CSE Strategic Plan 2022-2027

Executive Summary and Vision

Our successes of the past years flow from our long-term commitment to thematic research, which has given common purpose across our Schools and increased our relevance to funding bodies, industry and donors. This has been beneficial to the College and to the broader University. Data science and AI has long been a major part of University strategy. All CSE Schools now have strong data-intensive activity and our Bayes Centre demonstrates a new style of sustainable innovation that integrates academia, industry and the public sector to find new applications for the technologies that foundational science, engineering and mathematics provide. We have been pursuing similar strategies in biomedicine and data-intensive medicine/healthcare, and in sustainable biotechnology, energy and materials.

For each of these three thematic areas we expect consolidation and growth over the coming years to focus on the aims of Strategy 2030. We will integrate our aims in teaching, research and translation, built on an intentional strengthening of our cross-University collaborations and deepening our ability to address global challenges. In **data science** we will work with the Usher Institute (in CMVM) and the Edinburgh Futures institute (in CAHSS) to create a seamlessly integrated activity in data science and AI for the whole University. In **healthcare and data-intensive medicine** we will deepen engagement with "one health" in CMVM, synchronising developments across areas including genomics, molecular medicine, precision medicine and population health science, engineering/synthetic biology and diagnostics. In **sustainability**, we will focus on the climate crisis. Engineering design and advanced manufacturing for sustainability will be solutions-oriented and we will integrate our work in climate modelling, earth observation, environmental adaptation, social justice, risk and resilience, marine science and energy systems under the broad umbrella of the Edinburgh Earth Initiative. This theme also completes our vision of a new biology, using deep science, data and engineering technologies to drive progress in the circular economy and agri-tech. Crucially, these thematic efforts amplify (not diminish) our deep commitment to foundational study. Our foundational research and teaching makes our translational and innovation capability unique and our translational success makes our foundational research and teaching relevant and exciting. Each of our Schools maintains this balance in a style that is unique to its discipline.

In coming years we will see revolutions in higher education. All world universities recently have tested their limits in new styles of teaching. We must now make the most of our strengths in this area. Our students are diverse, of many nationalities and from many backgrounds and we must continue to diversify intakes, ensure inclusion and widen participation while also strengthening our student cohorts. The arrival of our new Nucleus building is an opportunity, for the first time, to bring more of our students to the KB campus for teaching at all levels. We will use the Nucleus to drive revitalisation of a student-centred community at KB. The Curriculum Transformation Programme provides an opportunity to develop cross-University cohorts with common understanding in the thematic science (for example, data science) that enables other disciplines. In on-line education we have in place much of the essential operational structure to run sustainable on-line programs at University scale and we are exploring practical ways to reach large-scale student cohorts in data science. Our rapid pivot to on-line education during the pandemic provided experience developing virtual laboratories and remote experimentation that provides new ways to reach into virtual education in our other disciplines, and we expect to do so with a particular thematic focus on sustainability. Over the planning period we will balance these opportunities to transform our curriculum and to expand and diversify the range of students we can reach, as we simultaneously develop education on campus and on-line.

The drive for renewal in research and education post-COVID-19 will be highly competitive as economies rebuild. It is crucial, therefore, that our business operation makes it easy for our academic base to excel in its core operation while leaving enough capacity to pursue new opportunities quickly and safely. An imperative in the coming year is to stabilise cross-University business processes in a way that makes these accessible, efficient and transparent to our Schools. The change here is intense, with fundamental change in HR, finance, student support and research support. This root and branch overhaul is over schedule and over budget but there is great

willingness to embrace effective change. In doing so we must gain "headroom" for new value-adding activity not only through more efficient processes but also by simplifying what we do and renewing a focus of support on the student and academic base. Critical requirements for CSE to support our academic success and the delivery of Strategy 2030 include regeneration of our estate and prioritisation of actions to support staff wellbeing, development, diversity and inclusion. All of our plans will place an emphasis on making effective and urgent responses to the climate crisis.

Our vision must be imprecise because the history of science tells us that the most ground-breaking advances come from unexpected sources. We must not lose the instinct to follow the science wherever it may go; learn from those who subscribe to different visions; and adapt as disciplines change.

Reflections on 2021-22 Plans and Operating Context

In the midst of COVID-19, the keynote for 2021-22 was stability and intensity of focus. To this end, the objectives agreed in our 2021-22 plan were:

- *To continue our trajectory towards all our Schools being in the world top 20 and UK top 3 for research*. We await the REF outcome as a key indicator in the UK.
- *To press ahead with our long-established pattern of focused, interdisciplinary, thematic growth in data science, biotechnology, data-intensive medicine/healthcare and sustainable energy/materials*. We have aggressively grown data science in all aspects. In research, £88M of CSE's new grant funding last year is DDI-related. In technology transfer we have delivered the vast majority of City Deal KPIs for the University and have (within College budget) delivered the Bayes Centre with the internal rate of return (IRR) that we forecast (16%), placing it in the top 5% of recent building projects for IRR. We have grown EPCC to support (now) UK-leading data infrastructure and compute capabilities. We also have expanded biotechnology, with our School of Biological Sciences generating more research grant income last year than any other University school (20% of the University total), and also large industry investments (e.g. Fujifilm-Diosynth). In data intensive medicine/healthcare we have supported joint initiatives with CMVM (e.g. Advanced Care Research Centre, Health Data Research UK) and within CSE (e.g. our doctoral training centre in biomedical AI) so we are well prepared for deeper engagement. In sustainability we have supported new groupings (e.g. in environmental change, energy, circular economy and marine science) that are well placed to contribute to the Edinburgh Earth Initiative (which is being run out of our Edinburgh Centre for Climate Innovation). The broad result of these and other initiatives has been an increase in research and industry income of 23% and 65% (respectively) across the College.
- *To accommodate the growth in student numbers.* We were at capacity with the additional students inherited from the previous year's over-recruitment and had hoped to rein back new recruitment this year but Scottish Government's changes to exam diets resulted in a 16% over-recruitment for undergraduates in 2021-22, alongside increased international undergraduate recruitment in many Schools. This has been welcome financially, and has been a reason why we, again, exceeded our targets for contribution to University surplus (an additional £3.7m of unrestricted surplus). However, it has placed unsustainable challenges on our staff and estate capacity, with increased risk of poor student experience. We are addressing these challenges for the future, in getting away from expectations of continual year-on-year growth and to make progress on widening participation and diversifying our international student body.
- *To put greater focus on early career researchers and future leaders in research.* We have (within the recruitment constraints of the past year) bolstered our early career staff and we are grateful for our share of University SFC funding channelled into Schools. More importantly, we have been opportunistic in hiring high-achieving early career staff who brought fellowships with them, allowing us to reinforce our strengths through a period of University austerity. Conversely, there have been surprise shocks – most notably UKRI's regrettable reneging on its Global Challenges Research Fund commitments.

