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Can Designing For Mars Stimulate Our Thinking About Designing More Sustainably For Earth?

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CAN DESIGNING FOR MARS STIMULATE US TO THINK MORE SUSTAINABLY FOR EARTH?

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ABSTRACT

This work describes the use of an arts-based project to stimulate creative thinking about design and sustainability for engineering students of all disciplines and years. 'Building a Martian House' was a public art project where a house designed for Mars was built in the centre of the city of Bristol, UK. It was conceived by artists, designed by the public, architects and engineers and built by construction companies. In this work, a workshop for students was developed and run based on this art project. Its aim was to use the challenge of designing for Mars as a provocation to thinking about sustainability in designing for Earth. This workshop was run for two hours for thirty-five students from different years and disciplines and involved two exercises to stimulate creativity. Students completed a pre-and post-workshop questionnaire as feedback. An important part of the workshop was the viewing of an exhibition of sixty images from the Martian house project. These images covered the design, development and building process of the Martian house and artefacts within it. Feedback from the questionnaires indicated that the workshop fulfilled some of the aims, it was interactive and guided, offered teamwork and independent design opportunities and provoked thoughts about resource utilisation and sustainable design.

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1 INTRODUCTION

1.1 Background to the project

The ability to think creatively is essential for surviving and adapting to the world's rapid technological, economic, social, and global changes (Beghetto, 2015). Previous work has established the use of arts to increase creativity in engineering courses: “*Bring in the arts and get the creativity for free*” (Csikszentmihalyi, 1996) and an arts-based instructional model for student creativity in engineering suggested: “*exposing engineering students to different ways of thinking is essential for growth in creativity*” (Laduca *et al.*, 2017). Recent literature has covered the types, forms and conditions of learning and characterising knowledge and the artistic experience (Morari, 2023). In other work creativity has been defined as the capacity to create novel ideas, acts, or products that alter existing domains or turn existing domains into novel ones (Styhre and Eriksson, 2008). Asking students to design for a completely novel context and environment could therefore hopefully stimulate their creativity. The aim of this educational project was to use an arts-based project as a springboard to encourage students to gain new perspectives on engineering design for Earth and sustainability. This would be achieved by them participating in a workshop and viewing an exhibition which uses the ‘Building a Martian House’ arts project (<https://buildingamartianhouse.com/>) as inspiration.

In August 2022 a Martian House was built as a public art project on the harbourside of the city of Bristol, UK. This explored how a home for life on another planet might be designed. Mars is a place with a harsh environment and limited resources – no air, low pressure, little sunlight, cold and high levels of radiation. It was hoped that designing within these constraints and imagining how a small community would live on Mars would stimulate students to think more about building and living sustainably on Earth. The Martian house started as an idea seven years ago and progressed through workshops, designs, architectural drawings, construction plans, build and opening to the public (see Fig 1 and 2). It was hoped that many of the assets (photos, drawings and artefacts) developed could be shared with students. This would be achieved as part of an installation which would take viewers on a journey through the project asking key questions about reuse of materials along the way. This was a unique opportunity to use this remarkable project as a provocation to learn. Another goal was to bring innovative ways of thinking about sustainability and resource use into the curriculum, as mandated by new UK Engineering Council accreditation guidelines (called ‘AHEP4’).

This paper covers the background to the work and the Martian House project in section 1, then section 2 outlines the workshop developed for the students, along with both pre- and post-workshop questionnaires put to the students and how the exhibition was developed. Section 3 describes the results of the questionnaires whilst section 4 is a discussion of the work and its limitations. This leads onto some suggestions for further work in section 5, with recommendations in section 6 and conclusions in section 7.



