UCL, UK

Case Study Part B – Institutional context

Undergraduate engineering student intake (1st year cohort 2020/21):	**≈ 1350**
Number of engineering faculty:	**≈ 300**
Duration of undergraduate engineering degree (to BEng):	**3 years**

1. Defining features of UCL's engineering education

The engineering school at UCL (UCL Engineering) brings together ten departments of engineering, technology and computer science. Historically, almost no connectivity existed between the undergraduate programmes offered by these departments; they operated autonomously, with most following a largely traditional, teacher-centred approach. In 2014, UCL Engineering launched the Integrated Engineering Programme (IEP)[1], a root-and-branch reform to undergraduate education across the school. Three features set apart the IEP's approach. It:

1. **connects students' learning across disciplines:** the IEP established a common school-wide curricular structure, which embeds opportunities for students from across UCL Engineering to come together to engage in shared multidisciplinary learning experiences;
2. **immerses students in authentic problem solving:** the first two years of the IEP curriculum is structured around five-week cycles; the knowledge and skills acquired by students in the first four weeks is applied to a one-week 'scenario' in the final week when students work in groups to tackle a real-life societal challenge;
3. **develops students' professional skills and mindsets:** from the first year of study onwards, emphasis is placed on student self-reflection and the development of professional capabilities such as critical thinking, creativity, decision-making and team work.

The successful delivery of the IEP undoubtedly benefitted from three other innovations that were rolled out at UCL at around the same time. The **first** was the launch of the *Connected Curriculum*[2] in 2014: a UCL-wide initiative designed to connect students' learning with both university research and authentic problems facing the world. The **second** was a radical reform of UCL's academic career pathways in 2017[3], which opened up new career opportunities for faculty on the basis of their contribution to education. The **third** was the establishment of the *Centre for Engineering Education*[4] (CEE) in 2015. Described by one interviewee as "*the external arm of the IEP*", the CEE aims to inform and foster a community of practice in engineering education research and innovation, bringing together instructors and educational experts at an institutional, national and global level.

[1] Integrated Engineering Programme: https://www.ucl.ac.uk/engineering/study/undergraduate/how-we-teach

[2] Connected Curriculum: https://www.ucl.ac.uk/teaching-learning/connected-curriculum-framework-research-based-education

[3] UCL Academic Career Framework: https://www.ucl.ac.uk/human-resources/policies/2021/mar/academic-career-framework

[4] UCL Centre for Engineering Education: https://www.ucl.ac.uk/centre-for-engineering-education/

2. UCL's experience of emergency teaching in engineering

2.1. Emergency teaching restrictions

In response to the COVID-19 pandemic, UCL took a 'safety first' approach to its emergency teaching restrictions, characterised by one interviewee as "*a mixture of pragmatism and the extreme end of the spectrum in terms of safety*". UCL is home to a number of prominent global experts in public health and this expertise base undoubtedly guided their approach, making it one of the first UK universities to suspend all in-person teaching (from 13th March 2020) and announce its plans for a fully-online curriculum throughout the 2020/21 academic year. While all curricular teaching and assessments were delivered online during this academic year, some optional 'enrichment' activities were held on campus between September and December 2020. Characterised as being "*educationally valuable, but not part of the core learning*", these 'enrichment' activities included informal talks, tutorials and lab exercises.

In mid-March 2021, UCL announced that the 2021/22 academic year would be delivered in a blended mode, termed "*blended by design*", with in-person sessions focused primarily on practice, practical, interactive and group-focused activity. Where lecture classes are very large and unlikely to enable meaningful interaction, instructors are encouraged to consider online approaches if appropriate.