- *To work with University support services across the board to improve the quality of our core services*. Although there has been great effort (and investment) all round, this remains sub-optimal. Initially problematic new systems (HR, ESC, enquiry management) are becoming embedded but none is excellent and despite a lot of activity, change outcomes have been slower than expected (e.g. we have yet to see research support improve). Expected savings to Colleges through broad efficiency gains have not been delivered (in 2019 we were predicting a cross-University saving of £7M this year) and in fact we continue to increase costs in dealing with system change. We are encouraged that this issue is now broadly recognised across the University and we continue our commitment to reach an improved position.

Broad challenges emerging in 2021-22 are:

- Against the odds, the College has grown research, teaching and surplus but this has involved "running the College hot", with unusual and sustained patterns of workload-related stress being reported at all levels and in all staff groups. We wish to avoid a cycle of staff loss/sickness leading to further stress.
- While large scale infrastructure developments (e.g. the KB Nucleus) give great opportunity, our estate at the smaller scale needs urgent attention as a consequence of the (effective) moratorium on small works over the preceding two years.
- We are running out of space for the new research, industry and teaching activity we have initiated. Remote teaching and working during COVID-19 has masked this, to an extent, but availability of physical space is now a limit to increasing activity and income in all our schools.
- Several major University initiatives have begun in the last year and will drive through in the next. These include People & Money, Finance Partnering, Student Support, Growing Research Together, Digital Strategy development and Curriculum Transformation. For a School, this means that simultaneously most of its underlying operations are changing and this occurs at the confluence of differently structured University change processes. This has created complexity (and cost) to the College over the past year, with consequences for future years.

Strategic Performance Framework: aligning activity to performance measures

1 Widening participation: Number (and proportion) of UG entrants from a SIMD0-20 area				
	2018-19	*2019-20*	Baseline: 2020-21	Target
University	*194 (11.1%)*	*200 (11.5%)*	190 (9.3%)	20% by 2030
College	*CSE 41 (8.8%)*	*CSE 33 (7.3%)*	CSE 43 (8.1%)	
Commentary	Widening access to students from disadvantaged backgrounds is an ongoing challenge that has been accentuated by the pandemic which has disproportionately affected students from poorer backgrounds and increased attainment gaps. We are implementing a range of measures that aim to improve access routes, recruitment, support and retention. Future initiatives to build multi-faceted local partnerships (e.g. the Babcock/Fife College Rosyth partnership) will integrate WP activity with our broader thematic developments in research, teaching, impact and industry engagement. We are working closely with the recently launched 'IntoUniversity' project. Centres in Craigmillar, Govan and Maryhill work in partnership with local schools to support learning, aspirational thinking, and transition into higher education. We are rolling out a mentoring scheme that connects young people with researchers and teachers in CSE. With COL we are developing develop a STEM Foundation Programme that removes barriers to undergraduate study. The programme will comprise a suite of pre-undergraduate foundation courses for Widening Participation students (local and global) and fee-paying international students. With zero entry requirements, it will open our doors to the significant pool of students that do not meet our contextual entry requirements. We anticipate this programme will launch in September 2024. To improve recruitment and support, we are currently evaluating practices in our Schools, and will review the WP student experience through surveys and interviews. We support summer schools and school outreach, offer academic support with level-7 courses such as collaborating with a new UK-wide "Levelling Up programme" for mathematics and hosting the Scottish hub for this. We will ensure WP student needs are addressed in curriculum transformation and new student support system. The 2030 SIMD20 entrants target is extremely ambitious despite these actions. Actions to manage the risk to success need to involve: better evidence-based understanding of what works; learning from successful comparator institutions; an institution-wide focus on ensuring that our recruitment message is consistent with messages we present to other audiences (and, importantly, on making that message a reality). The SIMD20 measure only partially reflects progress and may not measure success so well as a more holistic view of widening participation, including retention and outcomes.			

2 International student diversity: Ratio of largest overseas market to 5th and 10th largest markets			
	2018-19	*2019-20*	*Baseline:* 2020-21
University	*Ratio to 5th: 14:1* *Ratio to 10th: 19:1*	*Ratio to 5th: 21:1* *Ratio to 10th: 31:1*	Ratio to 5th: 20:1 Ratio to 10th: 37:1
College	*CSE ratio to 5th: 14:1* *ratio to 10th: 22:1*	*CSE ratio to 5th: 17:1* *ratio to 10th: 36:1*	CSE ratio to 5th: 18:1 ratio to 10th: 35:1
Commentary	Diversity for financial resilience implies recruiting (self-) funded students from wealthy markets, whereas diversity to support social inclusion and offer the benefits of international experiences for more students, would require scholarships. Both outcomes could be achieved, but require very different approaches; the rationale for this target must be clear. Opportunities to increase our intake from a greater range of countries where there is the ability to pay include re-building our European intake, focusing on North America, and emerging South Asian markets. Our developing relationships in India through the Gujarat Biotechnology University and other opportunities emerging from this should increase our profile and recruitment in South Asia. Other actions in development include potential 2+2 programmes with South Korea and Singapore and trialling different phased offerings to better suit application markets for different countries. New programmes, the development of online distance delivery and more flexible learning options may help to break into or expand new markets. Our thematic areas of data, health and sustainability should offer particularly attractive options. Our online Data Science, Technology, and Innovation part-time lifelong learning MSc is part of our strategy to increase diverse international student participation through collaboration with international partners in Europe and Africa with a view to scalability. We see an opportunity through the Edinburgh Earth Initiative to expand internal or externally-funded scholarships in order to recruit from a more diverse and socially-inclusive international student population. Lack of clarity on the institutional support available towards agreed diversification priorities presents a risk to progress.		