Fig. 1. The Martian House on Bristol's dockside (exterior)



Fig. 2. The Martian House (interior)

2 METHODOLOGY

2.1 Workshop

The workshop was run for undergraduate engineering students from first to fourth year and all engineering disciplines. At the University of Bristol, the disciplines include Mechanical, Civil, Aerospace, Computing, Electronic, Engineering Design and Engineering mathematics. It was advertised through year group lists and through student societies and quickly reached the capped capacity of fifty participants. The authors decided to use a voluntary extra-curricular two hour-long workshop to engage students. This was for several reasons, firstly, it offered a way for the students to engage in creative activities in small groups which would encourage teamwork and facilitated working across disciplines and year groups, secondly it mirrored the process used in the design of the Martian House and, thirdly, it was flexible to the unpredictable numbers. The format of the workshop is illustrated in Table 1:

Table 1. Workshop activity details

Time	Type of Activity	Activity details
2 days before	Student completes	Pre-workshop questionnaire is sent out
20mins	Authors talking to slides	Introduction to Martian Environment, introduction to previous Martian habitat experiments, explanation of design process
15mins	Students creating	Challenge questions: What are the essentials needed to live on Mars? What resources do you think are available on Mars? Make a list.
10mins	Students report back	Joint list of essentials and resources is made
40mins	Students creating	Choose an essential item you'd like to design. Using your list of available resources, explore how you might design your item with what is available. Make a rough design - paper sketch or digital.

10mins	Students report back	Each group presents their design which they have sketched on a large piece of paper
10mins	Authors talking to slides	The artists talk about the design process for the Martian House, its features and ethos.
10mins	Students walking and looking	Students view exhibition as they exit the workshop
Later	Student completes	Post-workshop questionnaire is sent out

This involved a mix of introducing the topic to the students, then allowing them to be creative by working on two lots of challenge questions together. After each of the two lots of working together, they reported back to the whole group. Group size was four to five people in size to promote teamwork and groups were composed of mixed disciplines and year groups. At the end of the workshop, the artists gave a brief description of the design process for the Martian House, its features, including artefacts within the house, but also the ethos of the project.

2.2 Questionnaire

To understand the effectiveness of the workshop, an anonymous pre- and post-workshop questionnaire was devised. The questionnaires received approval from the Faculty Ethics committee before being deployed (Ethics application no.14027). The questionnaires were deployed digitally via link and QR code and sought permission from the participants to be published. These were deployed a few days before the workshop. The post-workshop questionnaire was deployed straight after the workshop.

2.3 Exhibition

Over the seven years that the Martian House project has been in development, there has been a strong focus on visual storytelling. This has included having an artist capture early workshops, the architect creating rendered moving images for a summer open-access activity at the 'We the Curious' science museum and having the final Martian house build and subsequent use captured by a professional photographer and subsequently turned into a short documentary (<https://www.youtube.com/watch?v=Migiyq7QxPc>). As well as the artists themselves keeping a rich visual record of their work. As a result, it was decided to bring into the workshop a visual narrative element, in the form of a photo exhibition, on the way out of the room where we held the workshop. The reason for doing this, beyond sharing the story with workshop attendees, was to create a visual legacy of the project for other learners to engage with, in line with the 'LEARN' approach where "all spaces should be considered learning spaces", even, in this case, corridors! (Taylor, 2019)

The exhibition was set up by collating a wide variety of different outputs from the Martian house project and laying them out in a large space chronologically. The

artists then selected the most appropriate images, and added five statement-based posters, which captured the essence of the project: “It takes seven months to get to Mars.” “Everything you own will be important.” “You’ll need to fix everything when it breaks.” “Suddenly your rubbish becomes something you might need.” “Can designing for Mars give us the perspective we need for living on Earth?” The students examined the exhibition on the way in and out of the workshop.

3 RESULTS

3.1 Pre workshop questionnaire

Thirty responses out of thirty-five attendees were received to the pre-workshop questionnaire. The first question asked how much the students already knew about three different aspects: design for Mars, design processes and design for sustainability. Figure 3 shows the results for this first question.

