Sourcebook of Challenges facing Tertiary Education in Ireland in the Coming Decade

Dialogue Sessions Output

19th February 2021

The contents of this version of the Sourcebook of Challenges facing Tertiary Education in Ireland in the coming decade has been reordered to give prominence to its primary aim, namely, to accurately document the informed opinions of a cross-section of those working in and with the third level sector in Ireland. The Short Executive Summary has been moved to Appendix 5

The interviews were carried out in 2018 & 2019.

Contents:

Section One:

Revised Foreword

This exercise carried out over 2018/9 was intended to capture the high-level viewpoints of a range of mostly academics on the challenges and opportunities likely to arise in the third level education sector in the coming decade. The process used was to schedule a series of two hours long dialogue sessions, each for eight participants. The format of the six sessions, held in locations across the island, allowed participants an opportunity to speak un-interrupted for approximately ten minutes. John Hennessy chaired the sessions, and John McGowan acted as the minute taker; both are members of the Academy.

It had been intended to cover all third levels disciplines, but the difficulty in scheduling the attendance of a quorum, meant relying on contacts that were understandably mostly from the STEM disciplines. Accordingly, the inputs received were mostly from academics with these backgrounds. One to one inputs were also elicited from a selective group of leaders of technical firms mostly in the IT and software industry. This sector was chosen because of the characteristic dynamism of product development, and the speed at which obsolescence occurs, warranting investment in re-skilling of their employee base.

Although the views expressed were exclusively positive and forward looking, the participants were assured that the record of their views would be anonymised as far as practical. Some predictions and viewpoints are understandably contradictory. Only the views of those interviewed are recorded; neither of the interviewers' views are reflected. The interviewers did complete a **High-Level Summary** of the opinions most frequently expressed; this summary is now in **Appendix Five.**

It was intended that the points made would be summarised into major themes, but after scripting the points made by the participants it became apparent that the surprising diversity of opinions recorded would be lost in any such summary. Therefore, the feedback is presented as a series of individual points. Rather than publishing this document as a paper, it was instead to be added to the Irish Academy of Engineering's website as a downloadable pdf. The onset of the covid pandemic froze this work, as well forcing a recourse to near universal use of e-learning in the TLI's. To make the report truly representative would require a follow-on set of interviews to capture the emerging learnings from this reliance on e-learning.

This sourcebook of opinions will, hopefully, be of use to strategic planners in tertiary education, although it is recognised that all points would need deeper research, to, inter alia, reflect the lessons learned from working through the covid-19 pandemic.

The IAE would like to thank all those who participated in the various dialogue processes. Their contributions and lively participation made the output of the sessions very worthwhile and informative.

The views expressed are exclusively those of the participants, as recorded by John Hennessy and John McGowan, other than the assembly of the **High-Level Summary**. These views may not align with those of the IAE or those of other members of the IAE.

Section Two:

Dialog Sessions- A High Level Summary of Feedback

Moved to Appendix Five: Page 45

Section 3.0

Dialogue Sessions:

Section 3(a)

Clyde Road, Dublin (Autumn 2017)

Attendees: Representatives from UCD, DCU, DIT[1] and education sector liaison from a high tech MNC

1. The 2016 mix between university and crafts education (75% versus 25%) will change in the coming decade, to a greater focus on highly skilled technical crafts training.
2. The already obvious changing nature of employment towards less medium-term job security will have prompted a significant growth in mid-career up/re-skilling, lifelong learning, and more rigorous ongoing CPD. This requirement should develop into an ongoing source of revenue for all third level colleges.
3. Degree curricula will contain more complex mixes of subjects from different disciplines.
4. All courses will place a greater emphasis on appropriate methodologies for collecting learning performance data, and its exploitation for process efficiency and product quality enhancement.
5. The concept of all design processes will have expanded by 2030 to routinely incorporate a broader set of criteria of market, social, medical, and creative needs.
6. The need for greater learning continuum between school, third level and the workplace will have been recognised, and be in a gradual process of adoption.
7. Greater efforts to recruit PhD level graduates with industry management experience to third level colleges will have been instituted, with a view to inculcating the working characteristics of flexibility, resilience and “readiness for work” in post graduate students.

8. Activities in post graduate course curricula will be more focuses on creating wealth and identifying disruptive concepts and technology.
9. Providing innovative solutions for cost efficient use of sustainable energy sources will be a core component of all engineering education.
10. A major component of all technical (& other) degree courses will be training in the interpretation of data in the deepening information age, supported by artificial intelligence, supplemented by potential uses of virtual reality aids.
11. With the growing costs of third level education, the emerging pressure from students to foreshorten courses may have led to a wider spread of options on degree courses, and lifelong learnings.[2]
    a. Would such courses be able to draw on current experiments in accelerated learning, or as “upgradeable” qualifications as part of a structured lifelong learning regime?

12. No foreshortening of courses will have occurred by 2030. Current course durations will have been proven to be necessary to build competent engineering judgment and comprehension of the results of the increasingly capable digital tools.

[1] Now TUDublin

[2] See “New Model in Technology and Engineering” in Hereford UK offering more intensive foreshortened degree and masters courses. LIT latterly introduced a similar two-year night class-based degree in electrical engineering for electrical technicians

a. Computerisation will have replaced most routine tasks, so the market demand will be for higher level and deeper educational skills.

13. The numbers of PhD candidates in technical faculties will have continued to increase to meet market demands for higher skilled personnel.
14. The use of MOOC style classes for undergraduate lectures will have proliferated in all TLI's, especially for the more straightforward subjects. This will allow the student to listen to lecture at a time of their choosing and leave more time for college staff to act as tutors.
15. The logic of having so many engineering and science courses duplicated across a small country is questionable. But the rationalisation and centralisation of such courses into a select number of locations, as in Norway (Trondheim), will not have gained much traction by 2030.[3]
16. A greater and more effective focus on commercialising R&D output in third level colleges will be apparent at the end of the next decade, as will a greater concentration on areas likely to capable of commercialisation.

17. The intervening decade to 2030 will see increasing discourse on 21st century skills[4] development, and on the learning or acquisition of these skills. These skills include:
    a. R&D skills and outputs, reasoning.
    b. Creativity, innovation, planning, self-discipline & initiative.
    c. Communications.
    d. Leadership, team working, IT, media and internet literacy.
    e. Global awareness, civic and social justice literacy.
18. Third level education will continue to play catch up with emerging technology. This will prompt an ongoing focus on skills development, that can be achieve through multiple channels, including in-house training in employment.
    a. New skills that will be in demand are cloud computing specialisation, millennial generational expertise, social media managers, etc.
19. Marked progress will have been made in instilling the skills sets currently being demanded by MNC from graduates, such as analytical thinking, emotional intelligence, and the ability to collaborate, coupled with commensurate evaluation processes, anywhere, any place, any time.
    a. Graduates from colleges which imbue these skills though the teaching process will have a distinct advantage in the employment market.[5]
20. McKinsey's [6] observation is relevant to the likely demand for ongoing education in the coming decade: "*All of us are going to have to continue to adapt, get new skills, and possibility going back for different types of training and skill development. What's very clear is that what our kids need to do is learn and become very flexible and adaptable".*
21. Learners will have more opportunities to learn at different times and places. eLearning tools will facilitate remote, self-paced learning (u-tube, MOOC's etc).

[3] HEA's policy document: "Completing the Landscape Process for Higher Education". This rule out mergers by political fiat, applauds spontaneous alliances (TCD/UCD Innovation Alliance), and calls for regional clusters and other formal relationships in respect of individual disciplines.
[4] See **Appendix 1 (page 42)**
[5] Reference: President Brian MacCraith speaking when launching DCU's five-year plan.
[6] Susan Lund (McKinsey's Global Institute).

Classrooms will be flipped, which means the theoretical part would be learned outside the classroom via access to diverse sources of information & knowledge, whereas skills building will continue to be taught interactively face to face.

a. Students will increasingly be able to learn with study tools that adapt to their capabilities. This means above average learners will be challenged with harder tasks and questions once a certain level of understanding is achieved. Learners who experience greater difficulties with a subject area will get more time and opportunity to practice until they reach the required level. Teachers will be able to see clearly which learners need help, and in which areas.

22. We are today on the cusp of a fourth industrial revolution, the so called **Industrie 4.0**. Developments in previously disjointed fields such as artificial intelligence, wireless networking, machine learning, robotics, nanotechnology, 3D printing, genetics and biotechnology are all building on and amplifying the potential of one another, as part of an innovation, productivity, and quality revolution.
    a. In the coming decade businesses will have taken a pro-active role in supporting their current workforces through re-training and education. Employees will have to take a similar approach to their own lifelong learning. TLI's will have been expected to create appropriate training infrastructures.
23. An engineering school structure based on multiple faculties and disciplines training and supporting PhD students seems to be the optimum structure for the coming decade. SFI & EI may evolve into efficient enablers of commercialisation and provider of market knowledge.
24. Traditional university teaching skills & faculties will remain essential to train under-graduates.

25. PhD candidates require more peer-to-peer contact with potential employers. The employers need coaching on how best to use and motivate graduated PhD's. A structured approach to achieve this peer-to-peer interaction will likely evolve in the coming decade.
26. Gender balance within all faculties will have improved over the coming decade, but not to the point that it will not require ongoing attention.
27. Degree courses combining humanities and business have been a growing trend, aimed at deepening the students' knowledge and empathic skills. These courses will be well established by 2030.
    a. There is no known demand for courses specifically focused on enabling economic growth.
28. There is an apparent oversupply in students in engineering programs, but with ongoing options of working abroad, this will not be an issue with filling STEM courses.
29. The presently observed shortage of professionally trained level seven technicians will have prompted a response by the IOT's to meet what will be a growing marketplace need.
30. Demand for courses on data harvesting and husbanding will consistently grow over the coming decade, across the traditional disciplines.

31. TLI's need to invest in educational technology across the continuum of stages in the education process, otherwise progress in assimilating new technology will be inhibited at the third level, curtailing its effective adoption in the economy.