	The ratio to 5th is a useful measure, but whilst the 1st market is such a huge country, comparison with smaller countries is skewed. Consider ratios for regions rather than individual countries.	
3 Staff equality, diversity and inclusion: Gender, ethnicity and disability pay gaps		
	2018-19	Baseline: 2020-21
University	*Average gender pay gap: 16.7%* *Average ethnicity pay gap: 7.9%* *Average disability pay gap: -2.4%*	Average gender pay gap: 16.2% Average ethnicity pay gap: 7.1% Average disability pay gap: 0.97%
Commentary	We recognise that societal factors are at play, but improvements are underwhelming, which points to need for a better understanding of the causes and a more coordinated approach. We are working to develop a suite of focussed and affirmative actions across the College. The CSE Oct 2021 Equal Pay Report identified the main drivers of pay discrepancies across the College. For gender, a key contributory factor is unequal distribution across pay grade, with fewer women in higher compared to lower grade roles. We plan to introduce measures to increase the fairness and transparency of recruitment and progression. Clearer guidelines on starting salary negotiation are being developed. We are also evolving EDI-focussed measures to reduce the likelihood of pay imbalances arising from contribution awards. Data indicate the highest average salary gap is between men and women is at grade 10. We are therefore reviewing current practices and are considering the requirement of college panels to review grade 10 reward nominations. To improve recruitment diversity, we are preparing information and guidance for managers that highlights best practice. To remove potential biases and improve reach to under-represented groups, we are reviewing advertising practices, information supplied to candidates and selection procedures. We have introduced targeted fellowship schemes in some disciplines aimed at under-represented groups. In future, coordinated interdisciplinary recruitment drives to our thematic areas may help to increase diversity of applicants; we have seen this positive 'cohort effect' previously with Chancellor's Fellow recruitment. We are also using improved connections to alumni to ensure that we draw on as wide and diverse a mix of role models for our staff and students as possible.	
4 Efficient systems: Benefits realisation from P&M and associated HR and Finance changes		
Commentary	Benefits realisation (financial savings or improved processes) from continuing SEP changes is a long way off. Almost all changes so far have created increased workloads/more complex systems requiring more staff resource and/or slowing down processes. The design intention of efficient direct access on which People & Money was built has not delivered expected benefits due to the complex nature of most interactions. There is a risk that without additional insulation or delegation measures, the finance launch will further increase administrative burdens on (academic) staff and divert from income-generating outputs. Ability to refine and develop ways of working with our new systems and structures to streamline and improve is likely to be a 2-3 year timescale. In the meantime, we continue to incur costs of insulation of our core activities against the impact of change. Our Schools continue to devote management and subject matter expert time to engage fully in order to support governance and people transition processes, understand and implement imminent change (e.g. P&M, FBP, student support) and contribute to design of future change (e.g. GRT/Digital Strategy). We comment elsewhere on the burden of change for staff wellbeing and productivity. To increase efficiency we are addressing a lack of resilience in some College professional service areas and piloting shared service resource, seeking to limit unnecessary siloed ways of working or costs. We are interested in developing an understanding across the institution of how best to reduce implementation risks, support and deliver well-coordinated strategic change in future through a mixture of local and central change management support capacity. The pandemic delivered good examples of deeper relationships and working to resolve challenges (the successful management of buildings and re-opening processes is a good example of closer working between Colleges/Schools, Estates, and H&S). We have benefited from a greater "team spirit" across the institution, receiving and providing support in response to challenges experienced by different units. In CSE we are committed to building on this in our interactions with colleagues across the University.	
5 Staff engagement		
Commentary	There have been great examples of good practice in staff engagement during the pandemic. We intend to build wide staff and student community engagement in the coming years with our sustainability theme. However our community has been disrupted and staff engagement negatively affected by uncertainty and impact of multiple change programmes, COVID-19-related workloads, perceived distance between rhetoric and reality when it comes to staff wellbeing and value. Remedial actions planned in CSE include improving internal communications, better supporting staff induction,	

	career development and training opportunities (in all roles, and particularly supporting early career academic staff and associated issues of research culture), and ensuring effective management capacity. Sufficient resourcing of HR support to deliver these actions may be a barrier to success. Staff morale remains a challenge in this context and in light of the many operational difficulties, administrative friction points related to flawed systems, very high workloads, and constant change. Workload is the biggest risk to staff wellbeing and we have yet to find meaningful at-scale options to 'stop doing things'. This is exacerbated by the volume of requests for action (often unexpected or last minute) generated in different parts of our university which land on the same small number of individuals over short periods. As well as deeper analysis within the College, coordination of institution-wide activity is needed to clarify which of many actions are the highest priority, and which must be deferred. A renewed focus on the strategic priorities via this five-year plan may help to identify what we should stop doing. A key area of stress for staff is the poor state and lack of space in our working environment. A critical action for CSE in 2022-23 and beyond is to achieve improvement in the physical environment alongside successful implementation of hybrid working.

