

E&I Research Studentship project proposal 2019



Project title: Data Literacy in Engineering

Supervision Team:

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Project Highlights:

- Develop a notion of data literacy defining what engineers need to know about data modelling and statistics to make best use of big data.
- Understand the trends and challenges in the use of big data in engineering design
- Identify areas of knowledge that engineers require to make better use of big data and data analytics

Project Description:

Improved sensors, increased data storage and connectivity is enabling industry to collect much more data than ever before throughout the entire product life cycle from manufacturing and use. Companies will be able to obtain data from each individual product that they produce. For example car companies will have detailed data from millions of cars all over the world from which they can learn how the cars are used, how they are affected by environmental conditions and how individual components behave, as well as detailed information about how each specific component was manufactured. Instead of waiting for the real data, companies can also obtain comparable amounts of data from simulation. This makes data capture and data analytics big business.

The data is a potential source of enormous knowledge about product. It holds to potential to really understand what the users do with their products and how the products behaves as it gets older and is used in different ways. This could be vital information for engineering designers, if it reaches them at the right moment.

Much of the research in this area focusses on the technologies to generate the data or means to analyse the data, rather than on how engineering designers can make use of the data. One important aspect is for engineering designers to understand the inferences that can be drawn from the data. This requires a familiarity with arguments based on data. Engineering designers are usually very well trained in mathematics, but do not have a background in statistics and data science. Engineers also need to collaborate with data experts coming from a computing, mathematics or statistical background.

This PhD investigates the notion of data literacy in engineering design. The idea of literacy has moved beyond reading, writing and arithmetic to other areas, where people require a working understanding without being experts. Data literacy has been discussed in the information system community by the people who organise, store and retrieve the data, but not by the user community of the data. Statistical literacy has been discussed as an important issues in the context of medical doctors, but not in engineering.

The goal of the PhD is to develop an understanding what data literacy means for engineering designers. The PhD will look at literature on literacy in different areas in general and data literacy specifically.

The PhD will also need to understand the type of data that is generated in engineering companies and standard methods to analyse the data. From this, notions of data literacy can be defined in terms of the concepts that engineers need to understand, the techniques they need to be familiar with to enable them to work effectively with data experts and statistical experts.

This will involve interviews with engineers about the issue that they are addressing with big data or planning to address. It will identify analysis and visualisation techniques that they need to be familiar with; and identify way of acquiring the relevant knowledge given the mathematical skills that engineers already have.



Figure 1: Assembly line of an aircraft

The main outcomes of the research will be a definition of data literacy and associated skills in the context of engineering design. This definition will be used as the basis for developing an approach to instilling data literacy skills in engineers and will be tested with industry.

Research Methods:

The main research methods that will be used in the project are summarised below:

- Perform a structured literature review to investigate the concept of literacy in different fields in general before focussing on literature on data and statistical literacy.
- Carry out an empirical study with industry to understand the use of big data and statistical models arising from simulation, testing, manufacturing and use
- Develop a concept to data literacy appropriate to engineering designers.
- Identify the skills set that data literate engineering designers need to have.
- Propose ways in which engineers can acquire these skills

Indication of project timeline:

Year 1: Structured literature review and empirical study with industry

Year 2: Develop data literacy for engineers

Year 3: Propose ways to become data literate and validate with industry

References

- [1] Begoli, E., & Horey, J. L. (2012, August). Design Principles for Effective Knowledge Discovery from Big Data. In WICSA/ECSA (pp. 215-218).
- [2] Chen, C. P., & Zhang, C. Y. (2014). Data-intensive applications, challenges, techniques and technologies: A survey on Big Data. *Information Sciences*, 275, 314-347.
- [3] Li, J., Tao, F., Cheng, Y., & Zhao, L. (2015). Big data in product lifecycle management. *The International Journal of Advanced Manufacturing Technology*, 81(1-4), 667-684.
- [4] Koltay, T. (2015). Data literacy: in search of a name and identity. *Journal of Documentation*, 71(2), 401-415.
- [5] Gray, J., Gerlitz, C., & Bounegru, L. (2018). Data infrastructure literacy. *Big Data & Society*, 5(2), 2053951718786316.
- [6] Wallman, K. K. (1993). Enhancing statistical literacy: Enriching our society. *Journal of the American Statistical Association*, 88(421), 1-8.

Further details:

Students should have a strong background in mechanical engineering, data science or technology management. The topic would also suit somebody interested in engineering education. The student will join a well-established team researching engineering design at the Open University.

Candidate Applications

- 1000 word cover letter outlining how they are equipped in their educational background and expertise to conduct the research project,
- a CV including contact details of two academic references
- An Open University application form, downloadable from: <http://www.open.ac.uk/postgraduate/research-degrees/how-to-apply/mphil-and-phd-application-process> (Note: This is an Advertised studentship and you do not need to submit a proposal).
- IELTS English Language test scores on application. An average of 6.5 and no less than 6 in any one of the four components. Applicant should have these results when applying.

Applications should be sent to

STEM-El-Research@open.ac.uk by 28 February 2019