32. The next generation of instructional video clips, like **you tube,** will grow their capability of transferring knowledge and possible solutions. Developers of such instructional or assistance clips will need to comprehend the potential use to which the information might be put, to avoid inappropriate application.
    a. The parallel need to develop appropriate judgment in engineers (and scientists) to enable them to assess whether results or solutions from digital tools *"look right*". Such judgement takes time and learning to develop, but the need is increasingly recognised, and will have to be built into future curricula.
    b. The core engineering skill remains problem solving. Having enough mathematical ability, coupled with exposure to real life examples, are the fundamental input to development of that judgment.
33. Setting up a body to advise on the development of engineering judgement in students might be considered, such as a Council of Engineers or the equivalent for scientists.[7]
34. Communications skills will be increasingly critical to team-working and leadership in the coming decade.
35. Second level education will need to continue to challenge and motivate their students, especially those who can complete third level courses. Deficiencies in students' second level education is increasingly requiring catch up course in the first year of third level colleges and institutes. Need will have dictated some changes in second level education, although change at second level is typically slow to be implemented.
36. Gender balance, and the erosion of gender stereotypes, will remain a challenge for the coming decade, despite marked progress being made in recent years.
37. The Internet of Things will provide solutions and data on all aspects of living. Knowledge of the multiplicity of communications systems, and data security, will be constraint without a program to guide the development of suitable courses.
38. A greater emphasis on technician training in third level educational institutes seems inevitable, as the absence of a flow of qualified graduates will otherwise constrain economic growth.
    a. Unfortunately, the reluctance of students to enter even premium apprenticeships and master craftsman courses in preference to academic courses will have remained an obstacle.
39. Halting progress only is predicted in the areas of course rationalisation and college mergers in the coming decade. "Synthetic merger", such as the sharing of services with each institute retaining their individual identity and mission may be attempted.
40. Students are preoccupied with technology and apps, but its positive impact on education is overhyped. App loving students have sadly lost their capacity to listen at length, absorb a complex argument and summaries, dissect, and evaluate knowledge. A reversion to traditional campus teaching is therefore predicted by 2030.
41. Colleges missions often lag societal trends and employer needs. Educators will need to be more flexible in how and where they deliver knowledge in the future. This is apparent in the relatively slow uptake by faculty members in acquiring new skills in digital technologies.

[7] Engineers Ireland might be a more appropriate body to undertake such as task.

42. Employers are becoming increasingly more sophisticated in their expectations of graduates, looking for a more rounded “T shaped” person who can work across disciplines and systems. Colleges will respond; an early example is the TCD *“The Learning Foundry”* which will focus on *“user-oriented problem solving*”
43. The highly inefficient two semester pattern will change to year-round learning. The colleges will gain greater efficiencies and savings using “open educational resources”, married with ***ePortfolios*** to document student learning.
44. Technology companies will be incentivised to develop new educational products to address the affordability of third level education. But it is not presently clear whether faculty members are familiar with the capabilities of artificial intelligence, virtual reality 3D printing, drones etc. There is a gap to close in the coming decade.
45. Although the use of machine learning and MOOC’s will rise, it is not apparent that they will replace faculty by 2030. Classrooms will be flipped with theory dealt with by online courseware platforms and practical applications covered in colleges and in the workplace.

Section 3(b)
Belfast Catalyst Institute (Spring 2018)

Mix of senior academics, PhD student, and industry representatives

46. As an overarching input, the teaching of STEM subjects should be integrated into the curricula of communication subjects, such as writing, speaking, and foreign languages.
47. Demand for third level education is growing; degree-based courses are overwhelmingly favoured over apprenticeships and will continue to do so until the societal status of apprenticeships and that of "master craftsmen", reaches that evident in the German workplace.
48. Career long CPD is inevitably going to become an increasingly more rigorously policed requirement.
49. Opportunities for hands-on experience of making things is diminishing.
50. It is expected that future graduates will necessarily be better schooled than in previous generations in communications, team-working and creative problem solving.
51. Students ability to write clearly understandable reports, and to communicate effectively, are capabilities that will require focused teaching and practice.
52. Secondary school education is based on achieving high assessment scores. The process is deliberately designed to counter complaints and appeals on the assessment process. No credit is given for creativity and *"out of the box"* thinking.
53. CPD training in emerging technologies is currently loosely structured and administered. There is a need for the professional registration bodies to be charged with tightening up CPD training, possibly following the lead of the pharmacists and medical profession who require annual revalidation that emerging treatments have been fully understood, not just lectures attended, or articles read.
54. The market is demanding more generic engineers, who can readily pick up new skills and are flexible in their approach to working.
    - Regrettably, there is no proven assessment method to identify these characteristics of a person being able to readily absorb new skills and an ability to work flexibly within a team-working environment.
    - Bombardier has started to hire a mix of engineers and qualified trades (who came through the apprenticeship route). The latter are as likely as the former to rise to leadership positions.
    - The fundamental issue is determining the optimum mix of logic intelligence, creativity, and inter-personal skills.
55. The lack of encouragement and promotion of creativity and imagination, as well as alternative ways of thinking, is limiting the potential of many bright and talented students.
    - There are only limited pedagogical methodologies to bring forward these personality characteristics, but there is a recognition that people with these traits can excel in the working environment. This search and development may need to start in Primary School.
56. The threat from automation and robotics to tradition work is unavoidable, but it will increase productivity and wealth creation, enabling part redistribution through the tax and social welfare systems.

a. Will this curtailment of work lead to demands for a universal basic income? What then should the TLI's focus on?

57. Proponents of **21st Century Skills**[8] in secondary schools would recognise that these characteristics could be built upon in TL education.
    a. Parents need to be influenced into recognising that these skills are going to be necessary for a fulfilling life. The key is to convince principals through the School Retooling process being launched in NI.
    b. The challenge will include selling the concept of student centric education, and to improve the experience of education for the maximum number of students, while regarding the unengaged talent pool as an opportunity, rather than a challenge. This approach is being used in San Diego CA.

PhD student

58. Lecture theatre is dying, due to lectures / slides being provided on the intranet.
59. Tutorials are a more productive use of lecturers' time.
60. Partnerships between universities will be more common.
61. Inter-disciplinary courses will be increasingly prevalent, as is happening at Cambridge, or in the liberal arts colleges in the US.
62. Student voice will become increasingly influential in NI TL colleges, as legislation requires surveys of their opinions, which must be publishing in league tables. There is an increasing consciousness amongst students on whether courses represent value for their fees.

63. Better links are needed between career guidance teachers and future employers and TL colleges. The goal is a better match between ambition, market needs and aptitude & ability.
64. The role of external students in NI was discussed. The obvious number of external students in the environs of QUB are attending master's courses, not undergraduates. Is there an opportunity to attract more overseas under-graduates?
65. The impact on a shrinking TL education budget of under-writing fees for NI students attending colleges in Scotland and English universities will have to be address.
66. Personalisation of education is going to increase, including the "*designing your life"* program in QUB.
67. Biometrics & AI are reputedly being used to customise on-line coaching using software such as machine learning enabled DeepMind (https://deepmind.com/. Also noted the usage of the **"scientific method**" [9]

[8] 21st Century Skills **(See App 1 page 42)**

[9] The **scientific method** is a body of techniques for investigating phenomena, acquiring new knowledge, or correcting and integrating previous knowledge. To be termed scientific, a method of inquiry is commonly based on empirical or measurable evidence subject to specific principles of reasoning.

Section 3(c)

Galway (NUIG/GMIT) (Spring 2018)

Academics (engineering IT & liberal arts) medtech & civil engineering business sectors.

68. Student learning style continues to change, driven by students' expanding understanding of the capability of technology and its widening potential application.
69. The student base is changing through internationalisation. To sustain and grow this student cohort requires flexibility in teaching to adapt to their differing natural learning skill.
70. There is growing competition amongst universities to grow this cohort size, driving competitiveness in fees and ranking in international benchmarks.
71. Technology in medtech science continues to change rapidly on topics such as information technology in smart devices and smart materials; the third level sector needs to respond.
72. Aside: a goal for the coming decade: handheld aids to self-diagnosis.
73. Pressure for integration of engineering disciplines will continue, driven by the complexity of most modern manufacturing and analytic processes.
74. Resources for Irish universities are markedly less than those provided in universities in other countries. This apparent gap will have to be addressed in some format in the coming decade.
75. There is a huge demand for people who can make "things". This is mostly satisfied in the medtech sector by comprehensive in-house training programmes at present. There must be a role in the TL sector in satisfying this demand.

GMIT academic

76. There needs to be an even more active promotion of engineering as a career, including its promotion amongst females. Ensuring that there is an open collegiate working environment is an enabler. Role models for successful and fulfilling careers in engineering are needed.
77. Engagement of industry with undergraduates needs to be expanded, and not just focused on post-graduates.
78. Students are demanding a more active (experiential) method of learning, incorporating project and field work.
79. Undergraduates need to be inculcated with a range of attributes such as understanding background theory rather than just finding knowledge or techniques, coupled with a comprehension of the requirement for life-long learning.
80. The role of apprenticeships and technicians in TL education needs to be developed including redefining the status and function of the role. Their function in the medtech industry may be a good starting point.
81. Believe that the role of lecturers is to firstly be educators, then researchers, versus the apparent reversal of these roles in the universities.

Civil engineering consultancy

82. The TL education sector need to inculcate an appreciation of what a satisfactory design outcome of an engineering problem should look like, rather than mindlessly relying on the output of formulae or software programs.

83. Graduates need to have well developed report writing skills, able to communicate ideas and opinions succinctly.
84. All graduates should have a good understanding of business dynamics, including management of accounts.
85. Also, consciousness of their responsibility for delivering safe construction and completed structures.
86. Courses to deliver process engineers for water systems are needed. This course is only available in the UK.
87. Radically new technologies are coming to the construction sites. Examples include smart controls for HVAC, quality prefabricated modules, BIM, 3D printing, driverless vehicles, AI, automation of most professional tasks.[10]

IT & education research:

88. Need to benchmark teaching methodologies in leading (technical) universities, such as Singapore, UCL, Aalborg, MIT, as well as understanding their ongoing research on teaching methodologies.
89. Different teaching methodologies are needed for a more diverse student body, moving from didactic education to more inductive teaching, such as online interactive classes, societal based activities, affording flexibility to students to catch-up, and more project-based work.
90. Education is also seeking to develop attributes under three categories:
    a. Knowledge
    b. Application
    c. Interpersonal.
91. Aim is a broader based CV, giving a better insight into a whole range of outcomes and achievements, as well as demonstrating a student's leadership potential.
92. A focused program for CPD for academic staff needs to be instituted, especially in creative use of technology.
    a. Mention was made of *The Framework for Teaching & Learning*, defined by the National Forum for Teaching in TL.
93. A new assessment process for students is being introduced by integrating the process into course work, with an insight to teamworking, problem solving and communication.
    a. AI applications for education are in a nascent stage but becoming more common. The insights gained from the analytics will be fed back to students.[11]
94. There is a broad recognition that fostering research skills should begin in undergraduates, and perhaps the senior cycle of secondary school.
95. Inputs gained from students from online coursework is challenging lecturers to make education more engaging, such as more extensive projects with industry.
96. There is no indication the AI applied to online learning will lead to more effective teaching.
97. Learning should evolve to be more focused on student personal goals and ambitions, rather than just follow a standard course.