6 Research quality/competitiveness: REF performance, supported by a between-REFs proxy such as share of UKRI income

	2017-18	*2018-19*	*Baseline 2019-20*
University	*5.8%*	*5.2%*	5.4%
Commentary	The University submitted returns to 28 of the 34 units of assessment including joint submissions in CSE with St Andrews (Chemistry) and Heriot-Watt (Mathematical Sciences, Engineering). CSE returned 848 independent researchers, contributing to a total UoE increase of 46% compared with REF2014. Roughly half this increase reflects a change in REF rules such that every eligible researcher was returned. The other half is genuine growth. UoE reported 50% more PhD completions and 66% more research income per annum compared with the last REF. 65 impact case studies were submitted from CSE. Our three broad strategic themes will identify opportunity, raise awareness and facilitate multidisciplinary consideration and connectivity to further improve our research quality and competitiveness. Post REF2021, and mindful of the new funding landscape, CSE Schools are reviewing their research strategies in this context. The CSE College Impact Committee (CIC) has been re-established with refreshed terms of reference: to share School impact strategies, outcomes and best practice, identify synergies, and consider and develop cross-disciplinary strategic impact activities. Additionally, the CIC aims to encourage and support activities to generate and monitor impact and innovation from research. CSE is actively participating in the GRT programme to design a University research support ecosystem that enables us to thrive in an increasingly fast-changing, competitive funding environment.		

7 Research activity: Total research income

	2018-19	*2019-20*	Baseline: 2020-21
University	*£286M*	*£296M*	£324M
College	*CSE: £112.3M*	*CSE: £129.9M*	*CSE: £169M*
Commentary	CSE Research Award total in 2020/21 was £169M (21% increase on the previous year) with 70% coming from Research Council and Government Sources. Charitable funders accounted for 20%. 7.6% was from Industrial Sponsors with the remainder attributed to Other Sources. CSE have reported £54M in awards during 2021/22 to 31st December 2021 with a further £37.6M marked by ERO as indicatively successful. Over half of this is attributed to 4 high value awards. New additions to the suite of Management Apps and reports the College offers around Research Applications & Funding will inform future planning. Our thematic areas are designed to build value propositions that ensure success in future competition for research income, diversfying our income sources to attract more industry and strategic funding. Our strong links with EPSRC continue after promotion to the top tier based on our historic awards success. We are hosting a NERC virtual meeting between UoE Senior Leadership and their Executive Leadership and will use this opportunity to hold strategic discussions around NERC priorities, concerns and funding opportunities. UoE has been identified as the training partner for the Rosalind Franklin Institute's new PhD training programme. CSE continues to be very successful with funded Fellowships schemes through Research Councils, ERC, Royal Society, Wellcome Trust and Leverhulme Trust. A further 3 UKRI Future Leader Fellowships have been awarded to colleagues in Biological Sciences, Chemistry and Physics & Astronomy. We		

<table>
<tr><td></td><td colspan="3">have appointed one of the first Turing AI World-Leading Researcher Fellows. The fellowship includes establishing the Edinburgh Laboratory for Integrated Artificial Intelligence (ELIAI).</td></tr>
<tr><td colspan="4">8 Research activity with industry: Total value of industrial and translational research awards</td></tr>
<tr><td></td><td>2018-19</td><td>2019-20</td><td>Baseline:2020-21</td></tr>
<tr><td>University</td><td>£49.6M</td><td>£55.4M</td><td>£78.6M</td></tr>
<tr><td>College</td><td>CSE £23.7M</td><td>CSE £19.1M</td><td>CSE £27.1M</td></tr>
<tr><td>Commentary</td><td colspan="3">Engineering and Informatics are the main current drivers, accounting for 75% by value of industrial awards in 2020-21. Three sponsors (incl. their subsidiaries) accounted for 52% of industry awards (by value) in 20/21. There is £0.5M currently in the applications pipeline. Translational Funding is more diffuse with UK Government and UKRI Research Councils the main source of funding. There is £3.56M currently in the applications pipeline.
EPSRC IAA has continued to be utilised strategically to grow and nurture industrial partnerships through secondments and collaborative projects. The additional flexibility of the forthcoming UKRI harmonised award will enable cross-University, cross disciplinary activity for UKRI benefit. This builds on successful established IAA mechanisms (secondments, open calls, strategic partnership development, AIM days, Fast Forward events) and we plan to exploit the greater flexibility in support e.g. through the relaxation of the requirement for previous UKRI grant funded activity. CSE continue to exploit opportunities afforded by the EPSRC Prosperity Partnership scheme with a joint application with HWU involving Leonardo UK currently under consideration.
All our disciplines are increasing industrial activity, with strong engagement by early-career appointments. For instance, the Fujifilm Diosynth UK Prosperity Partnership has now commenced, strengthening the strategic relationship established through UoE's lead in the FDUK Centre for Bioprocessing 2.0. This contributes to a broader pipeline of Biological/Life Science activities. In Chemistry, 52% of REF-eligible PIs had some form of industrial engagement in 20/21. Investment in the Edinburgh Complex Fluids Partnership paid off for REF Impact Case studies in Physics, and this group is building external industrial income. An NDA signed in Mathematics will shortly have a significant UoE-wide announcement. Future focusing of our research onto thematic priorities with clear translational opportunity will help to increase success in this performance measure.</td></tr>
<tr><td colspan="4">9 DDI Innovation and collaboration: Research and entrepreneurship related to City Deal TRADE targets</td></tr>
<tr><td></td><td>2018-19</td><td>2019-20</td><td>Baseline: 2020-21</td></tr>
<tr><td>University</td><td>Research grants secured: £117.8M
Start-up companies 21</td><td>Research grants secured: £192.2M
Start-up companies 37</td><td>Research grants secured: £173.5M
Start-up companies 57</td></tr>
<tr><td>Commentary</td><td colspan="3">This is a core area of activity for the Bayes Centre, supported through (1) extensive business development activities that focus on raising industry funding for research and innovation projects and (2) growing a community of industry partners associated with Bayes through co-location, virtual membership, and project-specific collaboration. Bayes activity lies at the heart of DDI – we have benefitted from an institution-wide growth of research and entrepreneurship activity since our launch, but also significantly contributed to producing TRADE deliverables over and above targets set out by the City Deal. An important element of our contribution to entrepreneurship targets is our support of the wider local and regional tech ecosystem. This is enabled by bringing start-ups and SMEs into the University through a range of entrepreneurship and investment programmes, while at the same time supporting University spin-outs and spin-offs.
Our contribution to delivering DDI industry income targets for research and adoption projects has focused on connecting academic staff and students to industrial opportunities with a focus on providing connectivity across disciplines within CSE (and beyond). We have established a strong brand as an entry point for industry to the University's expertise.
<table>
<tr><th></th><th>2018-19</th><th>2019-20</th><th>2020-21</th></tr>
<tr><td>Bayes-tagged Industry research grant awards from across the University (not just CSE)</td><td>£4,307,946</td><td>£10,061,835</td><td>£6,003,242</td></tr>
<tr><td>CSE</td><td>£4,300,061</td><td>£10,054,053</td><td>£5,997,000</td></tr>
<tr><td>CAHSS</td><td></td><td>£7,782</td><td></td></tr>
<tr><td>CMVM</td><td>£7,885</td><td></td><td>£6,242</td></tr>
</table>
The tagging of all DDI-related research grants, which is performed by Bayes as part of its role within the DDI Programme has resulted in a total research income of £243.7M (not just within CSE) being returned as "data-driven research" (27% of total University research income).</td></tr>
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10 Curriculum transformation	
Commentary	Several CSE Schools had initiated curriculum renewal prior to the launch of the Curriculum Transformation Programme, and some opted to accelerate change in response to COVID-19-driven impact on teaching. We seek to develop a consistent UoE and College vision building on these changes. CSE is fully engaging with the Curriculum Transformation Programme and intends strong engagement with students, employers, and other external institutions. We see clear opportunities to build common approaches and content around CSE strengths in employability, skills and experiential learning, and our thematic areas of data and sustainability. Curriculum transformation will not succeed unless we invest in change. We anticipate the requirements for successful engagement and delivery, starting in 2022-23, will include: • Backfill and support resource in Schools to enable full academic engagement with curriculum design and implementation. • Robust systems to underpin course and programme administration. • Development of our estate and digital infrastructure (including learning technology expertise) to support new teaching modes.

