

A PROPOSAL TO DEVELOP WRITING SKILLS OF FIRST YEAR ENGINEERS WITH FLASH FICTION

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Abstract: A novel approach to improve the communication skills of undergraduate engineers is to be trialled. First years will write and read aloud an engineering related short story set in 2050, critiquing their peers in workshops. The aim is to enhance student engagement in the process and consolidate basic skills before they attempt to write a full laboratory report; it is also an opportunity for interdisciplinary collaboration and research.

Keywords: writing skills, engagement, creative writing, climate emergency

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1. INTRODUCTION

1.1 Communication skills

Professional engineers need good communication skills, so the Engineering Council (2020) requires that graduates of accredited MEng and BEng programmes have as a learning outcome the ability to '*Communicate effectively with technical and non-technical audiences*'. The responsibility of accrediting UK Civil Engineering courses lies with the Joint Board of Moderators, a body that represents five institutions, the largest of which is the Institution of Civil Engineers. Their guidance on becoming a chartered engineer, which graduates may be attempting after a few years of industry experience, defines communications skills more fully and includes that they must '*Communicate well with others at all levels including effective use of English, orally and in writing*' (ICE, 2022). While courses to develop these skills are available to working graduates through the institutions, they need to enter the workplace with a good grasp of them, and as the Institute of Engineering and Technology reported (IET, 2017) they are often not at the standard employers expect.

1.2 Undergraduate engineers

According to the Royal Academy of Engineering (Lawlor, 2016), students often underestimate the amount of report writing and communication involved in an engineering career. While they join university with the requisite A-level in Mathematics (or equivalent) their other qualifications are often also in STEM subjects, avoiding those in which writing is required. They must have a GCSE (or equivalent) in English, but less than 1% of civil engineering undergraduates at Cardiff University will have A-level English and most will be out of practice with their writing skills. More broadly than this, as Walton (2020) states, '*a student's understanding of a given problem is only as strong as her or his ability to effectively communicate that understanding*'; writing skills are imperative for undergraduate engineers.

2. EXISTING APPROACH – LABORATORY REPORTS

2.1 *Current format*

A common process to improve undergraduate engineers' writing skills is with laboratory reports. The basic format typically includes sharing a rubric that explains the report's sections and detailing their content, with a briefing in which this is explained and any questions asked. Variations include a scaffolded approach as explored by Selwyn et al (2018) who reported improved skills over a series of five laboratories; first year engineers at Bristol University were able to feedforward comments after each submission and focussed on specific sections in each iteration.

Based on this research, a simplified scaffolded model was adopted at Cardiff University in 2018-19 for first year civil engineers on a new 10-credit professional development module. The reasons for simplification were that of logistics and the concerns of over assessment, affecting both students and staff alike. While formative assessment is unregulated, university guidelines recommend that summative assessment for a coursework-only 10-credit module should be around 2000 words, i.e., the length of one laboratory report, and in any case the module has other assessed components.

An in-class laboratory (Centre of Pressure) in which the full cohort of ~180 students participate is completed in Week 5 of the autumn semester and reports are reviewed over three iterations. In Week 7 students reflect on their own Procedures and Results, in Week 9 they peer review a full draft and in Week 11 they peer mark final submissions. The report is marked formally by a single assessor, avoiding the issues with consistency and staff attitude to writing skills that Selwyn et al (2018) identified. Following summative marking, students are encouraged to contact their randomly assigned peer markers and compare results for a fourth iteration.

On final marking it is apparent that writing skills are still not at the standard hoped for, with the cohort average in the mid to high 50s over the last four years (2018-19 58.5%, 2019-20 58.4%, 2020-21 59.1%, 2021-22 54.3%). Student feedback for this year included comments that while they found the laboratory report hard, views were positive from those that engaged with the module. Anecdotal evidence following discussions with colleagues also suggests that while there are students with excellent writing skills, it is evident that in later years of study they are not sufficiently developed in the wider cohort.

2.2 *Improvements to this format*

Future improvements could build on the work of Walton (2020) who examined the efficacy of an iterative practice and feedback model over seven technical reports. They concluded that there was little improvement beyond the fourth cycle, so it would be worthwhile ensuring that the fourth iteration at Cardiff was completed by apportioning marks to the process. The self-reflection phase could also be made more explicit to adopt the findings of Selwyn and Renaud-Assemet (2020), who found that attainment improved for students who completed a reflective section as part of their submission.