[10] "*Demand for IT expertise will replace tasks displaced by technology as career options for engineers.*"

[11] Prestigious colleges are offering free MOOC's, coupled with a regular assessment process within the MOOC's, as a basis for personalising the learning, and building their databases of learning styles.

General Discussion

98. Constrained funding for TL should result in less numbers but higher quality students[12].
    a. The increasing impact on academic staff of work-related stress was raised.
99. Industries are too changeable in their feedback on new technical challenges as inputs to future coursework for TL courses. A more rational process is needed.
    a. It was noted that the feedback sought on industries' expectations on skills required by students before outplacement gives a more accurate insight on emerging technical trends.
    b. The monthly magazine, "*Future Trends in Technology and Education Report*" was recommended as a useful reference.
100. Better training in entrepreneurial capability for all students should be targeted, such as an introduction to coaching platform like the Blackstone Entrepreneurs Network[13].
    a. Developing an insight to entrepreneurialism, as a corollary to innovation, may be another skill that will be included in future coursework
101. Students are conscious that they have many options. These include colleges' approach to learning, together with their international rankings, as factors that influence choice. Obviously, colleges also need differentiators with other competitor institutions.
    a. The issue of limited industry support for TLI's in Ireland was discussed, concluding that this was related to the undersized indigenous industrial & service base.
102. Again, the reputed higher workload for academics in Irish TL colleges was described as a differentiator with TL colleges in other countries.
103. The case of Stryker's recruiting systems was discussed. This relies on the using the Gallup Interview process to identify leadership potential in candidates. The characteristics on which the interview questions are based could be included as coaching in TL colleges.[14]
    a. The use of this system, although drawn-out, may be better than the use of traditional CV's in selecting the best candidates for leadership positions.

[12] The low likelihood of this being implemented was not discussed.
[13] This is a Colorado US based network, but similar coaching networks exist in other locations.
[14] The questions are online.

Section 3(d)

Carlow: 30th October 2018

Hosted by IT Carlow, with academic and industry partner participants.

104. Background points: majority of students in IT Carlow are part-time, a percentage that is predicted to grow in the coming decade. Most students are attending courses or engaged in part-time degrees aimed at career growth and promotion.

Farm solutions supplier

105. The potential of a career as master craftsmen, after following an appropriate apprenticeship, including release periods from work, will need ongoing promotion with secondary schools' career guidance counsellors and parents.
    a. The aim would be to gradually achieve a tenfold increase in this type of graduate, mimicking their importance in German industry.
106. In Germany, apprentices typically work a full-work day (including internal training courses) and attend supplementary courses at night.
107. The practical ability of graduates from the Lapple internal apprenticeship program, which was hand-skills based, delivered a capability for innovative and creative solutions from craftsmen who innately understood metalcraft.
    b. In the future machinery manufacturing industry these master-craftsmen will be a key component in innovation and continuous improvement in the coming decade as part of a flexible workforce.[15]

Senior engineering academic

108. Level 6 & 7 courses are looked down upon amongst the student base; this is likely to persist (to some degree) until the positive career prospects become more widely known, because of a much-increased number of master craftsmen working in industry.[16]
109. Promoting these careers will need a joint TLI / industry marketing campaign, which will require a funding source. It is important that this becomes an established annual practice for industries employing master craftsmen, working with TLI's.
110. The optimal time division between working, training and education needs to be developed for each sector; at present apprentices are working 36 hours a week, which, coupled with lectures and studies, represents a considerable burden on candidates.
    a. These challenges will have to be addressed, solutions tested, and revised regimes decided on in the coming decade.
111. The Leaving Cert courses in engineering related subjects are out of date, teaching skills that are being or have been superseded by technology advances.
    a. There is an urgent need to update these courses, including upskilling teachers, on an ongoing basis. This would seem to be the domain of the Apprenticeship Council[17].

[15] Reputedly 80% of student decisions on careers are heavily influenced by their parents; this is unlikely to change;
[16] The widely discretised metal bashing industry in East Tyrone, might act as a role model.
[17] **The Apprenticeship Council** was launched in November 2014, tasked with identifying sectors where new apprenticeships can make a real difference to both employers and employees. In accordance with the

b. Their proposals on block releases are being opposed by industry and will be slow in gaining traction.
c. This is likely to be a key area for strategic goals, if a rebalancing of the high numbers entering level 8 course versus level 6 & level 7 courses is to be achieved.

112. In the interim industries are relying on the availability of mostly Polish craftsmen, whose training closely mirrors that in Germany. The strategic sustainability of this reliance on foreign technicians is questionable, in the context of a broader challenge of sustaining high percentage levels of employment as MNC investment levels begins to plateau or contract in the coming decade.
113. The attitudes and behaviour of third level under-graduates have changed in recent years. They have more *"problems".* They also have a strong sense of entitlement and they communicate in a different manner to recent generations of students. They have less deference to lecturers and higher expectations.
    a. Staff feel intimidated and may need ongoing coaching and training to understand how to deal with an evolving social phenomenon through the coming decade. This mirrors increasing recourse in MNC's to training for managers on how to manage and motivate millennials.

Life-long learning academic

114. ICT firms place a significant business weighting on developing CPD courses, including preparation of commissioned training packages for industrial partners and public bodies. This is in addition to providing open course training for the broader engineering and technical markets,
    a. The firms see commissioned training as a key area for their strategic development, responding to the constant emergence of disruptive technologies.
    b. This area will provide career enhancing opportunities for ambitious software developers.
    c. It will feature strongly in future strategic plans for TUSEI.[18]
115. More / longer placements in industry will also be a sustaining trend, with up to two years of a four-year course spent on placements. This is the educational ideal, but the cost, especially to the receiving company, may need some national level legislation and financial underpinning.

116. Transversal skills, aka 21st Century Skills[19], are now gradually working into the curricula of courses, especially those courses covering new or emerging technology. Part of the 21st Century Skills cover topics such as leadership, teamwork, collaboration, cooperation, facility in using virtual workspaces. The aim would be for graduates to learn how to work "*smarter*", not *"harder*".
    a. The intent is to better prepare graduates for integrating quickly into the workplace. Investment in training lecturers in the many aspects of these skill

Apprenticeship Implementation Plan, develops calls & analyses proposals for apprenticeships in areas outside of the existing apprenticeships. Reports to the Dept of Edu &Skills on viable new apprenticeships. Monitors the development by industry and education and training partners.

[18] Technology University South East Ireland. Merger of WIT & IT Carlow into a technical university.

[19] 21st Century Skills: **(See Appendix I Page 42)**

sets will require ongoing dedicated programs, covering existing and newly emerging societal interpersonal needs throughout the coming decade.

Program manager for new drug substance introduction.

117. Observed that engineering graduates cannot plan, write, or deliver. Presumably, this will improve with an intensification of the transversal / 21st Century Skill program.
    a. US graduates do not appear any more prepared for the workplace, notwithstanding the very different educational outcomes that are targeted in the US education system compared to Ireland.[20]
118. Advocates a graduate skills development programme, including a more extensive placement programme, to improve interpersonal, communications and managerial skills, with a duration of up to seven (!) years of structured part-time training.
    a. Ideally this should be largely undertaken as part of their employers' internal training program. Given the cost of such an extensive program, there is scepticism that any such program will be widely implemented.
119. It was noted that UL engineers seem better aligned with a working environment than those from other colleges, seemingly because of their long-established placement programme.

Engineering manager in medtech company

120. The poor level of knowledge of career guidance teachers of the exciting challenges faced by employees in leading edge industries of innovating and complex problems solving, is constraining the growth of students taking up technology-based careers.
121. A more active involvement by manufacturing and service industries is needed in promoting career prospects in medtech industries, exploiting methodologies such as use of Virtual Reality (VR) in international plant inspections, so avoiding long haul travel and its carbon footprint, and the learnings from the analysis of the data generated by Industrie 4.0 instrumentation.
122. An equally important by-product of such a programme would be the improved community respect for local employers participating in the programme, with the added benefit of increased respect for the employees in their local community (i.e. leading to greater employee motivation)
123. To further reinforce the attractiveness of careers in leading edge industries, and facilitating easy access to upskilling or reskilling classes, a process of joint funding or facilitation of CPD courses for TLI academic staff should be considered.
    a. This could be, inter alia, part of a tactic of consistently upskilling TLI academic staff in the technologies underpinning fast developing industries.
124. The example of the approach of the Electrical Contractors of Ireland's regular inputs on to the Apprenticeship Council on apprentice curricula may be a role model.[21]

[20] US colleges target the ability to understand technical issues and team-working skills to enable the collective intelligence, compared with a more theory-based learning approach in Ireland.

[21] "LIT *recently introduced a new two-year degree in electrical engineering for experienced tradesmen. "They are absolutely committed to this new apprenticeship model. We want to see people achieve progression through apprenticeship-based degrees. We want to see people* ***learning while earning****. This is a model which we believe*

Sales director of commercial testing laboratories

125. This firm *"loves"* placements as part of their social responsibility programme. Chemistry skills of student placements are poor, engineering skills somewhat better.
126. CPD is important in the company, as is attendances at conferences focused on understanding competitor advances and the identification of new maintenance techniques.
127. The company strongly supports industry & TLI cooperation, and the constant updating of course curricula to incorporate the best in kind methodologies.
128. Noted that they include the Toyota approach to Lean. This relies, inter alia, on line operators' observations of possible deviations from specification, as part of their quality programme.
    a. The effectiveness of such an approach is dependent on the intensity of the training of all line operators in the values of discipline and quality awareness.
129. The firm has an entrepreneurial culture. They advocate a greater focus on business training, funding sources and accountancy for graduates.

