Session 4 Notes – Skills

Table 1

Nataliya Aleksieva – NR, Amar Sohanpal-MOD, Manu Sasidharan CSIC, Haitao Lan CSIC, Keith Bowers-COWI, John St Leger-HS2, Mehdi Alhaddad-TfL, Viviana Bastidas Melo-CSIC, Sakthy Selvakumaran-CSIC

Flipchart Notes

Alex- eg. Graduate engineer

- Pick along the way
- Management
- Digital
- Cost drawing? > develop skills > think through hg
- Learn from work
- Depend on school – eg. Digital skills
- Decision how to use data (solve problems)
- How to obtain data, interpret data eg. Sensors
- Train how to think
- Blank box- dangerous > understand > sense of checking
- Program coding > how to work , not specific
- Critical thinking > process depending > challenging
- Don't lose important thinking

Question 2

- Think together, team
- Communicate
- Integrate different ideas
- System thinking
- Different skills > depend on different companies

Question 3

- Self learning/satisfaction
- Salary ?

Other notes

Q1

- A long-term target should be set
- Good management and organization skill
- Learn how to use digital data and related skill
- Don't lose drawing skills. The skills will help you understand and think your problem thoroughly
- Learn from work
- Different schools teach different skills related to digitalization

- How to use data to make decisions and solve problems
- How to interpolate and obtain data using sensors
- Train students how to think critically and logically
- Obtain checking skills and don't just rely on those machine learning skills because it is a black box and students should understand the problem itself
- Foundation skills of program coding and know to work. Don't need to be specific (learn different coding language later)
- Critical thinking is important and students should learn how to challenge

Q2

- Think how to solve problems as a team
- Communication is key
- Learn how to integrate different ideas together
- System thinking
- Different companies need different skills

Q3

- Self-learning is significant which make you self-satisfaction
- Salary also needs to be considered

Q4

- Expect what industralization 4.0 looks like
- Learn new techniques, e.g. AI, Quantum, nano...
- Learn diverse topics
- Learn from experience
- Resolve problems from different perspective
- Bring your own expertise to clients and understand processes
- Learn how to pack all problems together
- Build foundation skills
- Know your own limitations
- Work as a team and create safe and respectful environment
- Need to have room for different ideas, not just civil engineering and we need voices from science, architect...

Question 4

- Industralisation 4.0 look like
- New tech eg AI quantum, nano….
- Diverse
- Experience > perspective
- Resolve out
- Bring own expertise to client
- Understand process, package all together
- Building block/foundation
- Know own limitation
- Work as a team > safe respectful environment
- Room for other ideas > not just civil eg. Science, architecture system

Table 2

Daniele Fornelli- Geo Obs, Haris Alexakis- Aston, "Jason Sun CSIC, Paul Fidler CSIC, Mark Enzer-Motts, Peter Hewitt-LOR, Adam Box-Topcon, Manar Alsaif, UoC, Paul Fidler-CSIC, Brian Sheil-CSIC

Help Alex to

- Achieve better proactive maintenance and optimise assed management via digital twinning/digitalisation.
- Address future sustainability challenges and become innovator in an Industry 4.0 environment?

1. What are the missing skills Alex might have to achieve their primary goal?
2. How have you dealt with any similar gaps in skills/knowledge in practice?
3. How your company is willing to address the issue in the future?
4. Any suggestions to improve Education (higher or not) to help people like Alex?

Note: Table 2 was asked to begin by discussing Question 2, but the discussion quickly moved on. In the text below, numbers in [square brackets] indicate the question (if any) that may have been discussed…

Discussion

Paul began by suggesting that an obvious first point of call for Alex, if Alex was unaware of how to do something would be to search on Google or Wikipedia in the first instance. [2]

Peter responded that this was all very well and good if Alex knew what skills were missing. Laing O'Rourke have recently set up a 'Data Academy' to run courses using funds from their Construction Industry Training Levy budget – some of those courses have introduced staff to new ways of manipulating data in Microsoft Excel, and also Power BI. Although most people at the firm had been using Excel for years, many were unaware of some of the newer capabilities, and so the courses were useful – particularly for members of staff who had left University a long time ago. [2/3]