However, there are issues with this approach. Most students turn up for the laboratory, but attendance steadily reduces over Weeks 7, 9 and 11, and those that do engage may not necessarily act on feedback to feedforward. Possible reasons for this include apathy towards the importance of writing, despite a guest lecturer promoting the need for this skill as a professional engineer in Week 8, or that the process itself does not carry marks. A solution therefore could be to further apportion marks for the iterations of Weeks 7, 9 and 11, but this

would lead to the problem of over-assessment and is in any case, a workaround solution; engagement appears to be the key battle. As Laplante (2019) alludes to in the preface of his technical writing guide, engineers must find the process interesting.

3. PROPOSED APPROACH – FLASH FICTION

3.1 Initial concept development

All UK educated students are required to have passed GCSE English Language. According to the Department for Education (DfE, 2013), the GCSE requires that they would have read '*high-quality, challenging texts*' including literature from the 19th, 20th and 21st centuries. International students will presumably be familiar with works of fiction for their equivalent own language qualification, as well as having proven their ability in English by passing the International English Language Testing System or similar. It can be assumed therefore that students have read fiction, but from in-class discussions (see later) it is apparent that the current generation are less likely to do so in their own time. While they do watch films and drama boxsets, i.e. they like stories, entertainment is primarily accessed in very short clips across media platforms such as TikTok, Instagram, Snapchat and YouTube.

Flash fiction is essentially a very short story, and therefore may appeal. A successful story must be convincing and in flash fiction, the shorter the submission, the more important every word becomes. Consideration by the author must be given to build concise sentences and well-structured paragraphs; meaning must be clear and the interest of the reader maintained.

Therefore, to bridge the gap between previous studies and an engineering laboratory report, and to do so in a way that engages students, it is proposed that they consolidate their skills by writing a short piece of fiction. If they are proud of what they produce, they might choose to share this work with friends and family, as it has more appeal than a conventional piece of engineering coursework, and with students' consent the best ones could even be published. Peer reviewing of this work is also possible because unlike technical laboratory reports, students will know if one another's story makes sense. The exercise would prompt a refresh for UK educated students of critical reading and comprehension skills; evaluation of a writer's choice of vocabulary, form, grammatical and structural features; and writing imaginatively and creatively (DfE, 2013). International students will have an opportunity to further develop these skills in English.

The concept can be extended with flash slams, a form of writing competition in which short stories are read aloud. As reading to an audience would allow spoken language skills from the GCSE syllabus to be revisited and developed for professional communication, it makes sense that students do this as part of the exercise. Technical report writing will still need attention in first year, but in a more focussed laboratory report assessment than is currently the case, because students will have already polished their basic writing skills.

3.2 Coursework brief

Set in the carbon neutral (or not) world of 2050, students will be required to write 500 words of flash fiction, sparked by engineering research. This must be correctly cited and referenced in an introductory paragraph, and the submission must include a short video in which they read their stories aloud. Current areas of research at Cardiff include self-healing concrete (Davies et al, 2021), automation of buildings (Elnour et al, 2022), and urban flooding (Xia et al, 2022), so examples could be super-worms that ingest a self-healing chemical, an automated building that becomes self-aware and anti-human, or the impact of a tsunami on repurposed infrastructure.

Story ideas are only limited by the students' imagination and can be as silly or serious as they like.

3.3 Student focus groups

Concept development continued with two groups of ~20 second year students being asked for their opinions on the coursework brief. The more vocal members of the first group responded that they would prefer detailed, personal feedback on their laboratory reports to improve specifics, implying perhaps that they were among students who did not fully engage in first year for weeks 7, 9 and 11. The group's other point was more pertinent however, and would need addressing; they did not feel that writing fiction was a skill required by industry.

For the second group, interest in futuristic science fiction was generated before its purpose shared, and regardless of their engagement in first year they were unanimously in favour of the idea. As well as developing writing skills, following the first group's concerns, benefits of writing fiction were explained: it would help engage an audience, which the third person, passive voice of a laboratory report does not, and it would develop the imagination, necessary for problem solving in industry. Furthermore, research by Masterton and Jeffrey (2020) suggests that the integration of liberal arts within an engineering education can be useful in a future career.