2.2. Managing the transition to emergency teaching

Interviewees consistently characterised UCL as "*quite a bottom-up 'let all the flowers bloom' type of institution*", with an open and flat hierarchy. Despite its wide disciplinary base and size – spanning twenty thousand undergraduates – the university has historically taken a highly consultative approach: almost all major institutional changes have been built on community-wide dialogue and consensus. The immediate closure of campus and pivot to online learning in March 2020, however, necessitated a rapid, top-down decision-making process that was described as "*just the opposite of what we do at UCL*". The university established what was termed a "*Gold, Silver, Bronze crisis management structure*" (GSB)[5]: a protocol often adopted during disaster response by UK emergency services that separates strategic, tactical and operational decision-making. Most of the key decisions made through this GSB approach were relayed to the UCL community via virtual town hall meetings: "*if there was an issue that we needed to talk about, we just got all the important people into a virtual room and we had a town hall*". Although in-person town hall meetings have long been a feature of UCL, interviewee feedback suggested that the virtual format, and the importance of the information being relayed, drew much larger and more diverse audiences following the introduction of emergency teaching. With each focused on a different topic of particular interest, such as the first-year experience or the recording of lectures, these virtual town hall meetings were held up to twice a week during the summer of 2020, and allowed major

[5] Gold, Silver, Bronze crisis management structure: https://www.ucl.ac.uk/coronavirus/ucls-planning-and-response/covid-19-crisis-management-structure-ucl

decisions to be conveyed rapidly and clearly. In conjunction with the Unitu[6] 'student voice' platform, virtual town halls were also used as a mechanism to capture community-wide experiences and feedback on these key topics. Indeed, it is interesting to note that, although the GSB command structure was only employed for the first six months of emergency teaching, virtual town hall meetings have continued to be a regular fixture at UCL, with community feedback as a major focus.

The pivot to emergency teaching in March 2020 came two weeks prior to the end of UCL's second term of the academic year; the third and final term is almost exclusively devoted to end-of-year exams for undergraduate programmes. The early focus for managing UCL's online pivot at the undergraduate level was therefore on assessment: how best to deliver the end-of-year exams remotely. In light of the size of UCL's undergraduate population, their geographical spread across time zones, and concerns about the capacity of the university's learning management system, the decision was made that all UCL exams would be online 'open-book' assessments, each undertaken over a staggered 24-hour period. The process of transitioning the exams to the new online format, for many, shone a light on "*the scale of how much assessment we do*" at the undergraduate level, with 1086 items of assessment planned for the end of year exams in UCL Engineering alone. In particular, it was observed that half of all undergraduate exams were taken by first-year students. In response, and as a means of reducing the overall assessment burden and the stress placed on students, UCL replaced all first-year exams with a single integrated assessment. Termed Capstone Assessment, it was described by one interviewee as "*a single piece of assessment, a self-reflection, that synthesised how students achieved their learning objectives for the year*". Although UCL offered examples of how such a synthesis assessment might be achieved, it was left to each department to design their own approach. Across UCL Engineering, the first-year Capstone Assessment ranged from an open-ended "*robotics build*" in the *Electronic and Electrical Engineering* programme, to a reflective series of essays on how students had met the competencies set out in their disciplinary professional engineering standards in *Civil, Environmental and Geomatic Engineering* programme. A number of interviewees went on to suggest that assessment had long been an "*Achilles heel*" for UCL Engineering: while the IEP had radically reformed the curriculum, the end-of-year exams were left largely untouched. They went on to note that "*more changed in that 10 weeks [in preparation for the 2020 exam period] than had changed in 10 years. These utterly immovable regulations just got swept aside… A lot was learnt around assessment*".

In parallel with the roll-out of end-of-year exams, preparations began for the 2020/21 academic year. Interviewees noted that the early announcement of UCL's fully-online delivery for the 2020/21 academic year offered clarity to instructors, and ensured that "*time was not wasted*" by preparing for alternative scenarios (such as blended or hybrid teaching) depending on the COVID-19 restrictions in place. Interviewees nevertheless suggested that the summer vacation "*was a mad scramble to prepare for the start of term*". Within UCL Engineering, a major focus for the online pivot was the team-based projects that punctuate the IEP curriculum: in particular, how to design these student-centred and collaborative activities for delivery online. One added burden for the 2020/21 academic year was the

[6] Unitu Student voice platform: https://unitu.co.uk

size of the incoming first-year cohort. Due to COVID-19 restrictions, the UK government opted to replace A levels (the public exams taken by high school students prior to university enrolment) due to be held in 2020 with grade predictions made by pupils' teachers. A consequence of this change was that a far greater proportion of prospective students achieved the grades needed to gain a place at UCL Engineering and the school's undergraduate intake numbers increased by nearly 50%, from around 900 to 1350. As the school faced its first semester of fully-online teaching, therefore, it also had to support an out-sized incoming student cohort, most of whom were unlikely to meet peers face-to-face throughout the academic year.

