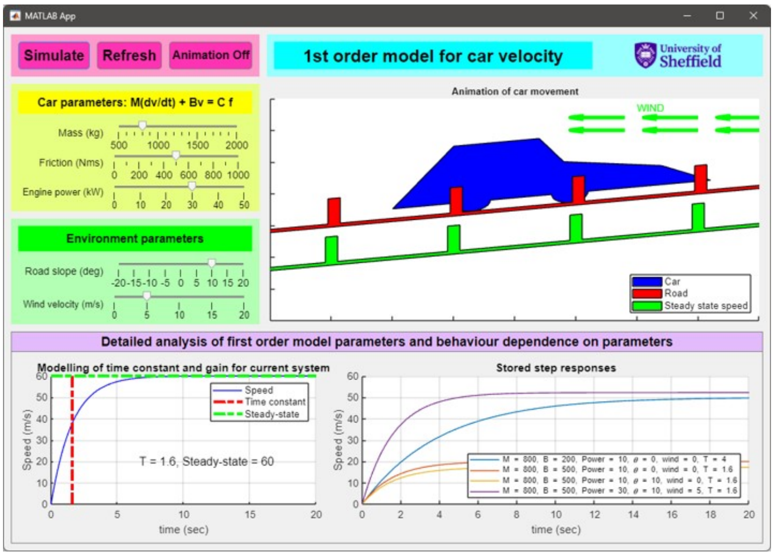


Figure 2. Screen dump from virtual laboratory on open-loop behaviour of car speed.

A toolbox has been created [24,78] and was officially launched at the IFAC world congress in 2023. The initial release covered only the bare bones of a first course. However, subsequently, the international community has been gradually expanding what is available. Therefore, now there are also resources on frequency responses, PID design, SIMULINK, non-linear behaviours, state space methods, and more. Of course, there are still gaps, and anyone is welcome to contact the authors with proposals for improvements, edits and additions. Anecdotal feedback from presentations at conferences has been very positive. Interested readers can see some YouTube videos of the associated virtual laboratories (links on [78]), which demonstrate how easily they can be deployed within lectures and teaching.

Explicit evidence of efficacy exists in the majority of downloads (over 6K), quick adoption by colleagues in City University, and some recent student quotes: *(i) "The MatLab control101 toolbox is excellent, both being easy to use and understand" and (ii) "Software which was introduced by the lecturer helped me to enhance my understanding on the lectures"*.

5. Some Inspiring Case Studies

The readers will probably take for granted that a core requirement for teaching at a university is to be inspirational and to engage students in becoming excited about a topic and its relevance to the challenges we face in society [1]. Consequently, it is sensible to summarise two of the case studies which have appeared recently [8], although the engineering educational literature is full of similar examples, and readers are encouraged to read them.

5.1. Exemplar Large First, Control Course from University of California, Berkeley

What is transparent in this case study (Section 4.1 of [8]) is how learning environments and assessments are designed to maximise student engagement, enthusiasm to learn, and development. Graduate employers consistently pass on the message that they want employees who are self-confident, good independent learners, demonstrate initiative, good at problem solving, communicate clearly, can work in groups, and more; often, their specific technical expertise is secondary. Of course, what is somewhat ironic is that all of these points are somewhat perpendicular to typical lecture course learning outcomes that may focus on specific technical skills, such as Laplace transforms.

In the Berkeley case study, year-one students are given a large group project that continues throughout the semester and requires the gradual integration of a variety of technical and other life skills, some requiring significant technical depth. Appropriate technical lectures are taught in parallel, but some of the skills needed for the project require independent learning and initiative. It is clear that the students enjoy the course and develop significant employability skills as well as a good awareness of what control is, why it is important, and how to implement it in practice.