Organiser

130. Foresees a changing landscape in the South East after the completion of the merger of WIT and IT Carlow into TUSEI. After the reorganisation of the new university, *"its leadership will lead the regeneration of the region".* This will be their big strategic vision for the coming decade.
131. This vision will aim at training local business leaders for world market roles, with a true international market perspective.
132. It will also aim to produce socially responsible graduates, presumably through the implementation of a far-reaching introduction of the 21st Century Skills program, or equivalent.
133. The technical university will be known for its approachability in support of local leadership in ambitious international programs or challenges, such as socially enhancing programs, like carbon neutrality, including reducing air travel through use of video conferencing.
134. The employability value of degrees will erode at an accelerating pace, opening an expanding market for upskilling or reskilling of impacted graduates.
135. The need for upskilling will extend to TLI staff who will be challenged to maintain their relevance in an era of expanding innovative and disruptive technology, aimed at CPD and life coaching.
136. Separately, it is predicted that the Humanities courses will trend towards more people and lifestyle centred curricula.
137. Also, cyber-security will become an ever-growing challenge as internet traffic grows exponentially with the advent of the Internet of Things. The capabilities of 3D printing as an industry enhancing tool will continue to broaden and deepen.[22]

will succeed, and one that can be applied in other sectors. This apprenticeship is at the forefront of how learning is changing in Ireland." said Professor Vincent Cunnane, president of LIT.

[22] It is now possible to print tungsten components. Technology already in use in the medtech industry.

Section 3(e)

UCC: 6th November 2018

Attendees included a wide range of academics from STEM and humanities departments

Organiser

138. Technical and managerial skills agenda will predominately be set by industry, including that of re-skilling and up-skilling. Increasingly TL colleges are seeking to link research and teaching, following the example of the Sciences PO college in Paris[23].
139. Medical students are already being offered non-medical courses to widen their understanding of a broader spectrum of STEM disciplines. Other disciplines are gradually following that lead, mainly through exposure to inter-discipline working with other schools of science, humanities & engineering.
140. There is a marked increase in the level of reported mental stress amongst the student population.
141. Students seem to be less resilient, especially the high performers, whom any TL college needs to nurture. These trends are not so pronounced amongst the average student population.
142. All colleges need to become more international in their outlook. The fact that Irish students are attending PRC TLI's as part of their placements is indicative of a trend that will grow through the coming decade, leading to the development of a better international cross-cultural understanding. Diversity begets stability.

143. The distribution of capabilities in Irish students attending Irish TLI's is obviously mixed (normal distribution?). But the brightest have a broad set of options for TL education whether in Ireland or internationally. Irish TLI's need to compete for and attract these exceptional students.
144. This is going to require extra resources to retain these students, however it will take years to match the attractiveness of competing leading universities.
145. The parallel was made with the 20 years journey within UCC to become credible in bio-pharma R&D, noting that ongoing review of and re-ordering of priorities is a constant necessity.
146. How does UCC compete with research globally? Encourage the brightest to do the best work? How to utilise the full extent of external scrutiny to protect the loss of reputation? These are questions that any college strategic plan must address.

147. The inculcation of **21st century skills**, such as professionalism, cooperativeness, active learning, reflection, and self-correction should be targeted.
148. TL colleges need to create spaces where students can be more cerebrally challenged. This needs creative environments for learning, which cannot occur in tiered lecture theatres.

[23] See Appendices 3 & 4: (pages 44 & 45): App 3: FT article from May'2018 on "AI Bi-lingualism"

149. Students are more reflective and welcome the challenges in a connected curriculum.[24]
150. Any such transition will need resources for the professional development of staff, such as development of case studies of "to-day's" best practice, promoting an ethos of a teaching and learning institution.
151. Present teaching and learning practices need to be reviewed bottom-up and top-down to enable a transition to an environment where student and staff priorities get matching focus.
152. Colleges need multiple ways of engaging with students including so-called "self-correcting" courses.

153. Expect more demand for multiple primary degrees, as opposed to masters &/or doctorates in a single discipline, e.g., chemical engineering & accountancy. Many students do not want or need a higher-level degree. Facilitating the completion of two different courses, whether over-lapping or sequential but with exemptions for certain subject coursework would be decided by negotiation with the student.
154. Multi-centred degree courses will become more common, e.g., part of degree program might be run in UCC, the rest in Harvard. These courses might be full-time study or part-time. The example of engineering combined with a foreign language was quoted.

155. Sees an evolution in the engineering discipline, with more emphasis on systems, cloud-based data management, and analytics. This would-be in part a fulfilment of a demand for engineers who are flexible on courses taken or who can successful overcome disruptive technology in their working career, merging skills associated with R&D, industry and academia.
156. Graduates will need to be able to upskill through-out their 70 years career. This may happen automatically through their work exposure in dynamic companies, which automatically upgrades their core technology knowledge. But most will need to revert to a public or private TL educational institute to acquire the necessary new skills. [25]
157. Students will need to learn more soft skills for life and their word-place.[26] These acquired skills will be a strong differentiator in the workplace.
158. Bodies to aggregate and certify mixed location courses, such as UCC / Harvard / OU, will be needed to ensure an appropriate quality standard.
159. Need signature programs to attract students. Examples quoted include courses such as a BPhil: Batchelors degree in R&D.
160. The gender gap in STEM will have to close in the coming decade. Advocates the need for role models of women in senior positions.
    a. Staff student ratios need to be reduced to improve the student experience.

[24] See UCC Website: In UCC a ***Connected Curriculum*** emphasises the holistic development of students and staff through research-based, collaborative enquiry. It is designed to prepare students for their future, combining academic with professional, community-based, field-based and inter-professional learning to develop values, skills and aptitudes that promote civic participation, social inclusion, sustainability and impactful, global citizenship.
[25] In other words, upskilling may become a bigger percentage of TLI's output.
[26] 21st Century Skills **App1 Page 42**

b. Attracting more philanthropy will be necessary to support investment in TLI infrastructure.

161. The downstream value and advantages for industry of financially supporting TLI's needs to be sold, as part of a program to grow the 53% of college income currently from non-government sources.

162. The sustainability of the current funding model is tenuous: advocating a 1% increase in corporation tax to fund third level education. The driver is the projected 20% increase in student numbers in the third level sector in the coming decade, and that does not include re-education and upskilling. Hence the need for new ringfenced sources of funding.
163. Research indicates that further investment in pre-school education will lead to better TL quality graduates. The investment needs to happen now to positively impact graduates of the 2030 class.
164. The EU colleges are going to have to reorganise and reposition themselves to compete with the whole spectrum of US and PRC colleges. This will involve the emergence of ten plus EU Ivy League colleges. UCC will need to focus on relationships with a number of these colleges to allow undergraduates to spend a year studying there, before returning to their parent college.
165. Holographic lectures have been delivered in UC London. Irish colleges need to get into the network delivering these hologram-based lectures.
166. The EU trends, and their transforming education paper, have highlighted the necessity of addressing the 20% of over-qualified graduates in Ireland as a result of current graduate skills mismatch with market demand. This is lowering national productivity.[27]

167. Colleges need to focus on the UN's Sustainable Development Goals (see para #176) and reflect these in their strategic thinking and in their plans for tackling each relevant challenge in the short term in designing course work.
168. Eirgrid's difficulties in obtaining planning permissions for OH transmissions lines, and Apples difficulty in getting planning permission for their proposed data centre in Athenry demonstrates the poor ability of the engineering profession to influence public concerns.
169. The need for new tactics to gain public support for the challenge of global warming is necessitating the use of experts in public psychology. Graduates in disciplines dealing with the public (versus individuals) need sensitization to these psychological techniques.
170. Also, the third level sector will need to address wider access to all sections of the population to some form of third level education or training.

171. The biopharma / food engineering department is looking to develop a dynamic model of matching academic courses with student preferences, and those of industry.
    a. In addition, colleges need to work more assiduously on student diversity, including biased views of gender equality.

[27] Manufactures took advantage of the downturn to recruit overqualified non-industrial graduates. They learned quickly but left once the recovery was established to return to their previous career.

172. The current UCC strategic plan considers the organization of research and graduate studies. The plan covers research, in the context of sustainable development, migrating to "**circular development**", inculcating in students the concepts of smart product design, life system assessments, novel products and materials, all in a sustainable environmentally responsible manner, coupled with manufacturing competitiveness.
173. The strategic plan also considers new processes[28], such as de-bottlenecking of processes and quality by design. In summary the curriculum changes would alter the traditional approach for manufacturing a product.
174. Universities need full engagement on the concerns that guide the global agenda and influence the creation of research and education programmes currently being developed in the world-class partner universities.

175. These include:
    a. Plural societies,
    b. Sustainable development[29]
    c. *Circular Economy*'[30]
    d. Development & optimization of agricultural production systems.
    e. Exploiting nanotechnologies and biotechnologies for the sustainable production of food.
    f. Bioenergy.
    g. Preservation and reduction of food losses.
    h. Sustainable production of biomass for industrial use and bioenergy generation.
    i. High-quality food production, health, and wellness.
    j. Materials and technologies such as the development of new medicines and systems related to drugs,
    k. Development of biomaterials and biosensors,
    l. Development of biotechnological processes,

[28] Including flexible plants, as designed by contract manufacturing companies.
[29] UN sustainable development goals copied above.
[30] A *circular economy* is a regenerative system in which resource input and waste, emission, and energy leakage are minimized by slowing, closing, and narrowing energy and material loops; this can be achieved through long-lasting design, maintenance, repair, reuse, remanufacturing, refurbishing, recycling, and upcycling. This contrasts with a linear economy which is a 'take, make, dispose' model of production (Wikipedia)

m. Development, modelling and simulation of materials for electronics and photonics.
n. Development of alternative energies and biofuels**.**
o. Protecting biodiversity and responding to climate change, in addition to:
p. Basic science at the edge of knowledge.

176. The production phase of any new process has a potential impact on the environment, supply of resources and generation of waste. Smart product design and production processes can help save resources, avoid inefficient waste management and create new business opportunities".

177. "… *re-thinking and re-designing the way we make stuff"* explores how through a change in perspective we can design products that can be "*made to be made again'"* and… so build a restorative economy."

178. "Circular Economy" is an industrial economy that promotes greater resource productivity aiming to reduce waste and avoid pollution by design or intention, and in which material flows are of two types:
    a. Biological materials, designed to re-enter the biosphere safely,
    b. Technical materials, which are designed to circulate at high quality in the production system without entering the biosphere as well as being restorative and regenerative by design"

179. Reorganization of the university's current graduate programs will be underway in the middle of the coming decade, which will combine efforts and expertise with international partner institutions to share science, technology and engineering evolving learnings, generate knowledge and seek solutions to the leading global problems.

180. The future of advanced economies will be guided by the tension between entrepreneurialism and sustainability. Preparing graduates' moral compasses will be an expectation of student aspirations from their learning. This will include hypostasising on *"what-if"* reviews of all new products.