11 Talent – data skills: 83,000 people gaining qualifications via certified data skills courses and MOOCs			
	2018-19	*2019-20*	Baseline: 2020-21
University	*9,676*	*11,602*	12,284
Commentary	CSE makes a major contribution to this performance indicator. There is strong cross-School/cross-College engagement with many schools taking opportunities to increase relevant data skills courses through shared teaching resource. Informatics' Data Science Unit also offers data skills courses for researchers in the University. The Bayes Centre runs the Data Science, Technology and Innovation (DSTI) online learning postgraduate programme which is part-time intermittent, enabling students to study while they work. The programme continues to grow both in student numbers and in the number of courses available from all three Colleges with 10 Schools/Deaneries contributing courses. Credit-bearing courses are also available to students on the Data Skills Workforce Development Upskilling portfolio, a £1.1M SFC funded University-wide initiative, with financial management and reporting led by the Bayes Centre. Course contributions come from all three Colleges and DDI Hubs. Bayes promotes data skills MOOCs across the University to students and is involved in Una Europa, contributing to MOOC/Lifelong learning activity related to data skills training.		

12 Student experience: student satisfaction - the NSS and other national student surveys				
	2018-19	*2019-20*	Baseline: 2020-21	Target
University NSS	*79%: quartile 4*	*78%: quartile 4*	71%: quartile 4	TBD - Quartile 1
University PTES	*83%*	*78%*	73%	
University PRES	*79%*	*N/A*	71%	
College NSS	*CSE: 76.3%*	*CSE: 78.7%*	CSE: 78.8%	
College PTES	*CSE: 78.5%*	*CSE: 79.1%*	CSE: 86.0%	
College PRES	*CSE :79.2%*	*N/A*	CSE: 73.8%	
Commentary	CSE Schools have no consistent pattern in NSS outcomes. Some of our Schools in some years place much higher than the UoE average and in the upper quartile for Russell Group. We have set up College-level student staff liaison committees (UG and PG) to give a greater student voice. Student Experience work will include reducing assessment, clearer marking and assessment guidelines, more training and mentoring for teaching, improving mechanisms and offering more diverse options to elicit student feedback, and community building initiatives. To support future student satisfaction we must improve technology installation to a consistent standard across our teaching spaces and create upskilling opportunities for staff in effective use of learning technology. PRES results also show considerable variation. PGR student concerns centre on research culture, which inevitably took a hit during the pandemic. Student satisfaction with supervisors remains high. We have strengthened the student voice with dedicated EUSA PGR reps. Issues raised by our students centre around the poor quality/lack of space for PGR students on our campuses, and around feelings of isolation. Our plans for building community and proposals for investing in our estate will support improvements.			

13 Graduate outcomes: Graduate entering graduate level employment or further study

	2017-18 Graduates	Baseline: 2018-19 Graduates
University	*87%*	86%
College	*CSE: 91.6%*	CSE: 89.9%
Commentary	2018-2019 figures show CSE places 7th in UK benchmarking for this KPI. In some areas (Chemistry and Informatics) we are in the top three with rates around 97%. In Mathematics and Biological Sciences, which have lower rates than our average, we are trialling approaches such as creating a Director of Employability role, a student portfolio for skills recognition, and the introduction of more skills and learning advice related to employability within our student support provision as well as strengthening link to Careers service. Over the next 5 years we intend to increase opportunities for students to develop and recognise transferable/employability skills, entrepreneurship training, work experiences and exposure to industry-linked study through integrating research and teaching in our thematic areas. We aim to build on successful alumni engagement to provide more opportunities for industry engagement and innovation in the curriculum and as extracurricular activity. Provision of student Makerspace and use of the KB Nucleus will facilitate industry engagement and activities linked to employability.	