Despite the challenges, the online pivot at UCL undoubtedly benefitted from considerable institutional investment in its teaching and learning workforce. Over the preceding decade, the cadre of education-focused faculty that had grown considerably; in addition, a range of new roles were established in response to emergency teaching. These roles included *Student Success Advisors* (to offer mentorship and advice to first-year students), a significant expansion of instructor hours allocated to Post Graduate Teaching Assistants (PGTAs) and (in the case of UCL Engineering) an increase in the number of Learning Technologists allocated to the school from one to four and the appointment of new undergraduate teaching assistants. In addition to this investment in human resources, the transition of UCL's engineering programmes to online delivery was guided by two broad strategies – driven by the university and the school respectively – as outlined below.

The **first strategy** was to establish a clear benchmark for what constitutes minimum acceptable practice for online education at UCL and to offer instructors targeted support for meeting this threshold. In April 2020, UCL launched the *Connected Learning Baseline*[7] which (building upon the university's *Connected Curriculum* approach[2]) provides a checklist of components and features that embody good practice in online teaching and learning. A web of information, resources and support mechanisms were put in place to assist instructors to meet this Baseline when pivoting their courses for online delivery. These included an asynchronous, eight-hour professional development course[8] in online learning (in which half of UCL's 6000 instructors have already participated) and the appointment of *Connected Learning Leads* in each department (to inform and coordinate the development of digital learning resources within that discipline). At the same time, and in response to the online pivot, UCL Engineering established the *Learning Technology Unit* (LTU) to offer strategic advice for school leaders and provide "*a one-stop-shop for information and help*" for instructors in the transition to online teaching. Accessed via a dedicated website[9], much of the support offered by the LTU focused on helping instructors to meet the Baseline. This included: training programmes in online learning (including a mandatory course for all PGTAs); technical advice (such as how to record videos from home); and pedagogical guidance (such as how to conduct formative assessment online).

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[7] Connected Learning Baseline: https://www.ucl.ac.uk/teaching-learning/publications/2020/may/ucl-connected-learning-baseline

[8] Connected Learning Essentials course: https://www.ucl.ac.uk/teaching-learning/education-planning-2020-21/staff-development-prepare-teaching-and-assessment-2020-21/ucl-connected

[9] Learning Technology Unit, UCL Engineering: https://uclengltu.com

The **second strategy** to support the online pivot was specific to UCL Engineering and involved seeding exemplars in online education that went beyond the Baseline, to inspire and catalyse more ambitious change across the school. Departments were each asked to identify two courses that would become such exemplars – termed 'gold' courses – which were joined by three of the 'shared' IEP courses that bring together students from across UCL Engineering. The leaders of each 'gold' course received support from the LTU to optimise their structure and pedagogy, including: a six-week training course (to advance pedagogical development in active online learning); a dedicated LTU consultant (to support course design and planning); and a student assistant (to help develop resources and evaluate teaching materials). A major focus for 'gold' courses was to embed an active and collaborative approach throughout the synchronous and asynchronous activities. It should be noted that one of these 'gold' courses was Mathematical Modelling and Analysis 1 (MMA1), as described in Part A of this case study.

Interview feedback suggested that, in combination, these two strategies have been highly effective in driving the rapid development of a robust set of online engineering courses that, in the words of one university leader, "*put technology and e-learning at the heart of what we were doing".* With multiple opportunities for active learning and collaboration with peers, student participation and engagement in the UCL Engineering Virtual Learning Environment (VLE) appear to have been high.