181. The EU will be in catch-up mode in the coming decade in translating research into commercial value; but the fear of failure will have to be addressed; there is some evidence that the opprobrium associated with failure will continue to abate.

182. It is important to imbue students with the sense that it is not wrong to fail, but rather failure teaches the internalisation of lessons learned, so increasing the chance of success with further innovation and commercial risk taking.

183. Culture is changing towards innovation and R&D. The Irish innovation knowledge development box (KDB)[31], coupled with the growing collaboration between MNC's, universities and government, are underpinning this process.

[31] Despite speculation that the Irish KDB would be limited to income from patents linked to research and development conducted in Ireland, the box is slightly more generous and driven by the pharmaceutical and technology focus of the Irish economy. It applies to arm's length income derived from qualifying expenditure in the EU by a company liable to Irish corporation tax from:-

- computer programs
- qualifying patent and supplementary protections.
- plant breeders' rights.

184. This collaboration could be grown and brought to a sustaining maturity if ringfenced funding via a 1% or 2% tax on patents income was implemented. This income could also finance the education of graduates with the requisite spectrum of skills demanded by industry and service companies.
185. The five-year Bologna MSc program will be well established by the mid-decade. Lecturing engineering and science students will remain challenged by the fact the few lecturers are active practitioner, compared with medicine where most faculty members are practitioners.
    a. Structures are needed to encourage more faculty members to spend time as practitioners & consultants and vice versa.
186. The revolution in technology will continue to change lives in the coming decade. The current controversy on personal data storage and its usage to influence consumers, coupled with the development of smart systems, demonstrate the need for solid ethical foundations in graduates.
187. Holograms need to be made interactive, possibly using smart phones for interactive feedback. This technology will be commonplace by the middle of the coming decade.

188. The dominant big world issues in 2030 will be food, water, and the nature of work.
189. TL colleges will be under increasing pressures from industry to produce graduates with specific balance of capabilities between technical capabilities, ability to learn and well-formed people skills. In addition, the colleges will have to produce graduates with either depth in a specialist area, or solid generalist skills. Or put differently produce graduates with neurological diversity.
190. By 2030 Irish TLI's will have to have achieved a sustaining engagement with PRC colleges, in addition to participating in the expected evolution of the EU spectrum of TL colleges. The Irish TLI's will have to figured out an efficient and mutually beneficial method of engaging with African TLI's[32]
191. The UCC annual budget is circa €350m pa. Expectation of staff is that they constantly develop their professional skills and knowledge, but limited funding may cause a downward spiral in their ability, which may be difficult to stop.
192. What is expected from staff if their renumeration falls below market because of pressure on public and private funding sources? This statement prompted a comment that the university may curtail the number of students starting in the 2020 academic year.
193. Brexit, in whatever format it ultimately ends up, offers the opportunities for Irish colleges and research centres to "snap up" the brightest and best researchers in the UK, attracted by the availability of EU funding in Ireland, such as the successor to the Horizon 2020 programme.
194. Ireland will, by 2030, have adapted to the changed circumstances of dealing with a reformed European Commission, and have internalised the scale of opportunities that will be presented, including relationships with continental partners.

[32] The fact that code writing in Lagos is now more cost effective than Bengaluru signals an emergence of Africa as a technology development centre.

195. Individualised and personalised learning will be commonplace in 2030, supported by analytics, so improving the satisfaction of students as customers of the TL colleges.
196. There is considerable inertia in the third level sector. This is apparent from the evolutionary only change in the past decade. The biggest advance in this period was in the growth of the TL R&D infrastructure; the big danger for the coming decade is its contraction.[33]
197. Is there enough radical thinking in the assessment process for accreditation of campus R&D operations? Are we looking at getting in deeper or becoming more generalists?
198. Are we comparing and assessing our college against global best practice comparators?
199. Is more agility possible from SFI and other funders, such as the EU, for rapidly developing breakthroughs? There is a strategic risk that the public funding of R&D per capita is trending downwards, while countries such as Serbia's profile is rising rapidly. Is the level of maturity in our R&D processes lower now than 10 or 20 years ago?
200. There are advocates for measuring students' performance based on how they apply learning to externally based work projects. This is likely to be reflected in future strategic plans.
201. Identifying locally based work placements remains a challenge, especially for those following online courses. Placements involving multi-discipline projects teams are especially difficult to source.

[33] Although some "weeding" is always necessary for a vibrant sector.

Section 3(f)

Institute of Technology Sligo Dec'2018

Participants were a mix of senior academics mostly STEM & one industry representative

Strategic planner:

202. Described a process for degree courses modelled on Aarhus, designated as "*path dependency*", based on an interaction between theory and practice through placements. The process involves selecting six topics, following the subjects though online courses.
    a. Performance is assessed based on the use of learned theory from the chosen topics in the externally sourced projects, measuring the appropriateness of application not theoretical knowledge.

203. Predicting 10K students in IT Sligo (ITS) in 2025, up from the current 6K. Some of the increase will be natural growth in demand including local NW demand. Otherwise, online courses will be the major contributor.
    a. Currently there is 2K students in online courses, mainly in workplace commissions, such as from NIBRT or from MSD.
204. Retaining local students is a challenge, in competition to online distant learning. Other challenges include:
    a. Accommodating increased apprenticeships numbers, and not just in trades but also professional apprenticeship, as used in the large consultancies (e.g., PWC for accountants and lawyers) or insurance companies for actuaries.
205. The present apprenticeship programme for trades is not working nationally so cannot make prediction on future demand and structure.
206. ITS aims to be an interlocutor between theory and practice, using work placements and the encouragement of more critical thinking.
    a. The current demand from graduates is for practical people skills in addition to theoretical knowledge.
    b. There is more demand for blended learning, with soft skills, rather than for courses that are based predominantly on theory.
207. Clients are looking for a varied blend of qualifications and professional experience.
208. A three months placement is too short to develop a sense of professional responsibility.
    a. ITS are constantly looking for work experience that is not academically based (to develop workplace inter-personal skills)
209. Local industry is pressing for graduates in three specific areas:
    a. Precision engineering, including its application in medtech,
    b. IT sector skills,
    c. Tourism.
210. In addition, there are local shortages in sales and digital marketing qualifications. In part these gaps are addressed through employers commissioning the development of bespoke training programs for in-house usage.
    a. These training programs are also retention factors.

b. Students and employees typically prove to be creative in the use of online tools.

211. ITS is experiencing a growing demand for workplace learning custom products, mirroring the growing prevalence of two or three career changes, even stretching to people in their 70's.

212. Lotusworks has observed that the availability of online training, much of it experimental, is prompting individuals to re/upskill.
213. Many organisations expect technology to take over from people but have recognised that investment in those displaced is needed to maintain morale.
214. The increasing prevalence of AI in banking has been noted.
215. These trends were apparent thirty years ago, but the pace of innovation has speeded up. The transition in Stryker from foundry-based casting to 3D printing, including printing outsourced orders[34] are tangible examples.
216. Lotusworks added that it must be the responsibility of individuals to "own" their reskilling, noting that the shortage of skills persists.

217. Demand for hybrid / integrated models of multi-discipline courses is likely to grow.
218. ITS is working with small IT companies, who outsource projects to students, who benefit from the experience of working on real tasks.

219. There may be no tool pattern makers in ten years; but without demand there can be no courses. This is also true of typesetters.
    a. CNC tools are being replaced by more efficient and flexible digital tools.[35]

220. Student demand for mechatronics tends to be part of a blend of parallel skills with subjects such as informatics.
    a. The driver behind these blends appears to be industries such as data centres, who are looking for ways to automate (remote) problem solving using cameras and (semi) automation.
    b. The newer automation allows replacement of code to servers, as well as accommodating remote safe training cycles.
221. The global sustainability challenge was mentioned, stating that all students were likely to be required to take some grounding on understanding how to minimise anthropogenic impacts on the earth.
    a. An example is the LEED driven different impact categorisation of electric arc furnace manufactured steel compared with that produced by smelting.[36]
222. Mechatronics has also experienced a consistently growing demand for distant learning.

223. Predicted that by 2030 the disruptive impact of a 50% displacement of manufacturing employees will be apparent.

[34] E.g. for Rolls Royce Aerospace.
[35] The issue appeared to be one of timing of sunsetting courses, transitioning to new technology.
[36] That categorisation has recently been challenged.

224. The UK is the model for manufacturing automation, including its well-funded network of "Catapult" research centres.[37]
225. Ireland scores highly in innovation, and has, (because of the level of MNC investment in manufacturing plants, a highly skilled (and disciplined) workforce.
226. The big challenge is with wage inflation, in part caused by the strength of the €, but also by competition in recruitment amongst the significant pool of companies located in Ireland.
227. Indigenous companies provide most jobs in manufacturing. They undertake less innovation and design work.
    a. Increasing innovation and addressing the ongoing streamlining of logistics are the two major challenges that the sector faces. These factors should be addressed in third level institute's strategic plans.

Senior civil structure academic

228. Productivity in the building/civil/structural industry has flatlined for decades, but digitisation of design and the use of virtual buildings (BIM or digital twins) has brought many benefits, such as clash detection, and use of VR (virtual reality) to demonstrate the building features to clients before starting construction[38].
229. The introduction of Lean Construction (the Toyota way) is enabling the development of roadmaps for waste elimination. Sisk has appointed a director of productivity to drive continuous improvements.
    a. The digitisation of construction, including its logistic chains, will be well embedded by 2030, and there will be pressure for new innovative methodologies to continue the process. ITS would plan to support these transitions.
230. Knowledge of sustainability, LEED type certification and optimisation of life cycle costs will be key parts of all construction professionals' education, as will the by then well-established automation of a high proportion of offsite manufacturing.
231. 3D printing of building components will have advanced to the point of being a practical capability in the industry.
232. Blended learning continues to be popular with civil/structural engineering students.
    a. Use of workplace learning is widening and will be a key component of future graduates' careers.
233. This embracing of life-long learning is more marked in the UK than in Ireland. But this is likely to change as graduates with in-demand expertise increasingly dictate terms on working hours and employer investment in employees' skills.
    a. Interestingly student inter-personal skills have improved because of social media usage;[39]

234. Recognises the trend towards individualised learning, driven by student expectations ("*need to know a bit about everything*") and employers looking for blends of specific skills (such as degrees in self-driving technology, on which ITS is partnering with China.