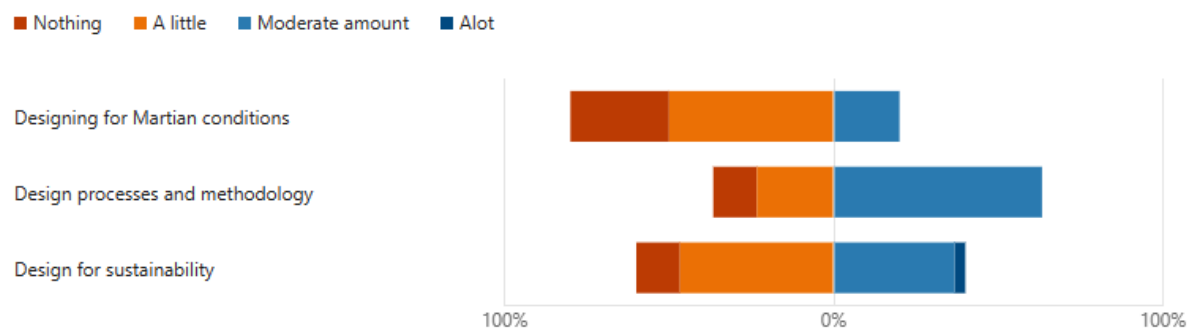


Figure 3: The results of the question: How much do you know about...? (n=30)

This illustrates that the area that the students thought that they were least knowledgeable about was designing for Martian conditions (with 30% knowing nothing and 50% knowing a little). More of them were happy with design processes (with 63% saying that they were moderately confident) but 47% said they knew only a little about design for sustainability.

In reply to the question: what do you hope to get from the workshop? 67% of respondents replied with some variation on ‘Discover more about Mars habitats’, whilst 20% replied with some variation on ‘More knowledge and fun’.

3.2 Post workshop questionnaire

Twenty-six responses (out of thirty-five attendees) were received in response to the post-workshop questionnaire.

In response to the question ‘has the workshop changed how you might think about designing for Earth?’, all participants answered either Yes (50%) or Maybe (50%). When asked to explain this answer, 70% of the response were variations on “we need to use the resources available to us more deliberately”, and “the focus on designing with limited resources could be easily applicable to Earth”. In contrast, one

student pointed out *“I don’t think there’ll be acceptance on Earth for the basic living style on Mars”* and another very practically said: *“It personally has made me want to design a hydro/aeroponic system to use at home...”*.

In response to the question ‘How much more do you know about...’, 92% of students felt that they had learned at least a bit more about designing for Martian conditions, 85% said that they had learned at least a bit more about design for sustainability, then 81% said that they had learned at least a bit more about design processes.

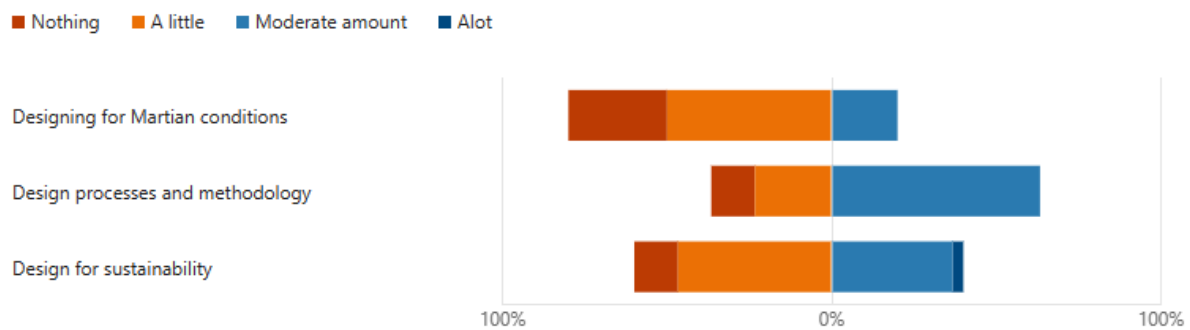


Figure 4: Responses to the question: ‘How much more do you know about...’ (n=26)

In response to the question ‘What did you enjoy about the workshop?’, students mentioned *“Good mix of independent work and being told stuff”*, but also *“the freedom to think creatively”* and *“the atmosphere was great”*. Several students also mentioned *“working in teams”*.