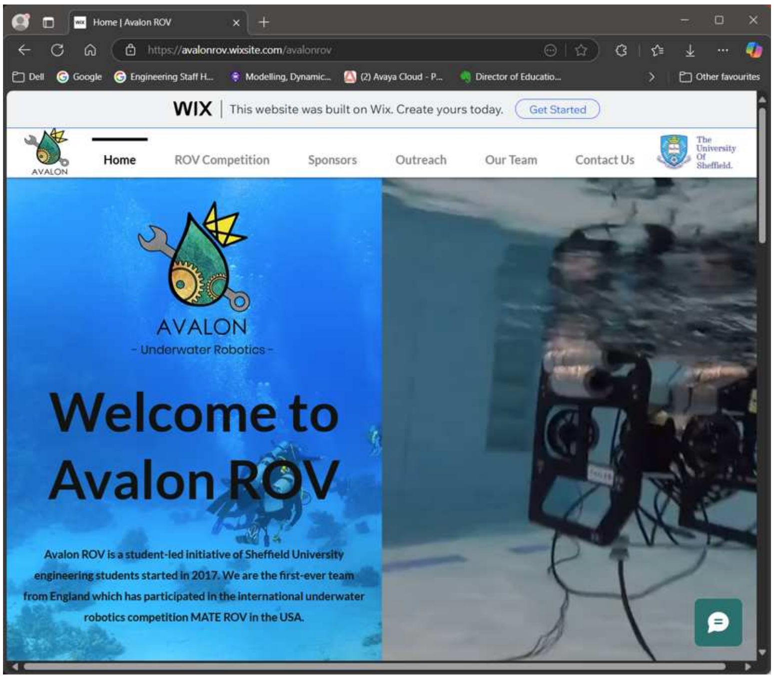
5.2. Imperial

The example from Imperial (Section 4.4 of [8]) is similar in ethos to the previous subsection, which is the embedding of learning around frequent access to and use of proper hardware [53]. Particularly, compared to many traditional control modules, the access to the hardware was not a small supplementary add-on of a few hours but far more extensive and intrinsic to the whole student experience and learning. To quote, "*The Imperial experience has shown that a proper integration of challenging and intriguing experiments into a basic Control Systems course has been a great selling point for students, who thereafter are keen to learn more ... in subsequent years ...*" .

5.3. Competitions

The efficacy of competitions in engendering effective student learning and enthusiasm for the topic is well known [79–81]. There is strong evidence that a competitive element fused into a curriculum in an inclusive and enjoyable manner is both popular and encourages much deeper student learning. Again, the educational literature is full of examples of these concepts being deployed across a wide range of engineering disciplines and platforms.

A slightly different alternative is to take the learning outside of the assessed curriculum altogether, i.e., with *student-led activities* linked to national or international competitions (e.g., see Figure 3). Ironically, despite the lack of marks, students devote huge amounts of effort into these and gain knowledge of a wide range of technical topics, often in great depth. One well-known example is Formula Student (https://www.imeche.org/events/formula-student, accessed on 11 February 2025), where student teams from around the world design, build, test and race a small-scale Formula 1-style racing car. This is an annual engineering competition held at Silverstone and run by the Institution of Mechanical Engineers. It should be emphasised that this is just a single example and that, within the author's institution, there are 10 similar national or international projects just within engineering.



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Welcome to Avalon ROV

Avalon ROV is a student-led initiative of Sheffield University engineering students started in 2017. We are the first-ever team from England which has participated in the international underwater robotics competition MATE ROV in the USA.

Figure 3. Webpage of student competition on underwater robots.

6. Conclusions

This paper has attempted to provide a summary of good practice in control education. What is clear is that, just as with research, education is changing rapidly. Those of us responsible for training the engineers of the future need to be engaged actively with current developments. Making use of modern technology and ideas can both improve the student experience/learning and, ironically, reduce workloads for teaching staff. Indeed, the quantity and range of learning resources that can now be utilized make it much easier to provide students with a learning pathway that enables them to be more independent and to personalise their own learning. Indeed, even the generation of feedback on their progress can also be largely automated. A few key points mentioned previously are worth restating:

1. Given that information is readily available online, it is more important to motivate students to understand and appreciate core concepts. Rote memorisation and reproduction of a large number of procedures is less important, as computers can achieve much more, reliably.
2. Numerous computer tools exist for completing mundane computations and supporting control designs. A modern control engineer would be expected to use these tools competently and efficiently.
3. Embedding learning around authentic case studies, digital twins and hardware, often with some element of competition or open-endedness, will lead to deeper learning for the majority of people.

Let us return to the first paragraph of the Introduction section: We want to inspire students to develop an interest in control and feedback, and take the higher-level courses. By modernising and improving how we teach and what resources we provide, we can both engage students more effectively and help them learn better. Ironically, we cannot be explicit and tell readers to use Method A or Method B. However, sources such as [32] are attempting to curate different examples, which readers can use to identify good practices elsewhere and to help their own internal evaluations of what will work best in their local environment. This paper aimed to shed light on the most obvious and simplest examples that teaching staff could adopt. As within any survey, there is a limit to how many citations and evidence can be captured in a concise and clear fashion. Therefore, the objective was to be concise and clear; readers should use the citations within this article to obtain a deeper insight into the discussed topics and associated evaluations.

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