[37] Reflected in the high placing of the UK in WEF ratings for innovation,

[38] Adoption of digital systems in the construction industry made marked progress in 2019. Virtually all TLI's now have training courses in the proprietary software that enables the creation of digital twins and their construction.

[39] *"These students will likely be more assertive on value obtained in third level courses. "*

   a. ITS is also twinned with Kempton in Germany, and with the IDA, on a partnership aimed at creating a self-drive automobile hub on the west coast.

235. There is constant pressure to *"get student numbers up".* Fortunately, there are many EU companies that are interested in partnering with English speaking colleges. This trend will continue into the next decade.

Organiser

236. The biggest area of innovation in ITS is in online learning; it is an area of real expertise in the Institute. One of the keys to its success is the customer focus in identifying areas of opportunities and providing a fast turnaround on the development of online courses.
237. They are seeing increasing demand for new techniques which deliver an enriching learning experience, such as simulating tasks using virtual machines.
   a. One customer, Lotusworks, commissioned MOOC's[40] to allow employees to experience their teaching potential.
238. ITS is drawing on the experience of **Southern New Hampshire University** (SNHU) which is a major supplier of online degree courses. Their infrastructure includes a large call centre which monitors the progress of students and offers advice.
   a. ITS has two (online) student advisers and plan to grow this number going forward.
239. A constraint in future development paralleling SNHU is funding.
   a. Staff experienced in draughting MOOC's and recording personalised messages and tests are in short supply, especially those familiar with recording personalised messaged as part of an online degree course.
   b. SNHU has been willing to share experience on operational cost, funding of courses and fee determination, as well as offering advice on how to assess CV's. (SNHU has 5k students in the campus, and 100k online)[41]
240. The amalgamation of institutes of technology into new Technical Universities is proceeding slowly in the NW, mainly due to reservations on the part of GMIT.
   a. Any merger will result in challenges for ITS, in addition to the positives of more PhD's on the academic staff, and a bigger focus on R&D.
   b. But inevitable rationalisation of courses across the constituent colleges' campuses will result in a loss of experienced lecturers.
241. ITS does not want to lose apprentice education. The emerging new model of assessed workplace learning coupled with limited night course work, should have matured before the end of the next decade.
242. Other colleges are getting involved in online courses and will compete with ITS going forward.
   a. ITS staff are deepening their understanding of MOOC's effectiveness and growing their experience in their subject areas, enabling an organic maturing of its capability.

[40] Massive Open Online Courses
[41] Replicating the SNHU online capability would obviously be a strategic imperative for any TLI.

b. The challenge going forward in ITS will be to free up time in the academic workload to provide resources for new education models (such as online / MOOC's) as well as adding resources to copper fasten areas such as quality certification (ISO 9000).

243. The introduction of a lab apprenticeship program at Level 6&7 for the pharma / med sector is a typical example of an area for near future development.

244. The introduction of MOOC's for the insurance industry is another example of an emerging opportunity.
245. Institute of technology courses by MOOC is another possible area of opportunity. The attitude of the unions (IUA) may be an impediment.

Section 4.0 One to One Inputs

Note paragraph numbers 246 to 250 are deliberately skipped

Section 4(a)

Individual 1:1 Interviews (Business Sector)

Senior Geotechnical Engineer (Arup London); March '19

251. The interviewee, an Irish geotechnical engineer based in London, has observed in his work the onslaught of new technical applications gradually supplanting structural design in geotechnical projects.
    a. This is also apparent in the design of straightforward buildings, leaving only complex structures requiring the input of an experienced engineers.
252. He predicts that over the coming decade, with the gradual development of ever larger databases of successful projects, coupled with evermore powerful applications, the value of mining these resources will increasingly yield optimum design solutions.
253. Given the increasing effectiveness of Artificial Intelligence and Machine Learning across all branches of science on ever growing databases it will be likely that, as in the case of structural engineering disciplines, virtually all design, except that for the most complex structures, will be commoditised. and may be delivered gratis as part of a contract for professional advice on which databases to use.
254. Obviously access to the databases will be the crucial and may become a revenue source to the firms who originally developed the design. But only the largest companies would be able to play in this business.

255. For an engineer, the advent of AI powered design may basically eliminate the value add from third level engineering degrees, and much of their acquired experience. It will be necessary to extensively re-educate these engineers to exploit the new applications and consulting services. The resulting design may be automatically configured for off-site pre-fabrication.

256. In other industries, such as biopharma gene-based drug development, AI has already transformed the work, under-pinning the rapidly expanding area of personalised medicine.[42] Constant upskilling will be needed to keep pace with the technology, and to devise validation processes for the resulting products[43]

System integration and cloud services company executive. March'18

257. Their companies use a work culture of promoting productive ideas, then progressing them into spin-off companies. The sale of these spinoff companies is a perpetual aspect of the business. This drives a focus on innovation & agility skills amongst employees, characteristics that need to be nurtured in the third level cycle.

[42] **Pharma Exec 50 2018 Ranking**: Novartis, Otsuka, Pfizer, and Sanofi all formed alliances with Verily, Alphabet's life sciences unit, in hopes of reshaping clinical trials in disease areas such as cancer, mental health, diabetes, dermatology, and heart disease, using Google's data-management skills.

[43] **Postscript:Jan'21** The interviewee referenced Susskinds' books on the impact of artificial intelligence on the workplaces. The self-explanatory title of the most recent book by Daniel Susskind, "*A World without Work*" describes some radical changes that are probably in the offing, due to the very process the interviewee had observed in his profession.

258. The business process used is to focus on "*business conversations*", such as problem solving, with customers. This drives a need for strong communications and inter-personal skills, as well as negotiation capabilities, in addition to technical knowledge and experience.
259. Software applications are becoming ever more powerful and flexible[44]. They already include the capability to work with other vendor's products across many business categories. The need for custom software or deep coding capability is declining. Most situation only require enough knowledge of the capabilities of applications to *"hang a solution"* together.
    a. So, computer science graduates need exposure in their education to problem solving, and up-to-date knowledge of the changing integration capability of applications. This is an ongoing challenge for the TLI's in annually reworking coursework in computer science.
        i. This also presages a need for constant notification to TLI's on updates for commercial and analytic applications, as well as hands-on experience of their use.
    b. Ergo has relationships with IT Tallaght and the National College, whom they assist with reviews of vendor software on which course work can be built. This relationship may be too informal and may need to be more systematised for futureproofing of courses.
260. Data analytic & AI, and the underpinning predictive algorithms, will continue to be growth sectors. But it is also important to understanding key parameters, and the expected output of applications (so-called "black boxes") without getting tied up in understanding the precise process used. Practical experience of their changing capabilities is a parallel requirement.

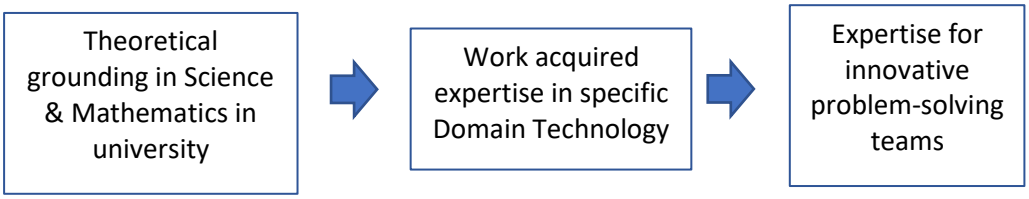
<u>Software executive April'18</u>

261. Interviewee is in the cloud storage and SAAS business, ensuring configurable and secure access to the cloud services.
262. As a background to predictions for third level education, the interviewee stated that the transition to cloud services will continue through the decade, due to exponential growth of services utilising AI, facilitating IOT devices and autonomous systems etc.
263. Demand for related skills will continue to grow, including a marked requirement for CPD and career upskilling breaks.
    a. Students will need to comprehend the inexorable growth in the complexity of communications / computing domains, specifically the purpose of all layers as they evolve. This will require increasingly deep and specialised technical education, and the ability to work in highly effective real and virtual teams composed of experts with complementary skills.
    b. These team-working skills will need comprehensive ongoing training, and the ability to keep abreast with emerging refinements of inter-personal skills, including those derived from the pedagogical study of the application of artificial intelligence (AI) to the task in hand.

[44] Including data analytics, artificial intelligence, machine learning, predictive services, augmented reality.

Software company lead designer: April'18

264. Teaching domain specific skills (e.g., networking, AI etc) in depth is not a role for the TL colleges. Their role should be focused on mathematics, and the science underpinning the theoretical basis of the IT subjects.
    a. *"understanding the maths behind excel is more important than proficiency in its use"*
265. Ideal progression for an IT engineer / software developer



266. "*Experts know more about less and less".* Therefore, problem solving &/or innovation of complex systems require teamworking of experts with complementary skills.
    a. Example quoted of CLOUDFARE product development work to increase the speed and security of applications and e-commerce, using their range of domain expertise, such as assembler knowledge, so enabling the development of new code that becomes the assembler.
267. Training in effective teamworking and problem-solving techniques are essential capabilities underpinning innovation and the search for the next "great thing"
    a. Software wins over hardware as the latter is now configured to let software decides how it works, e.g., firmware; (hardware that can be updated).
    b. There are multiple software types, knowledge of which is necessary to choose which is best suited to a challenge. Ericsson's use of Erlang programming language for the management system of communications towers is an example.
    c. Software programming languages can be self-taught using online sites such as **Pluralsight**, rather than needing to attend outside courses.

Software developer: preliminary observations on software development: April '18

268. "To stay current, consult outside your area of expertise, and learn from the skills and experience of others."
269. Computer science third level+ education is "good" but not good enough, with deficiencies in basic theoretical understanding and fault finding, debugging and problem-solving skills.
270. Waterloo University (ON) computer science faculty is a role model, basing their curricula on theory combined with a business orientation, i.e., students are educated in workplace disciplines, communications and teamworking skills.
271. Whilst it may be out of scope for an educational discussion, I feel industry has a responsibility to *'plant the trees they may never see the fruit of'*. This applies to building human capital internally but also in a national context.

272. Acquiring competence in software writing skills requires more of an apprenticeship type of education. Extensive placement periods to learn in the working environment of a successful company is necessary.
273. Draft Strategic 2030 Scenario: To enable software-based enterprises to continue to increase their role in the economy, a consistent common process needs to be developed for educating and training software graduates, leveraging the experience of the established teams in successful companies.
274. For efficient administration, a wide-ranging **common process** for **placements** needs to be developed between all the third level colleges and most companies active in the sector.
275. The process would be like the multi-phased out-placement scheme used in automotive design colleges' curricula.