3.4 Existing research

This approach to improve writing skills of undergraduate engineers appears to be novel but aligns to existing research at the discipline boundary of engineering and creative writing. Examples include envisioning innovation opportunities through science fiction in product design (Michaud and Appio, 2021), examining the plausibility of engineering in science fiction (Derjani-Bayeh and Olivera-Fuentes, 2011) and encouraging STEM professionals to share their experiences through creative writing for personal development (Niehaus, 2019).

4. PROPOSED FORMAT

4.1 Compound interest

Students will be shown a presentation by the Institution of Structural Engineers (Arnold et al, 2021) which states that current knowledge will only take us so far toward a carbon neutral construction industry, and that future graduates must play a key role in the necessary research to take us all the way. Students will then be asked to imagine life in 2050.

There are many different takes on what the future holds and examples from the entertainment industry will be discussed. They essentially fall into three broad categories: dystopian, utopian, and post-apocalyptic. Dystopian visions, in which an unfair society causes widespread suffering, include the boxset 'The Handmaid's Tale'. Utopian visions are much rarer and often become dystopian, such as in the movie 'The Circle', while post-apocalyptic worlds can be very dark, especially so in the film 'The Road'. All the above were based on novels: 'The Handmaid's Tale' by Margaret Atwood, 'The Circle' by Dave Eggers and 'The Road' by Cormac McCarthy, and in order to promote interest in writing, reviews will be shared that show the written formats were more widely praised than their screen adaption (see Table 1, which includes another example discussed later). The issues with comparing these non-scientific review scores will also be explored.

Novel	Novel review ¹	Adaption review ²
The Handmaid's Tale	82%	77%

The Circle	69%	21%
The Road	80%	68%
Story of Your Life / Arrival	90%	82%

Notes: 1. Novels reviews from Goodreads (2022) and converted to percentage;

2. Adaption reviews from Rotten Tomatoes (2022) audience scores.

Table 1. Summary of reviews suggesting that fiction in a written format is superior

In order to help foresee what might lie ahead, the same time frame in the past will be revisited next, as the near future might only be subtly different. Thirty years ago at university, lectures were mostly delivered using white-boards or overhead projectors; student accommodation was around £25/week and beer could be bought for £1/pint. Students had the choice of four analogue TV channels which they watched live unless they had access to a VHS video recorder, CDs had overtaken records and cassettes as the most popular music format, and all mainstream cameras used film. The internet was in its infancy, email was rare and used only for work, and few people had mobile phones.

Within civil engineering, perhaps the most obvious development in the last thirty years has been in the energy sector, with the phasing out of coal-fired thermal power plants and the growth of renewables. However, all sectors have evolved, for example the 5-year Asset Management Plan periods in the water industry has seen new technologies emerge to meet ever tightening restrictions in relation to water quality and environmental impact. In transportation, smart motorways have been established to maintain a more even traffic flow on heavily congested sections, infrastructure such as cycle paths developed and integrated with public transport to promote greener forms of travel, and Crossrail has delivered the Jubilee Line in London.

In more general engineering developments, the International Space Station has been operating for over 10 years, electric cars have been brought to mass market and self-driving cars are in development; these in particular highlight a long tradition of the mutual exchange of technology with science fiction, in which they were first encountered. A more dramatic example of this occurred in 1944, when the FBI raided *Astounding Science Fiction* magazine following the publication of the short story 'Deadline', in which the author Cleve Cartmill had very accurately predicted details of the first nuclear bomb.

4.2 Engineer as writer

To provide encouragement, published writers who trained within STEM subjects helps promote the idea that engineers can write fiction. Arthur C Clark, Isaac Asimov and Robert A Heinlein are often referred to as the 'Big Three' sci-fi writers of the 20th century, and all were educated in STEM subjects. A more recent example is Ted Chiang, a computer science graduate whose father was a professor of mechanical engineering and whose work includes the short piece 'Story of your Life'. A cover jacket quote on the 2020 edition states that '*Chiang puts the science back into science fiction*', as his writing no doubt draws on his education. This short story was recently adapted as the film 'Arrival' which students may have seen, and while both formats do very well in reviews as shown in Table 1, the written work has one of the highest ever scores.

Writers of mainstream fiction include J M Coetzee, who was the first author to win the Booker Prize twice, as well as the Nobel Prize for Literature; he has a degree in Mathematics and early in his career worked as a computer programmer for IBM. The renowned American writer Kurt Vonnegut is also worthy of attention because he studied biochemistry and mechanical

engineering. In addition, his introduction to a short story collection includes his eight rules of Creative Writing, and it is possible that his scientific thinking helped formulate them.