In response to the question ‘What would you change about the workshop?’, students suggested *“maybe snacks”* (!), 20% said *“make it more technical”*, 20% said *“more guidance on the design”* and 12% said *“more on sustainability”*. In response to ‘any more comments?’ there were few responses mostly expressing thanks. There was one comment on the exhibition: *‘Interesting exhibition’*.

4 DISCUSSION

This work has used an arts-based project as a provocation to creativity in design and thinking about sustainability. There were many limitations to this research. Only one two-hour-long workshop with thirty-five students has been run up until now, so the results are necessarily preliminary. It is challenging to measure how successful this was from questionnaires with just a few questions, the number of students responding were thirty and twenty-six for the pre- and post-workshop questionnaires, which mean that the sample size was small. As the responses to the two questionnaires were anonymous, it was not possible to know if the same people answered both the questionnaires, so it was hard to compare the answers. However, it appeared from the data so far, that the workshop did encourage the students to change how they might think about designing for Earth and that most of them learned at least a bit more about designing for Martian conditions, the design

process and design for sustainability. Interestingly, and perhaps not surprisingly, their response to ‘how much more do you know about...?’ was a mirror image of their response to ‘how much do you know about...?’. It is debatable whether people are a good judge generally of what they think that they have learned. In addition, whether what students **think** they want to learn is not necessarily the same as what they **will** learn.

With a short exercise such as this, it was not surprising that the students requested more technical information and more guidance. Indeed, the request for more technical information indicates that they are emphasising technical aspects instead of staying in the creative space. More information could be made available, but there is also never enough information! As authors, we wonder if we should push in the opposite direction, to encourage more integration of the arts/social aspect. We could encourage the students to go beyond their technical training: how does an artist approach? Some of the questions in the original Martian House project included: “Can designing for Mars give us the perspective we need for living on Earth?” and “How can we live well on Mars?” From the feedback it appeared that the format of the workshop with a mix of disciplines and years worked well for the students.

5 FURTHER WORK

Eventually it is intended to turn the workshop into a session within the first year Engineering Design unit which is taken by six hundred students across the faculty. One of the learning outcomes for this design unit is to help students see the interrelationship between society and engineering and to encourage thinking about sustainability. Ideally, the workshop would encourage students to critically examine their assumptions, values, and biases and reflect on how these factors influence their engineering practice. Whilst we have attempted to measure the impact from a short workshop on the participants, it would also be interesting to explore our own journey, having been active participants in the artwork.

6 RECOMMENDATIONS

The authors’ thoughts on recommendations from this work are as follows:

1. Arts-based projects can stimulate creativity in engineering and lead to a surprising amount of learning.
2. Unexpected contexts can offer new perspectives on challenging problems.
3. Mixing the students in terms of disciplines and years worked well and led to a good atmosphere.
4. Students will tend to ask for more and more technical information but can be encouraged to stay in ‘uncertainty’ and the creative space.
5. Workshops should include explicit opportunities for student reflection, self-assessment, and self-awareness. Reflection prompts, journals, and group discussions may be used to facilitate this process.
6. When exploring an education project, it is interesting for the practitioner to ask how being involved may impact on their own work, thoughts and biases.

7. Artefacts made during an arts-based project can add to an engineering education context.

7 CONCLUSIONS

This paper describes the use of an arts-based project to build a Martian House to stimulate creativity for engineering students in thinking about designing for Earth. A workshop for students was developed and run with the aim of using the challenge of designing for Mars as a provocation to thinking about sustainability in designing for Earth. Thirty-five students attended the workshop and feedback was collected. An exhibition showing images of the design process for the Martian house was set up along the corridor to the venue and formed part of the workshop. The feedback indicated that whilst the format of the workshop worked well and almost all the students felt that they had learned at least a bit more about the areas covered, a percentage of the students wanted more technical information and guidance. Further work will involve incorporating the workshop into an Engineering design unit in the common first year of Mechanical, Civil and Aerospace Engineering degrees.

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