2.3. Addressing the challenges of emergency teaching

Interviewees pointed to a range of challenges faced by UCL Engineering during the period of emergency teaching. Three challenges were identified repeatedly, as described below.

The **first challenge** was sequencing and managing students' workload. Many interviewees noted the extent to which the online pivot had affected students' ability to plan, prioritise and manage their learning which, in the words of one, often left them feeling "*overwhelmed and overworked*" at a time of physical isolation from peers and instructors. In particular, they pointed to the absence of informal interactions and out-of-class discussions that, when studying face-to-face, help students to both build awareness of how their courses are structured and identify the threshold concepts that are critical to their advancement. These interactions can include non-verbal cues picked up by students (such as "*those micro moments when you look at the person sitting next to you and they're not taking notes, so you know it's not important*") and their instructors ("*the different ways that you find to explain the same thing to students when you can see from their body language that the team is a bit lost*"). Interviewees went on to note that the online pivot stripped many of these informal interactions from the students' learning experience. This was understood to have left many students unable to conceptualise the structure and expectations of their courses, as well as gauge the relative priority of different course elements and topics: "*students are thinking everything is as important as everything else, and they're taking two hours to do an hour's worth of work, and they become completely overwhelmed because all they see each day is just more stuff to do and no respite".* Interviewee feedback suggested that these experiences had led to both high attainment and high levels of stress amongst students. Many went on to note that one of the key 'lessons learnt' from the experience of emergency online teaching at UCL Engineering was the

importance of clearly articulating the structure, deliverables and key learning goals of each course and "*walking students through the semester, step-by-step*". Particular attention was also paid to establishing regular 'office hours' sessions to provide informal help and support to both individual students and projects teams. Another strategy that proved successful in fostering peer support and addressing students' specific concerns was the widespread use of asynchronous online forums, which were established across UCL Engineering both at a course level and programme level.

The **second challenge** repeatedly identified was establishing a suitable online environment for effective team-working. Interviewee feedback pointed to a number of practical barriers that worked against open and productive group collaboration in an online environment. One was simply the fact that, as emergency teaching progressed, the proportion of students that switched their web-cams on for group working sessions progressively decreased: "*sometimes there is just a blinding silence in the breakout room and all of the cameras are off*". Another was the home environment in which many students were working, as noted by one UCL Engineering leader:

> *"one of the things that has come out most strongly in all of this is just the different resources that different students have, whether it's stable wi-fi, somewhere to work, home life, other responsibilities, all the sorts of things that you didn't know when they were in-person... when you bring people on to campus and you put them in your environment, certain things are possible. When you're asking people to do things in their environment, you have to be much more cognisant of what that environment is".*

UCL Engineering's team projects also faced the challenge of cross-time zone working. The school's undergraduate population is a very international group. Less than a third (31%) of the first-year cohort that joined the school in 2020/21 were from the UK. In some departments, the proportion of non-UK students is higher still: in *Electronic and Electrical Engineering*, 85% are drawn from outside the UK. With most based in their home countries during the 2020/21 academic year, students were engaging with the online UCL curriculum from a wide range of time-zones. This time-zone diversity presented a particular challenge for synchronous participation in the intensive, full-time, team-based projects that punctuate the IEP, such as the week-long 'scenarios'. One consequence, for example, was that some teams, in the words of one interviewee, "*broke the project down, split up the tasks and worked alone, without really collaborating*". These challenges appeared to be exacerbated for students whose competence in the English "*language is not at a level where they are confident to be able to engage with their teammates online*". UCL Engineering adopted a number of strategies to overcome these challenges. One was to preserve the middle hours of the day in the UK – a time-window most likely to be convenient for students accessing their education from abroad – for team mentorship and guidance. Another was to extend the interdisciplinary project taken by all first year undergraduates from five weeks to eight weeks, to allow more time to build connectivity and trust within each team.