Section 4(b)

Individual 1:1 Interviews (Academics)

Senior Civil Structural Academic: Feb'18

276. Evolutionary change only in the structure of third level education is predicted for the coming decade.
    a. Students like the process of brainstorming, which require education in the management of meetings and in people skills. Although this is initially resisted, its practical value in facilitating teamworking is eventually understood.
    b. Course work is likely to transition to a structure of major and minor subjects. The driver is that greater depth of knowledge is required on core technologies. Example quoted was structural design as core, thermodynamics as non-core.
    c. Professional registration is most student's goals, e.g., Chartered Engineer
277. Engineering course length of five years is not too long. The marketplace, especially overseas locations, seems to demand a five-year course, more specifically a master's degree.
    a. A point of friction is the fifth- year fees, which are 2X that for other years. Some easing of this additional burden is required.
278. Morale amongst students appears to be high, as exemplified by the engagement in extracurricular activities, and taking responsibility for organising events. This trend is expected to continue.
279. Teaching proprietary analysis programmes is strictly not part of an engineering curriculum, as doing so eats into time for teaching theory. But some knowledge of proprietary software is needed to link the operation of commercial programs to theory. A future issue for prioritisation.
280. There is an increasing need for researchers to be proficient in the capability and use of analytical software.

Retired humanities professor (Jun'18)

281. Have difficulty envisaging the teaching environment in the coming decade, having lived through the revolutionary change of the massive increase of the numbers attending TLI's in the past decades.
282. The change of increased numbers of students will be compounded by the increasing pace of technology development. Society will require people with the skills to lead and oversee this dynamic environment.
    a. Characteristics required include well developed technical and cultural skills, and an open personality.
    b. Interviewee taught technical communications, presentation skills, and report writing. (this constituted the first semester of the leadership course he led.) The second semester concentrated on inter-personal skills, including real life company-based scenarios targeted at deepening cultural and working life skills.
    c. This course work was effective in preparing under-graduates for the working environment.
        i. Ultimate interpersonal training would be an extra year of placement.

ii. Essentially this is all about taking responsibility for your own life, adaptability, and acceptance of change.
iii. This personality formation will be increasingly an expectation of all third level students.

283. Given the pace of technological change, more frequent mid-career upskilling will be required. The upskilling needs a broader scope to incorporate changes in working practices and communications methodologies.
    a. Much more efficient processes for delivering upskilling will likely emerge in the coming decade,
284. Language skills are becoming more important in 21st century life, but little seems to be done to address effective communications in English as well as through other languages.
285. Finland is regarded as a benchmark for effectiveness of their TL education for preparing students for the workplace. Need to understand their guiding philosophy and delivery process.
286. Interviewee had no knowledge of MOOC's being applied to liberal arts subjects or of TLI's undertaking studies of linkages between learning styles and students' interaction with MOOC's to hone delivery of classes to students' learning styles.
287. The value and appropriateness of educating 50% of each student class in TLI's versus 18% in Germany was mentioned, but the interviewee was not aware of any work on this challenge.
288. Interviewee was unaware of any programs to reduce TL education costs, through efficiencies.

Retired senior technical academic and administrator Feb 2019

289. Interviewee opened by stating that the state is not properly funding third level education.
    a. Essentially the TLI's are operating a consumer service: students pay and get a degree, rather than developing as citizens.
    b. Only TCD acts as a traditional mind broadening college.
290. The value students obtain from degrees in other colleges is not always apparent. For instance, MIT as an undergraduate college is poor, it excels as a post graduate college. The same might be said of many Irish TLI's. Students will be increasingly conscious of value.
291. Presidents of TLI's need to be able to lead and motivate the brilliant & disruptive. CIT has roots in Crawford Technical School. UCC at that time was strong in civil and electrical engineering, but little interest in electronics or chemical engineers.
292. CIT recruited staff from industry, starting with the four disciplines, chemical, electrical, software and mechanical engineering. The focus in teaching was on problem solving, which obviously improved people skills.
    a. This is likely to become more common.
    b. Performance in the final year project dictated whether you got a first-class honours degree, not your examination results. UL and DCU followed suit.
293. There is a crisis of a high drop-out rate in electronic engineering; mostly prompted by acceptance of students with low points in a drive for capitation income. Students will increasingly have to be directed to courses that match their capability.
294. This drives the question on whether too many students are entering TLI's; 60% in Ireland and 45% in Germany.
    a. Obviously, Irish parents value university education, rather than that of a master craftsman apprenticeship.
295. TL education costs €1bn per annum; interest on the national debt is €5bn per annum, showing the probable affordability of the cost to the state in the current fiscal climate. Funding going forward will be an increasingly contentious and possibly constraining issue.
    a. Cost of educating under-graduates approximately equates to that for secondary students. The cost for master's students is higher, due to the running costs of laboratories, and that for post-doctoral researchers is greater still with the need for advanced equipment.

296. In Germany, students qualifying from second level split into two cohorts:
    a. "Gymnasium" (academic secondary school)- awarded Abitatur diplomas. Less than 40% progress to University and Universities of Applied Science.
    b. "Realschule" (plus other secondary schools), awarding various diplomas. 50% of these secondary students progress to vocational or technical colleges and then on into the workforce. A small proportion may choose to go to a University of Applied Science eventually.
297. There is a big difference between the traditional University and the University of Applied Sciences. The latter are much closer to industry. All lecturers would have spent time in industry, many are still active in their profession. Project work, seminars, problem solving are their focus, they operate at Level 8/9 but there is some Level 10 now in the IT and Mechanical Engineering areas, again the driver is the industry rather than the university.

a. This approach should be attractive going forward to industry in Ireland, based on the quality of the learning experience, and the readiness of graduates for the workplace.

298. The way people learn has changed. For instance, students are looking for more experiential learning. As an example, UCC Humanities School attract US students to courses on Irish poetry, visiting locations through-out Munster.
    a. Demand for experiential learning is likely to grow in the coming decade.
299. SFI is funding specialised research centres to become local *"fraunhofers".* These employ PhD students as low-cost labour. They are independent of the TLI's but should migrate to be part of a TLI.
300. Best way to capture the effectiveness of the German TLI sector as a strategic objective is to benchmark German 2nd and 3rd level education and construct a scenario that: -
    a. Firstly: reduce the numbers going to TL universities to match that in Germany.
    b. Secondly designate a virtual single technical university in which each existing university has an interest.
    c. Thirdly, reform post-secondary training to provide useful and lucrative career training for the 55% of students not going to university.

Retired professor; June 2019

Proposal for an International University of Ireland: (an International research university)

301. The spread of English as the language of higher education and research in the elite universities of the world is making them more attractive to the best, internationally mobile, students and researchers. Course delivery through English cannot but improve a university's international rankings.
302. Paralleling this trend is the strategic pressure by governments, such as the French and German governments, on their TL sector towards competitive *"excellence Initiatives*", which target delivery of 20 plus world-class elite research universities in the coming decades. This competitive benchmarking is absent in TLI's in Ireland.
303. A typical catchment population for an elite university is five million. The ten leading TL colleges in Ireland have each an average catchment population of a half a million. There appears to be capacity to support only one elite university in Ireland.
304. In Ireland, the decade long PRTLI delivered a distributed investment in R&D centres in the campuses of the seventeen TLI's. SFI and EU Framework programs provided the funding for (STEM based) R&D, in their three priority areas, Life Science, IC&ET, and Energy.
    a. Primarily because of these investments, Ireland's position in the WEF ranking had improved to 10th in competitiveness, and 21st in innovation.
    b. The highest rated university in the Time's Higher Education Ranking in 2019 is TCD, at 120th.
305. Irish universities' ratings possibly will continue to fall compared to that of international peers. The most able researchers and students will naturally gravitate towards highly ranked, one speed institutions, in an increasingly competitive English-speaking academic world.

306. A role model for addressing this potential deterioration of standing is the path the French Government followed in setting up PSL Science & Lettres-Quartier Latin with an initial grant of €750m.
    a. Paris Sciences & Lettres (PSL) University is a world-class university driven by innovation and value creation. Created in 2011, **PSL** provides an academic environment where the sciences, arts, humanities, and social sciences are brought together, mutually enhancing intellectual pursuits, where basic and applied research go together, and where universities and the corporate world interact.
    b. **PSL**'s distinctive **federal** structure comprises 26 prestigious self-governing academic and research institutions, 178 research centers, over 80 libraries and museums. With 4,500 researchers and 20,000 students, PSL's strengths are therefore comparable to those of the world's top universities[45].

307. The option for Ireland would be to establish a single elite international university from the best parts of our existing universities and Institutes of Technology, at a marginal cost. A draft title could be the International University of Ireland: Science, Arts and Letters.
308. It would be characterised as a co-operative, multi-cultural international research university, privately and publicly endowed and motivated, offering the best from Ireland's existing institutions, in the cultural, educational and research sectors, drawing on their diverse histories and identities.
309. The goal would be to form one of the world's high-profile elite universities, with strong European and inter-continental presence, with distinguished Professors accessible to its outstanding students, and with a common citation policy for its publications.
310. It would aim to excite the public, private, and cultural sectors of society, with innovative ideas, products and processes from its ground-breaking agenda.
311. Existing internationally competitive staff would be invited to accept a joint appointment for limited periods of time as IUI Chairs, while retaining their facilities and rights in their home institution. They would be motivated by a 20%+ increase in salary, for the one day a week at their disposal for "outside work" at the IUI.
312. Top students would enrol in IUI but might be based for most of their time in their parent institution. The French University Excellence Initiatives provides models for Ireland.[46]

End of Dialogue Inputs

[45] PSL is rated 41st in the 2019 Times Higher Education Ratings.

[46] Appendix 4 (page 45) Abstract from FT (21st May '18) article on the transition of Paris based Elite **Sciences PO's** into an international institution.