Adam suggested that getting into schools early to motivate students, especially those that wouldn't necessarily go to University, was also important. (He also suggested taking a drone, as that often livens up the presentation and inspires people.) He also reccommended Apprenticeships, where students both learn and work. Students are immediately able to put their new knowledge to real world uses, rather than it being abstract and theoretical. [3]

Both Daniele and Haris were keen to establish what skills are missing from new graduates [1] to make them 'able to deal with data' from day one, and Haris was interested in what might be incorporated into a MSc course that would bridge the gap. [4]

Daniele gave an example of wanting to know what additional skills would be required for a new graduate (who should be assumed to be data literate) to be able to make use of data to determine whether a structure was safe.

Paul pointed out that damage detection using sensors is not a solved problem, so no course or new skill would necessarily help with that question. Furthermore, new graduates in the UK are not yet chartered (this may differ from continental degree courses). A lot of on-the-job real-world experience is required before they become chartered and can sign off on drawings etc. (Which has nothing to do with whether they are 'data literate' or not.) Paul also pointed out that it was quite likely Cambridge

graduates would not be familiar with design codes, although they'd probably be able to recognise the assumptions and theory hidden behind them.

Both Peter and Adam stressed that all good graduates should have the ability to learn more skills throughout their career as required. Continuous learning, or continuous professional development is important. It is also important to have the right mix of people on a project, be the 'nerds' (for want of a better word), sales people, surveyors or whatever.

Paul suggested that trying to enumerate a definitive list of missing skills needed by new graduates was not possible. Their needs would depend heavily on whatever project they were working on. What is needed is flexibility, with some professionals able to pick up new skills as required simply by reading up on the topic, while others may prefer either short courses, such as those provided in Laing O'Rourke's Data Academy, or longer courses leading to a formal qualification. One size doesn't fit all. University is where people go to learn how to learn.

Haris again mentioned the idea of an MSc course. He used the example of it taking him a year or so just to have a 'common language' with people such as software engineers who might be able to help with his projects [4]. Peter mentioned that Laing O'Rourke were already sponsoring a Masters-level course at Cambridge (the Construction Engineering Masters - CEM) [2/3/4].

Daniele pointed out that one of the issues he has is that engineers currently don't seem to either understand sensor data, or don't know what to do with it. Their thinking is very much around a 'model'. When given data that disagrees with the model, the usual result is that they question the data, and either ignore it, or ask for the data to be collected again, possibly in a different way.

Manar (from a slightly different perspective of a geologist) agreed that a common language was important (she gave an example of the term 'Sapphire' being used differently by Geologists and Physicists) and stated that University was where one 'learns to think'.

Table 3 (including flipchart)

Table 3 – Fraser Perceval (Jacobs), Fiorella Dell'Olio (CSIC), Carmen Muriana Cobo-TfL, Chrysoula Litina-(NH), Zaid Rawi (BP), Paul Campion (TRL), Chiho Jeon (CSIC/CAU), Felipe Rojas Parra (CSIC)

How can organisations better address the skills gaps in the future, and what commitments are needed to improve this situation more broadly?

- The main point is: what action the industry will take after recruiting to overcome the skill gaps?
- It is important to consider what kind of soft skills are advertised at the time of recruitment.
- Often the industry can buy soft skills training or run them internally.
- You need to have a commitment to re-skill or upskill your employees while at the same time employees need to commit to continuous training.
- For industry, it is fundamental to develop an environment that not only provides further skills but also creates the right incentives for commitment
- Industry needs to be in a position to offer a variety of different training opportunities from technical to soft skills.