The **third challenge** consistently raised was that of fostering community and connectivity across the engineering student population. While the IEP's online pivot offered a range of mechanisms for collaborative learning through team projects, what was missing were opportunities for students to connect informally outside of the formal curriculum, such as "*after a lecture or in the lift lobbies*". The

absence of these interactions was felt most acutely by the cohort of first-year students, most of whom had yet to meet peer students face-to-face. While UCL's student clubs and organisations appeared to have some success in providing online opportunities for students to build social networks, what proved more difficult to re-create online were the "*intellectual interactions rather than the social interactions*": the friendships and communities of support rooted in the shared experience of their engineering programme that help students to connect ideas, extend their thinking and spark new interests. Attempts were made by UCL to bridge this gap, such as through the establishment of *Virtual Common Rooms*[10]: online spaces where students from the same department or course were able to connect together. However, without a clear driver or objective for joining these common room sessions, student participation to date has typically been low. One department that has had more success in engaging students in activities that blend the social and the academic has been Computer Science. During the 2020/21 academic year, a number of Computer Science courses have been delivered via the web conferencing software *Gather.Town*[11], and students have been encouraged to remain in this virtual space between classes to "*walk around, meet each other and play [online] games*". Following the success of a (purely social and optional) all-day online *MegaGame*[12] held in early 2021, UCL Computer Science are also planning a virtual competition for the start of the 2021/22 academic year. Designed to "*build both fun and engagement*", students will be asked to develop and incrementally improve their own algorithms to play an online card game, where success and gameplay will be followed in real time and charted in an anonymised league table.

3. Impact of emergency teaching on future educational approach

Interviewees repeatedly noted that the experience of emergency teaching had called many in the global higher education community to "*ask big questions like 'what is a university for?' and 'what is the value [that] going to university adds?*'" and the UCL community had been no exception. Interviewees, however, went on to suggest that it was still "*too early to make a call*" on how the UCL Engineering education will be impacted in the longer term. For example, it was suggested that the true scale and nature of the effect of the pandemic and emergency teaching upon student mental health was unlikely to be fully understood for months or even years to come. In addition, while the importance of student competencies such as digital literacy, time management and resilience have come to the fore during emergency teaching, no decisions have yet been reached on whether or how they might be accommodated in revisions to the UCL Engineering graduate attributes in the future. Indeed, interviewee feedback made clear that school leaders and instructors were still primarily focused on the immediate challenges of emergency teaching: "*everyone's sort of looking day-to-day at the moment... there is an element of 'we've come out of something that feels like a war zone' and everyone is just still exhausted*".

[10] UCL Virtual Common Rooms: https://www.ucl.ac.uk/students/academic-support/ucl-virtual-common-rooms

[11] Gather.Town: https://gather.town

[12] Stone Paper Scissors games: https://www.stonepaperscissors.co.uk

Nonetheless, while no clear consensus emerged about the long-term impact of COVID-19 on the UCL Engineering education, interviewees consistently anticipated that the consequences of the pandemic would "*quicken the pace*" of a number of major educational changes already underway in the school. This acceleration was understood to be the product of two disruptive factors: the experience of emergency teaching (as a result of which, online delivery was likely be one of the significant teaching modes at UCL for at least two-and-a-half years overall) and the single outsized cohort of students that joined UCL Engineering for the 2020/21 academic year (who will be moving through the engineering undergraduate programmes until 2024). Interviewees spoke, in particular, about how these factors combined would lead to an acceleration of existing changes in three areas, as described below.

The **first area** of accelerated change was expected to be in the embracing of blended learning. The educational model to be adopted by UCL for the 2021/22 academic year is described as "*blended by design*": a blended-learning approach that combines, in the words of one interviewee, "*asynchronous content delivery with meaningful face-to-face activities, like tutorials or projects*". Interviewee feedback pointed to a widespread expectation that this approach would continue beyond the period of emergency teaching to become part of standard practice at the university. Interviewees noted that "*we have come a long way since COVID hit*" in designing and curating online materials that both engage students and support deep learning. In addition, and continuing on the pathway established by the IEP, interviewees suggested that it would soon become the norm that all face-to-face learning in the school would be dedicated primarily to active and experiential learning. Indeed, one university leader predicted that "*we will not be bringing big groups of students on to campus anymore unless it's for meaningful interaction, person-to-person individual peer-to-peer and student-to-teacher interaction. It won't be to sit in some lecture theatre*".