14 Social Impact	
Commentary	CSE delivers social impact through translational research outputs, our graduates and our community engagement. Our future thematic areas are designed to increase our local and global impact and commitment to make the world a better place. Current examples include: • Delivering the scientific evidence base to improve air quality measurement standards. • Research into the impact of remediation of peat bogs on carbon capture, presented at COP-26 in UN Policy Forum • Opening up data skills training to audiences who would otherwise not benefit from University-level teaching • Creating, supporting, and raising funding for initiatives with a focus on societal benefit (e.g. 'AI for Good' theme); and the overall focus of the Bayes Centre on regional economic development and prosperity • Curriculum ambassadors supporting secondary school teachers in Edinburgh • A project to set up a tutoring network with UoE students who tutor exam-level school students (National5, Higher and Advanced Higher) • A range of projects relating to COVID-19, e.g. development of the 'Permafrost VacSafe' portable cold box which stores vaccines without the need for a direct power supply.

15 Innovation – number of start-up companies			
	2018-19	*2019-20*	Baseline: 2020-21
University	*64*	*85*	110
CSE staff	*5*	*5*	5
CSE students	*25*	*32*	2
Commentary	After three years of growth in student start-ups, 2020-21 was anomalous. We infer this is likely to have been affected by COVID-19, not least since many CSE start-ups will be based around innovation arising from practical work and lab activity. We speculate that we may not see recovery until 2023-24, since the impact of reduced practical work may take time to work through. Start-ups based on data-driven innovation may buck that trend. Through programmes hosted by the Bayes Centre such as Venture Builder, the AI Accelerator, Engage Invest Exploit, and our online entrepreneurship training course we lead on DDI entrepreneurship activity at the University and have enabled delivery of outputs that exceed City Deal targets. Our ambitions for student Makerspace at KB, thematic links between research and teaching, and more industry engagement with student activities will support student start-up creation. Staff start-up rates are steady and we have had recent success in generating income through sale of successful start-ups. Our deepened interdisciplinary and 'real-world problem' thematic focus from 2022-23 onwards is intended to generate more and better value propositions for innovation including start-up activity. The number of start-up companies appears to be a narrow measure of innovation; other measures might include the number of small / new companies hosted.		

16 Net Zero - absolute (and relative to £M turnover) carbon emissions (tCO2)			
	2018-19	*2019-20*	Baseline: 2020-21
University	*78,903 tCO2 (71.6 tCO2/£M)*	*73,347 tCO2 (65.5 tCO2/£M)*	68,032 tCO2 (57.3 tCO2/£M)
Commentary	Our highly-serviced laboratory buildings require significant power consumption and generate other carbon impacts through (for example) transport of consumables and waste management streams. The HPC facilities we host on behalf of the academic community have very high power demands; although using electricity generated from renewable sources, this puts upwards pressure on national carbon emissions. The 'Midlothian' proposal to recycle heat outputs is designed to support our net zero targets and those of the wider community. Through our Sustainability thematic priority CSE is committed to building a community working for Net Zero. In 2022-23 we will develop a coordinated College strategy for setting and meeting interim and 2040 targets. As a critical step we require better data to understand our emissions and design realistic strategies to reduce them. This is expected to include passivhaus design for new buildings, retrofitting buildings for energy efficiency, pushing hybrid technology to reduce need for travel, reducing other operating impacts and supporting research into carbon management and reduction solutions. We aim to use KB as a 'Living lab' to trial new approaches wherever possible. We have proposed a switch-off of the KB CHP (currently under review with Estates) which would (subject to detailed assessment) immediately reduce our CO2e by 4800 tonnes p.a. with no capital cost. However this comes at a cost of £1.5M p.a. in increased energy bills (estimated prior to energy price rises). Carbon reduction on the urgent timescale required to address the climate crisis is thus at risk without discussion of institutional priorities.		

Major Strategic Ambitions and Plans

Our strategic ambitions derive from three principles. We believe that science, engineering and mathematics are together ripe for new approaches to education, and that our innovative spirit during COVID-19 plus the opportunities presented by the KB Nucleus make it timely to move on these. We believe that most of the growth in UK science/engineering in the next 5 years will be thematic and we can collaborate across Colleges to develop new, broad thematic initiatives that galvanise cross-University efforts and are world leading. We believe that, in the wake of COVID-19 and economic crises, we need to renew our duty of care to staff and students, with this exhibited clearly through practical change. We summarise below our plans in these three areas.

Creating a new model of science and engineering education

CSE is at a point of opportunity in education. We now have extensive, practical experience with novel forms of education (such as on-line exams, hybrid classrooms, automated assessment, remote engineering experiments). With the opening of the KB Nucleus in November we will, for the first time, be able to bring almost all our undergraduate students into KB and convene very large student cohorts in innovative teaching spaces. We have in place (through the Bayes Centre) the operational means to educate on-line via business models that generate surplus and connect across Colleges, and which have been tested in action. We are partnering with successful startups who have succeeded in distance learning at large scale for data science. All this is against a backdrop of broad student and employer interest in our thematic areas of growth (data science, healthcare, sustainability).

It will take a full five years for all the above to work through. The key practical steps for 2022/23 are:

- **Renewing our compact with students**. We have taken a dynamic approach to implementation of the new Student Support model in CSE, proposing a staged approach which introduces quick wins such as wellbeing advisors for all students in the College and the new support model for new students, whilst reducing the risk to student experience from wholesale change over a compressed timescale. We are introducing the new model for new taught students in September 2022 and for all new and continuing taught students in September 2023. CSE's share of the additional recurrent cost to deliver the new model at steady-state from 2023-24 is estimated as £1.2M p.a. for additional professional services staff; the estimated cost for part-implementation in 2022-23 is £0.7M.
- **Hybrid and digital teaching**. CSE has pioneered some excellent solutions to the challenges of blended and online education for remote lab experiments and virtual student fieldwork. To deliver the promise of the creative approaches we have developed, we need to improve the quality of our baseline digital facilities in teaching and meeting spaces. Academic staff must be able to plan in confidence, knowing that wherever they turn up to teach there will be a certain standard of IT infrastructure that allows them to use digital methods. This improvement needs to happen during 2022-23. New on-line delivery models may provide a means to cope with scale of residential teaching (some courses now at 900 students) and diversification from the "residential norm" to support widening participation and international recruitment, and deliver our City Deal KPIs (e.g. our Data Science Technology & Innovation Masters). From 2023-24, we will develop a viable business model, for investment over the remainder of the planning period to extend and adapt our capacity to deliver on-line education and training.
- **Grounding curriculum transformation**. Curriculum Transformation Programme choices will interact strongly with College ambitions as we accelerate our strategic plans. Elements which map well to CSE ambitions include common first year courses and a greater focus on employability and experiential learning. We already have excellent employability outcomes and can lead further improvements, informed by opportunities to develop common course provision aligned with our thematic scientific aims in data science, healthcare, and sustainability. The scale of the Programme implies significant cost. To enable true transformation of our curriculum will require significant academic time and engagement to mitigate the risk of achieving only superficial change without realising benefits. Starting midway through 2022-23 and running until 2025-26, CSE will need additional academic capacity in our seven Schools to release experienced academic staff time for curriculum design; we anticipate 15 FTE. We need to invest in learning technology expertise to support curriculum transformation. We anticipate requiring 8fte learning technologists, embedded in our disciplines and also able to work on cross-disciplinary and cross-College course development, who will build capacity to