- In reality, industry does not have a 'skills problem' because it often buys them from the global market, e.g. technical/digital skills from India where they cost much less.
- When it comes to technical and digital skills, it is important to establish, during recruiting, the minimum requirements. To what extent do we need specialists from the start?
- Not always there is in-house capability for training specialists.
- There is a need to talk about other skills that are often overlooked in engineering such as emotional intelligence (EQ), influencing skills, sales skills, leadership skills.
- Not all training courses can teach those skills, e.g. you can learn very well how to use Excel but not necessarily enough to interpret and use the data and results that Excel can provide.
- It is often difficult to understand and know what is available in terms of training opportunities. You need the learning-development team or HR to understand the needs of the industry and where the gaps are so that they can create a development programme that offers more tailored training.
- When academia develops masters courses, there is a need to involve industry experts who can advise on learning outcomes that reflect concrete skills used in the real world. In other words, the course and qualifications need to offer concrete tools for doing the job well.
- Qualifications v Experience. Often you need both.
- There are skills that only experience can give you such as teamwork, how to be effective in a meeting, how to behave in front of a client or in difficult situations, questioning skills, self confidence in front of an audience, etc.
- Sometimes we have the need to train engineers to 'un-learn' the skill to pretend that they have always the answer. We need instead to learn how to be comfortable with ambiguity and to find the middle ground.
- While education and qualifications tend to focus on always finding the right answer, we need to learn that the right answer doesn't exist.
- Errors needs to be accepted as part of the learning process.
- We need also to rethink what University education is for when it comes to preparing students for industry or for engaging with industry.
- In relation to the environment, for example, good training on carbon literacy and understanding where it fits is missing. At the moment, there is too much theory about it but less understanding about the practical benefits for business and industry.

Real world practice and simulation is missing at the level we need

Table 4 (including flipchart)

Carlos Laguna Sanchez-Motts, Dee Dee Frawley CSIC, Olly Wright-Aviva, Sharon Duffy-Thames Water, Tim Embley-Costain, David Pocock-Jacobs, Fergus Harradence-BEIS, Monika Kreitmar-CSIC, Xiaomin Xu-CSIC, Robert Mair, CSIC.

Transformation of skills and education, and cross-pollination of ideas between fields, to change behaviours in industry.

JP – teach Asset management in the undergraduate and post graduate curriculum. Must consider the whole asset life cycle.

OW- hands on practical experience - a year out in industry?

OW – in education degree courses have practical projects which factor maintenance into the design?

OW – need to factor in learning about value engineering

FH – behaviours are as important as skills – feeds culture.

Education must be from systems perspective and consider the TOTEX

DP - life cycle design and material selection included in engineering design courses.

SD – teaching influencing skills - being able to suggest. Enabling early career professionals and graduates to challenge existing views.

CLS – collaboration between industry and university earlier on.

SD – connect in with the challenges to maintain the assets earlier on in education

SD - Growth learning mindset – foster it in the education sector – learn how to adapt to a changing environment.

Table 5 (including flipchart)

David Simavorian-Accenture, Shelley Arora-Tailby CSIC, Chris Campbell-Skanska, Nicky De Battista-Epsimon/CSIC, Alejandra Masia-BP, Chris Barker-Arup, Jill Campion-UC Land Economy, Nikolas Makasis-CSIC, Kwadwo Oti-Sarpong, Dongfang Liang-CSIC

Q1

- Gaps around handling data and data interpretation. Being able to get the proper interpretation of the data you need to have a good knowledge of the fundamentals of civil or structural engineering – a proper understanding of how structures behave, how materials behave. At BP we have found during recruiting that about half of the graduates don't have a grounding in the fundamentals – even a basic understanding of very simple structures. We need to understand how to manage data, but you need the fundamentals to be able to get a proper interpretation. Need the adaptability to understand what a computer program needs to do and ability to adjust it to your purposes - somewhere in between having kind of a deep knowledge and having the familiarity to understand what it is and interacting.
- If you have a grounding in fundamentals and problem solving you can continue to learn new tools while at work. And as your career goes on, that's going to be more and more the case certainly with when using data in engineering.
- At LOR we put a number of people from a number of different teams on a Level 4 apprenticeship in data science, and that's been really effective. We decided not to bring someone in with all the skills and no understanding of the business and instead bring different people within the organisation up to a certain level in every different team and hope that cross pollinates. You then get different backgrounds, different experience and diversity in the team that is working towards some solution.
- Keeping loyal staff is pretty important and having that opportunity to develop is a plus.
- There's not a class in critical thinking, but critical thinking is part of everything today and an important skill.