4.3 *A formula for writing?*

While art cannot be created via a formula, Vonnegut's (1999) rules could help first year engineers craft a work of fiction, so are précised below:

1. *Use the time of a total stranger in such a way that they will not feel the time was wasted.*
2. *Give the reader at least one character he or she can root for.*
3. *Every character should want something, even if it is only a glass of water.*
4. *Every sentence must do one of two things; reveal character or advance the action.*
5. *Start as close to the end as possible.*
6. *Be a sadist to your leading character to see what they are made of.*
7. *Write to please just one person.*
8. *Give your readers as much information as possible as soon as possible.*

Other commonly shared tips include that the basics of what makes a good story are to show rather than tell, and to read drafts aloud. Most stories follow a 3-act structure of beginning, middle and end, which can be extended into Freytag's pyramid of exposition, rising action, climax, falling action and resolution.

Writing advice for flash fiction is easily found on the internet. A good example (MasterClass, 2021a) suggests the following:

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| 1. <i>Use strong imagery</i> | 4. <i>Try first person point of view</i> |
| 2. <i>Stick to one moment</i> | 5. <i>Surprise your reader</i> |
| 3. <i>Work with one or two characters</i> | 6. <i>Make good use of your title</i> |

Another (MasterClass, 2021b) includes that every story must have a plot and '*a strong plot is centred on one moment—an interruption of a pattern, a turning point, or an action—that raises a dramatic question, which must be answered throughout the course of the story*'. And according to Booker (2005) there are only seven plots:

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| 1. <i>Tragedy</i> | 5. <i>Rebirth</i> |
| 2. <i>Comedy</i> | 6. <i>Overcoming the monster</i> |
| 3. <i>Hero's journey</i> | 7. <i>Voyage and return</i> |
| 4. <i>Rags to riches</i> | |

Budding writers are encouraged to read. An excellent example of a situation left unexplained, allowing a story to be developed without unnecessary prose, is the short story 'The Metamorphosis' by Franz Kafka. Students will benefit from exploring examples of prize-winning flash fiction online, such as 'Tattoo Man' by Amanda Marples, which includes the judges' comments. And a flash slam example is 'Detached' by this paper's author. It came joint first in the 2018 Bristol Festival of Literature and its success was in part due to an awareness of the audience's needs.

4.4 *Critiquing*

The proposed format would see workshopping with peer assessment through four iterations. Students will be directed to critique their peers' work from the macro level of plot to the micro level of word. A guide developed for the Creative Writing programme at Cardiff University will be used, which begins by stating that attendance and engagement is effectively compulsory. Peer feedback, it continues, will be complemented by advice from a tutor, but the tutor is not an editing service, and feedback sessions should be used judiciously (remembering

Vonnegut's 7th rule). The final set of guidance notes complement the need for ethics in the engineering syllabus: values of equality and diversity must be recognised, discussions should be respectful and courteous, and any writing should be treated confidentially. Presentation practice will also be undertaken in the critiquing groups.

4.5 Next steps

A pilot is planned for 2022-23 with ~20 students, using the author and two engineering lecturers as tutors. One lecturer is very enthusiastic about the concept while the other is less so, a balanced approach being important to ensure all concerns are addressed. If successful in improving writing skills, this will be delivered to the full cohort, incorporating changes as necessary, the following year when a refreshed project-focussed teaching format for first years is due to commence. The use of postgraduates on the university's MA in Creative Writing as tutors will also be reviewed, an option proposed by the Programme Director in the School of English Communication and Philosophy.

5. CONCLUSIONS

A pilot will see first year civil engineering undergraduates at Cardiff University write and read aloud a piece of flash fiction to refresh and consolidate their communication skills, develop imagination and engage an audience, before attempting to write a full laboratory report. The need for a novel approach to improve writing skills is justified and views from current students are addressed in the concept development. A potential format is explained in which interest in science fiction is promoted by exploring its mutual exchange with technological development and highlighting the work of engineers and scientists who have become successful writers. The students' stories are to be set in the carbon neutral (or not) world of 2050 and draw on engineering research for inspiration. Guidance is given on writing and critiquing, and the potential for further interdisciplinary collaboration identified.

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