develop the tools and materials that will be part of our new curriculum approaches. For a change of this scale and complexity, requiring widespread consultation and engagement with students, staff and professional bodies, project management and coordination capacity across the College will require 5fte over the same period. We have included in our forecasts a provisional additional staff cost for delivery of curriculum transformation of £700k in 2022-23, £1.8M recurrent for the following 3 years.

- **Diversity in depth**. In 2022-23 we will commence a coordinated 5-year programme to improve diversity and ensure inclusion across our community, both students and staff. This involves: (i) gathering and understanding data to drive evidence-based interventions; (ii) frameworks for embedding continuous improvement, extending good practice and sharing knowledge across all Schools; (iii) engaging with our students, staff and target communities; (iv) an action plan and targeted resources to meet our goals and specifically to mitigate risk of failing to meet the target increase in SIMD20 recruitment. We will invest in project support to increase our coordination and leadership capacity for improvements to student and staff inclusion, widening participation, diversity in staff recruitment and progression, and work on decolonisation.

Driving thematic growth from strong foundations

CSE has, for the past five years, pursued a programme of thematic growth. This is in harmony with our commitment to foundational research and teaching while giving common cause across Schools/Colleges in areas where we agree that the impact will be greatest. It also provides clear propositions that allow other parts of the University to work in synergy (e.g. in technology transfer or philanthropy). In 2022-23 and beyond we intend to deepen our interdisciplinary commitment and extend cross-University collaboration across three thematic priorities. We will develop these themes to be highly visible, cross-disciplinary and collaborative to create more exciting and unique value propositions with a translational focus including impact on the UN SDGs and development of student skills, innovation and employability.

- **Building on our success in data science and AI**. This theme is mature and all CSE Schools exploit data thematically (eg. fintech in Maths, AI in Informatics, digital manufacturing in Engineering, earth observation in Geosciences). Over the past 3 years we demonstrated how our College's capabilities can yield the commitments and KPIs that are contained within the City Deal. Via the Bayes Centre we support teams that convene and amplify work across the University in data science, especially in knowledge transfer. This model has worked well (developing a raft of cross-University on-line education programmes and cross-University industry/innovation opportunities) and we embrace collaboration with the aim of making the hubs at Bayes, EFI, and Usher more than the sum of their parts. Planned investment in 2022-23 will extend our ability to deliver University objectives, make data science pervasive through our research and teaching, and ensure we continue on target for City Deal KPIs. Our other principal focus for collaboration in data science is EPCC, which runs the Edinburgh International Data Facility (City Deal) and is now a key resource to support the data science activities of the public sector in Edinburgh and more broadly in Scotland. To consolidate this, we are growing a team to increase our ability to engage in translational projects with academia and industry. We are well placed to lead the development of the UK Exascale Project to install an Exascale computer for the UK at the ACF by 2024.
- **Transforming collaborative research and translation in healthcare and biomedical science and engineering.** We collaborate extensively with CMVM across a range of biomedical, bioengineering, biotechnology, healthcare and health technology research and postgraduate training that links fundamental, applied and clinical sciences. With the proposed development of a translational research centre at BioQuarter (and the existing Innovation Centre at Easter Bush), there is a timely opportunity to coordinate, consolidate and extend these existing partnerships. We are committed to adding value and deriving more impact by identifying untapped opportunity and coalescing our activities around a strategic framework, to be developed in concert with CMVM. We can grasp this opportunity to develop and present clearer, stronger and more extensive value propositions to industry, government and charitable funders. Although this will need investment in staff capacity as plans develop, we anticipate much will be stimulated by external funding and local/national partnerships, sharing funding brought in individually and developing new joint proposals.
- **Placing environmental sustainability and climate change at the heart of what we do, creating a community that integrates research, teaching and practice**. We have the breadth and depth of research strength to provide research-led understanding and solutions on sustainability, social justice and responsibility, the

climate crisis and the imperative to decarbonise. This broad thematic area will drive a compelling research agenda and will create societal impact and culture change, in turn influencing and informing the transformation of our curriculum. It coalesces our existing strengths of energy, biotechnology and agri-tech, planetary sustainability, landscape change, risk and resilience, with areas of recent development including the circular economy and advanced manufacturing for efficiency. It links to our work with data science, space & satellites (remote sensing), and to our health theme (through global inequalities and impacts of climate change on human and animal health). Our expertise will be directed to delivering internationally-focused impact (e.g. via Shanghai Jiaotong Low Carbon College and the Gujarat Biotechnology University) *and* to informing the local solutions which will steer operational decisions including ways of working, estates and infrastructure development. Collaboration with CAHSS will enable the co-production of challenge-led responses and implementation of science-led solutions, generating meaningful impacts in places, among communities, and on policy. Working with and through the Edinburgh Earth Initiative, we will create and enact a 5-year plan to empower leaders and individuals, both staff and students, to mobilise behind a shared agenda, to inject energy and vision and create a critical mass of activity. Capacity-building investment in 2022-23 will accelerate the creation of vision and partnerships for strategic growth in this thematic area.