Q3.

- There's a lot of investment in digitalisation and bringing people with the skills to help all their teams so that all data that they are gathering is kind of managed in a certain way. Bringing people that can help build up the skills of others so that they are able to develop their own tools. But then there's a disconnect sometimes with career progression and as an engineering business as we seem to promote project managers, not engineers.
- Consultancies can bring people in and upskill them because they are going to be there working in technical design. In the client organization, they are not going to be exposed to this and it's very important to bring people with the right knowledge because they are not going to be exposed within the organisation – the work is going to be done by consultants. But it is important to have those skills in the client organisations as well.
- Again critical thinkingis key when getting something from someone else and say, well, does this make sense or not? Then, having that experience of knowing something quite deeply enables them to interpret and challenge why is this this way? Etc.
- Working from home can lessen the experience of new engineers. I think most engineers can always think back to a senior engineer that was quite influential in their career. I learned a lot from this person. We are losing asking questions and the value of office engagement.

Table 6

Lizzy Moyce-Arup, Cara Bootman CSIC, Matthew Foote-WTW, Joanna Bonnett-Cowi, John Pelton-Costain, Anne-Marie Friel-Pinsent Masons, Mike Spencer-IMIA, Nevena Vajdic, DRF, Farhad Huseynov-CSIC, Jennifer Schooling CSIC

Transformation of skills and education, and cross-pollination of ideas between fields, to change behaviours in industry

This discussion will consider graduate engineers and senior engineers as two cases in which upskilling - through either transformation in education, or lifelong learning - can improve organisations' ability to leverage digitalisation and data-driven methods. Specific topics of discussion will include:

- The skill gaps that prevent engineers and organisations from leveraging digitalisation/data-driven methods to achieve their objectives
- How these skill gaps have been addressed in industry - including examples of when this has and hasn't worked
- How can organisations better address these skill gaps in the future, and what commitments are needed to improve this situation more broadly:
    - How can different organisations across industry work together in this space?
    - How can industry and universities work together in this space?

JP – problem working out where gaps are, what training people have and where all the skills are.

Arup/COWI – have self declared skills records for staff.

AMF – Lawyers automatically have defined skill sets

MS – Civil Engineering degree is difficult to translate into the workplace as do not learn soft skills.

JMS – Soft skills gap too, people management, company culture, creating a learning culture, recognizing differing types of work place. Making digital tools robust for circumstances used in so operatives and engineers can interact in a proper way. Not just theory making work in practice.

JB – Practical aspects of Engineering essential.

JP – Client understanding also. Upskilling

JMS – Relevant skills are needed in right org to right level. Client out-sourcing lose skills this way. Not in a position to know what is needed. What roles need what skills. Great ideas of what skills needed for which roles. Smart Cities role – public sector, service public value.

JP – Skills are needed to be able to procure the skills required. Often the preserve of Masters, PhD to frame the knowledge required.

JMS – Aerospace industry does this well – to write a performance specification have to have the knowledge to know what want to build.

JMS – Teach bright young minds think people differently and consider outcomes and challenge rather that outputs

JB – Pre university education is also a factor, rote learning in FE, knowledge based rather than skills based learning.

JP – Find those with digital skills generally transferrable but not more complex problem focus.

JMS – Project based learning in early education, batter creativity, hot housing to learn facts, no teaching to think.

AMF – Lifelong learning. For lawyers feedback is constant, if you are not a good thinker and not able to think critically you cannot progress your career.

JMS – Feedback is often segmented as designer didn't get feedback on whether item designed worked etc. Don't see in projects how well things did and didn't work.

MS – France less fragmented industry.

JP – UK industry fragmented.

JMS – Risk that more digital we get less focused on.

MS – Unit on construction law in every UK degree.

JP – The environments people are working in need to be much more multi disciplinary, it is necessary prepare people to operate in that environment.

JMS – What to teach? Decision to be made what extend 1st degree multi disciplinary and add.

MF – Evolving pace in analytics, people with SME skills have to develop. Trouble getting those coming into an org to integrate as very different areas of experience. Need to know demand of what needed.