Appendix I: 21st Century Skills

21st century skills[47] comprise skills, abilities, and learning dispositions that have been identified as being required for success in 21st century society and workplaces by educators, business leaders, academics, and governmental agencies.
This is part of a growing international movement focusing on the skills required for students to master in preparation for success in a rapidly changing, digital society. The following list provides a brief illustrative overview of the knowledge, skills, work habits, and character traits commonly associated with 21st century skills:

- Critical thinking, problem solving, reasoning, analysis, interpretation, synthesizing information
- Research skills and practices, interrogative questioning
- Creativity, artistry, curiosity, imagination, innovation, personal expression
- Perseverance, self-direction, planning, self-discipline, adaptability, initiative
- Oral and written communication, public speaking and presenting, listening
- Leadership, teamwork, collaboration, cooperation, facility in using virtual workspaces
- Information and communication technology (ICT) literacy, media and internet literacy, data interpretation and analysis, computer programming
- Civic, ethical, and social-justice literacy
- Economic and financial literacy, entrepreneurialism
- Global awareness, multicultural literacy, humanitarianism
- Scientific literacy and reasoning, the scientific method
- Environmental and conservation literacy, ecosystems understanding
- Health and wellness literacy, including nutrition, diet, exercise, and public health and safety

[47] Also called Transversal Skills

Appendix 2:

Abstract from **World Economic Forum** Website on future **Educational Challenges**

These are similar themes to those emerging from the dialogue sessions.

a) Educational curricula that impart the knowledge and skills that are relevant to the modern workplace, help build early learner identities, develop local and global citizenship values, and nourish core non-cognitive skills are essential. Education creates the base for **future re-skilling** and **self-actualization**, and for civic identity.

b) As noted in the World Economic Forum's 2017 white paper *Realizing Human Potential in the Fourth Industrial Revolution,* educational curricula cannot remain fixed, as career paths change faster, and are less linear, than ever before. There is wide-ranging consensus that no single skillset or area of expertise is likely to be able to sustain a long-term career in the economies of the future.

c) Educational institutions need to provide both in-depth subject knowledge, and an ability to make **inter-disciplinary** connections. The Forum's 2016 report on ***The Future of Jobs*** noted that the core skills of the 21st century - such as complex problem solving, critical thinking, creativity, collaboration, and digital literacy - are important for enabling people to be flexible enough to adapt to the changing needs of the job market. These skills are ideally developed early, in basic education, and then refined at colleges and universities as well as during lifelong learning.

d) Future-ready curricula must deliver a strong base of foundational **linguistic**, **mathematical**, and **technological** skills. However, shifting demand for skills across industries will require that curricula be updated and adapted on a regular basis, as they are informed by the evolution of labour markets. Upgrades to curricula should be built into the system incrementally, thereby avoiding the excessive disruption and implementation time-lag associated with major, infrequent overhauls.

e) In order to ensure that education remains job-relevant, it is critical that more emphasis is placed on collating insights from government, businesses, and civil society in the curriculum design process. Technology and globalization are transforming the ways that we work and learn and disrupting education and training systems that have remained static and under-funded for decades

f) Prevailing gender biases have only introduced further inefficiencies and inequality, while existing metrics have failed to adequately reflect the explosion of independent contract work done on behalf of ride-sharing and other "gig economy" services. Greater efforts should be made to ensure that talent is developed and deployed for maximum benefit to economies and societies, by **mobilizing** businesses, governments, and civil society to pursue common agendas and collaborative action.

Appendix 3: Extracts from FT article by President of MIT (11th Feb 2019)

"*To prepare society for the demands of the future, institutions must equip tomorrow's leaders to be **"AI bilingual"**. Students in every field will need to be fluent in Artificial Intelligence strategies to advance their own work. And technologists will need equal fluency in cultural values and ethical principles that should ground and govern the use of these tools.*

The scope and urgency of this challenge are enormous and meeting it will require bold partnerships. At MIT, we teamed up with Stephen Schwartman, chairman, CEO and Co-Founder of Blackstone, who enabled us to launch a $1bn initiative, designed to accelerate cutting-edge research, foster innovation and deliver the power of computing and AI tools to every other discipline.

*Above all, it aims to educate the leaders of the **AI future**. A focus will be to advance research and education on the ethical implications and societal impact of computing technologies."*[48]

[48] The thesis in Daniel Susskins' recent (2020) book, "A World Without Work", referenced in footnote 43, describes one possible outcome of the expanding capability of Artificial Intelligence.

Appendix 4: Abstract from the FT (21st May '18):

Elite **Sciences PO's** transition into an international institution.

1. Monsieur Frederic Mion, *directeur de Sciences Po* describes Africa as the "new frontier" for universities and warns that western institutions are behind peers from China. "*The dean of our School for Public Affairs, … went to Tsinghua near Beijing a few months back and was stunned when at the lectures he gave he addressed an auditorium which was two-thirds full of African students," …*
2. Online learning is another challenge. "*I don't think we're going towards a world in which universities will all become virtual", …..."* But there is huge room for improvement in the way we use digital tools to improve the learning experience. Virtual classrooms, in which professors teach students remotely online, have been created for Science PO master's degree courses. But Mr. Mion says classroom teaching will always be key.
3. *"When I started this job there were a number of people … who said universities as we know them are dead, that digitalisation is going to kill you all?"* … "Now I have come to believe very strongly that the people who say that are profoundly mistaken about what a university is all about".
4. The reason universities will continue to need physical space is not to dispense knowledge but to **bring people together** to learn from one another. *…"If you were to try to create a market for purely online MBA's it would bomb"* he says, noting that people pay for such courses in part to be given the chance of meeting peers and forming bonds that will be a network for them. "*Learning is a communal thing.*

Appendix 5:

High Level Summary of Feedback

Long-term challenges and key opportunities facing the Third Level (TL) sector in Ireland by 2030 were discussed in a series of dialogue sessions held by the Irish Academy of Engineering (IAE) with a selection of Irish academics over the past two years. The output from the sessions is summarised below, derived from the inputs set out in preceding sections.

a) Macro societal trends are accelerating. Short-term issues of increased automation and 3D printing, coupled with longer-term issues like the proliferation of artificial intelligence (AI) and the growing consciousness for better environmental protection, are all creating the need for transformational change in how the third level education sector develops the required skills.

b) With the now established trend of diminishing medium-term job security, there is a corresponding requirement for changes to education and learning. Third level colleges will continue to expand their life-long learning opportunities, including upskilling & reskilling, on-line learning, part-time learning, resilience, student centricity, specialisation, blurring lines between disciplines, active learning, portfolio building, adaptive learning[49], work blended learning through placements, experiential learning and other connections with industry and services. It is best described as the need to educate for lifetime working.

c) Career long CPD[50] will be more rigorously policed. Greater regulation may be required including annual revalidation under professional registration bodies to ensure the quality and sustainability of the CPD process.

d) In a world where all information is freely available, creating new knowledge will require developed pedagogical methods and skills. The millennium generation expect the redesigning of the system of education to incorporate a broader skill set, sometimes called 21st Century skills. This comprises skills such as teamworking, self-discovery, exploration, problem solving, analytic thinking, communications (speaking and writing) and the ability to collaborate.
Future higher education curricula should deliver a base of foundational linguistic, mathematical, and technological skills. There is also a need for creation of new pedagogy tools and collective learning, together with linkages and networking between institutions across geographical boundaries.

e) In an open economy like Ireland's, operating in a global marketplace, there is a need to benchmark the higher education system against the best in the world to achieve a

[49] **Adaptive learning**, also known as **adaptive** teaching, is an **educational** method which uses computer algorithms to orchestrate the interaction with the learner and deliver customized resources and **learning** activities to address the unique needs of each learner.
[50] **CPD**: continuing professional development

sustainable globally competitive third level education system. It should continue to recognise the impact of global competition for talent and create frameworks to effectively compete for such talent. Recent reports on future strategy for higher education over the last two decades appear not to have adequately address how to achieve this level of international excellence and distinction.

f) The need to create one world class higher education institution built around co-operating and competing components of the entire Irish tertiary education sector may be a fundamental component of meeting this level of skill.

g) Attracting and retaining the most able researchers and those students who tend to gravitate towards highly ranked institutions in an ever increasingly competitive world will be an ongoing challenge. As part of a significant transformation of the Irish education system, institutions may have to reorganise and reposition to compete with, inter alia, US and PRC institutions.

h) Third level Institutions must be able to selectively influence the creation of research and education programmes, collating insights from government, businesses, and civil society in curriculum development.

i) The introduction of student centricity in educating a more diverse student population must be streamlined to deliver outcomes such as personalised development. The increasing potential use of pedagogical data as a basis for optimisation of learning, and its role in underpinning personalising the delivery of education, should be addressed in TL strategic plans.

j) Pressure from students for greater value and individualisation will likely increase. Capturing student views will become more important and impactful, as will the internationalising of the student base. The introduction of methodologies for collecting performance data and its application for process efficiency and product quality enhancement will become paramount.

k) Greater efforts will be needed to bring industry managerial experience to third level-institutions, inculcating the working characteristics of flexibility, resilience, and work readiness in graduates. This will help focus on creating wealth and identifying disruptive technologies while supporting the interpretation and analysis of data in the deepening information age. This interchange between industry and academia should also support the building of competent judgement and comprehension of the results of the increasingly capable digital tools.

l) Third level programmes combining hard and soft sciences will increase, as will those supporting the student's knowledge depth and breadth, coupled with the development of empathic skills necessary to work across disciplines. Students will also be expected to comprehend the systems supporting the inexorable growth in the complexity of communications and data processing. This will require increasingly specialised education and the ability to work in highly effective real and virtual teams composed of experts with complementary skills.

m) The need to continually invest in technology at all stages of the education process was noted in multiple dialogue sessions. Higher education institutes will otherwise be challenged to stay current with societal trends and employer needs. A need is emerging for a structured approach to upskilling of faculty members in emerging technologies.

n) Furthermore, continuing technology development such as in robotics and multi-media will drive the need to imbue all graduates with a solid ethical foundation.

o) Of even greater importance will be the need to address public eco-concerns in educational areas such as productivity enhancements aimed at waste reduction, avoiding pollution, the safe disposal of biological materials, and designing equipment for reuse of components.

p) There will be a need to broaden the pedagogical methodologies associated with developing innovation, creativity, and entrepreneurial capabilities. A desirable component would be to recognise, develop and grow capabilities of all students, including those with complex personalities, as such students can excel in the workplace.

q) Capabilities to underpin innovative drives will increase dramatically as the search continues to develop the next '*'best thing"*. Combining business orientation and academic theory within a curriculum should enrich agility skills. The understanding of key parameters and expected outputs (without getting tied up in understanding precise processes) will be important in growth areas where predictive algorithms are already prevalent.

r) Talent, tax incentives and a stable environment for doing business remain key ingredients underpinning Irelands performance as a location for manufacturing, services, research, and development.
The attraction and retention of specialised talent in research, entrepreneurial and innovative activities, are critical for the continuing growth of the global reputation of our third level education sector.

<u>EOR</u>