In orienting a significant part of our capacity towards these thematic areas we will be building unique cross-University value propositions that respond to changes in the UK funding landscape and take advantage of spending priorities in the CSR. We are developing signature commercial partnerships and expect that industry demand will increase as the visibility of our thematic areas increases. This will further enhance our competitiveness, diversifying income and mitigating the risks arising from increased concentration of research funding towards large-scale centres of excellence. Our ambition to develop strong cross-disciplinary propositions will also secure greater success in focused postgraduate training programmes such as CDTs, whilst pervasive industry and other end-user engagement (including via our alumni) will enhance taught student experience by informing curriculum transformation, offering skills development and employability opportunities.

Thematic growth also has an estates dimension:

- Full development of our health and sustainability themes will depend on completion of the "new biology" narrative (where we anticipate a business case for £50m of completion funding) and engagement with the developing narrative in biomedicine which ultimately will require physical space in Bioquarter and KB.
- Our rapid expansion of Engineering has led to innovative uses of space externally (notably our collaboration with Babcock in Rosyth that supports our CityDeal commitments to digital skills development and optimises data-driven design). We also need modern space within KB for core engineering that drives our sustainability theme (where we anticipate a business case for a £39M new building).
- Our commitment to the University's thematic data science expansion means that the Informatics/Bayes complex is now full and we are now operating a "Heathrow" model of stacking potential collaborations until we can accommodate them. The difficult 2-year gap between now and the opening of EFI/Usher must be bridged with improved space provision.
- We are in a position of dominance in the UK in large scale data and computation but this also raises issues of carbon cost. Our Advanced Computing Facility already runs on "green" electricity and we want to go beyond this through novel methods of energy conservation/recycling – for example the EPCC "Midlothian" project to store/recycle cooling energy in groundwater, contributing to social good and to our net zerotarget.
- Progress in all our thematic areas is placed at risk by the constraints of our estate; regeneration of the King's Buildings though a series of small capital improvements (see below) is an essential step in achieving our aims.

Rebuilding staff and student wellbeing

In our Operating Context section we flagged the issue that CSE is "running hot", with staff having to work hard on all fronts in order to maintain stable operation. Part of this, of course, is forced by adaptation to COVID-19 and a turbulent funding environment. We must also recognise that as a University we have been poor at managing change (a key, recurrent criticism in staff surveys across the University). In the wake of the pandemic, we have an opportunity to address this; rebuild staff and student wellbeing and, with that, engagement and trust in our organisation.

This is a cross-University issue. The priorities for CSE are:

- **Providing organisational stability**. Our Schools are the focal point for interaction between staff, students and much of our external environment. For this reason, they are also at the intersection of all cross-University change programmes and are currently in the midst of a maelstrom of initiatives over which they have little direct control. This creates dissonance between each change programme management (which cannot understand why Schools are slow to adapt) and the Schools (which cannot understand why each programme does not recognise the complexities of its core business). Our objective is to be simple, efficient and operationally lean. However the practicalities of dealing with the current crop of change programmes will, we estimate, create a pulse of £350k in staff costs for College professional services over the next two years as we require additional staff capacity to mitigate risks to our core business from many simultaneous changes and the interim/improvement measures required. In this way we aim to bring the College back to a stable state operationally; improve staff morale; and resolve the tensions between devolved autonomy and standardised core operations.
- **Revitalising the King's Buildings for our students.** The opening of the KB Nucleus in November is an opportunity to extend innovative teaching across our programmes, taking advantage of the creative learning spaces we have designed in this flagship building. It is also an opportunity to revitalise KB as a University centre of student activity and social interaction, welcoming all members of the University community to the KB campus. We know that the move of more teaching into the Nucleus will significantly increase the numbers of students using KB and the surrounding environment. We will work with other budget holders to plan the study, social, transport and welfare facilities needed.
- **Stabilising student numbers and achieving a diverse student population to ensure excellent student experience**. Our taught student numbers have grown by 36% in the past 5 years, with particularly high growth in Informatics (50%) and Mathematics (95%); continued rapid growth is not a sustainable strategy. After over-recruitment in the last two years we would like to stabilise our total student population at c.9,900 by 2025-26. Within this total we plan to increase WP entrants and achieve a small increase in the percentage of overseas students (from a greater diversity of origins).
- **Regenerating our physical environment**. The KB estate has lain fallow for several years, whilst pressure has grown on space and facilities. The capacity and condition of our estate is now one of the most immediate risks to our ability to deliver Strategy 2030 and to our future income generation. Working with Estates, we will propose a five-year framework to unlock our estate capacity through 'small scale' estates improvement and reconfiguration across KB, and in the Informatics/Bayes complex. This will address immediate issues of overcrowding and poor quality. It will enable us to respond to the space opportunities that we expect from hybrid working, releasing and reconfiguring space to improve student experience, to enable industry engagement and thematic research development, and to create spaces for innovative and cross-disciplinary teaching arising from curriculum transformation. The time and investment needed to regenerate our estate is analogous to the planning used for large capital projects. The immediate backlog of work, which we would hope to address in 2022-23, is in the region of £7M. We would then look to maintain a programme of refurbishment and adaptation in future years within the framework. Included in this programme will be improvements to our digital technology installations to bring all teaching and meeting rooms up to the same standard, and capacity to use Murchison House as a test-bed for new hybrid ways of working and multidisciplinary modes of space use. Our ultimate ambition is to make KB a flexible "living lab" for innovation amongst our students and staff.

The next years will be significant for Science and Engineering, rich in opportunity. These opportunities arise through the remarkable effectiveness and central role of our disciplines in addressing many of the great challenges in society, challenges which we can solve only in partnership with other disciplines and through external collaboration. The College will help the University to achieve the ambitions of Strategy 2030 by driving forward on these, based on our existing strengths and foundational excellence in teaching, research and external engagement, and bolstered by the developments we are working towards in our staffing, our infrastructure, and our estate.