The **second area** forecasted for accelerated change was in the creation of new flexible learning spaces that facilitate informal collaborative learning. Interviewees anticipated that, hand-in-hand with the widespread adoption of blended learning, there would be an acceleration to the reform of UCL's physical estate: "*I think that the days of raked lecture theatres are gone... it's the informal learning spaces that we will need: flat flexible spaces that are a blend between learning and social are going to be the new common spaces that will be developed*." These informal, flexible learning spaces will not only be utilised for curricular experiences designed for face-to-face delivery, such as team projects and tutorials. In addition, interviewees anticipated that many students would choose to undertake asynchronous online learning activities within such on-campus spaces, often working collaboratively with peers. While open and flexible learning spaces are integral to the design of the UCL Engineering buildings in the university's UCL East[13] development, due to open in 2022, some interviewees suggested that "*UCL will need to think carefully about what spaces we need on our [main] campus and how to use timetabling to make sure that students are able to find the best places to work at a given time*".

[13] UCL East: https://www.ucl.ac.uk/ucl-east/

The **third area** where interviewees anticipated fast-tracked change was to the educational culture. Over the past five years, with the introduction of new student-centred educational models (such as the IEP and the *Connected Curriculum*[2]) and a new academic career framework[3], interviewee feedback pointed to a progressive improvement to the status and recognition of teaching and learning at UCL. The effect of this can be seen most clearly in the number of education-focused faculty that have been promoted to senior academic roles in recent years. Some interviewees went on to suggest that the experience of emergency teaching had helped to reinforce and accelerate this ongoing cultural shift at the university. They described, in particular, how a cohort of education-focused academics had "*stepped up to the plate*" during emergency teaching to take on new leadership positions, such as the Connected Learning Leads, that established many as mentors and "*focal points for development and support of their research-oriented colleagues*". Some cautioned, however, that "*it is not a given that this will equate to a long-term elevation in status*" of education-focused academics at the university. They noted that this group "*have taken a disproportionate amount of the burden [of emergency teaching]*" and risked replacing educational leadership and innovation with "*ever increasing teaching loads as researchers became frustrated [with emergency teaching] and want to get back to their research*". Nonetheless, interviewee feedback suggested that the experience of emergency teaching had "*given people who were teaching-focused a stronger voice*" and helped to both increase their visibility and build a widespread appreciation of the contribution that this cohort of education-focused faculty has made.

Indeed, the ways in which UCL has navigated and weathered the online pivot was understood to have "*endorsed a lot of the decisions the university has made*" in recent years to build capacity in and support for teaching and learning. Many also went on to compare UCL's response to emergency teaching to UK peer universities, commending the support UCL has given to students and staff (regardless of their role or position) and the rapid, clear, and evidence-based approach taken to decision-making. In the words of one faculty member: "*UCL has got a lot of things right… when the big edicts came, they were very clear, they were early, and they were right on point*".

Source of evidence

The case study for UCL Engineering (including Part A, the review of the Mathematics Modelling and Analysis I (MMA1) course, and Part B, this review of the 'institutional context') drew upon one-to-one interviews with 21 individuals: UCL's Vice Provost for Student Experience; the Director of the UCL Arena Centre for Research-Based Education; the Director of the IEP; the Vice Dean Education of UCL Engineering; the MMA1 course lead; the UCL Engineering learning technologist; nine UCL Engineering academics (including three departmental leads for MMA1 and two Connected Learning Leads); two PGTAs engaged on MMA1; and four UCL Engineering undergraduates.

Further information about the methodology for development of CEEDA case studies is given at the project website[14].

[14] CEEDA case study structure and approach: https://www.ceeda.org/about#case-studies