Chapter 6
In Between Science and The Arts: Dancing a PhD in Renewable Energy

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Abstract The arts are an arena in which the body is central to the process of inquiry and indeed constitutes a mode of knowing. In a traditional academic setting, engineering and the arts are considered separate fields. This dance project aims to bridge the gap between these fields and between academia and wider society through a participatory approach to expressing engineering knowledge. Participants were invited to convey the knowledge, and viewers were entertained by academic information presented in an alternative medium. This chapter outlines the approach taken to produce the film, from initial conception of the idea to planning and filming.

Keywords Embodiment · Dance · Science communication · Renewable gas

Introduction

I first learned about the 'Dance your PhD' competition as a result of a social media training programme for researchers that was held at the Marine and Renewable Energy Research Institute (MaREI) at University College Cork in Ireland (UCC), where I am currently a PhD candidate.[1] The programme focused on how to build a social media profile, the work required to effectively communicate science research using social media, and explained why it could be valuable for researchers. I set up

[1] Open to PhD candidates in biology, physics, chemistry and social science, the 'Dance your PhD' competition was first launched in 2007 and is held annually, sponsored by Science Magazine, the American Association for the Advancement of Science and HighWire Press. A panel consisting of both artists and sciences selects the winners. In 2017 it offered a cash prize of $2500 USD, divided among the four categories. Winning videos can be viewed at http://www.sciencemag.org/news/2017/05/announcing-2017-dance-your-phd-contest

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my twitter account with a professional profile and found out about the competition through this platform, from a tweet by the European Union Science Communication hub, which promotes science communication in Europe under @EUSciComm. The tweet announced the 10th annual Science Magazine 'Dance your PhD' competition. Its aim was 'to encourage scientists to explain their research topic to a general audience with a video that should delight and inform the public' (Science 2017). Participation was to be judged by artistic merit, scientific merit and the creative combination of both. Text could be used to narrate, but the excessive use of text was to be penalised, so it was necessary to be as concise and imaginative as possible with the description of each scene. It was immediately apparent to me that this was a brilliant way to disseminate scientific research, and I started thinking of an outline for my research straight away (see Image 6.1).

My professional and academic background had previously alerted me to the value of collaboration between science and the arts. I graduated from UCC with a degree in Civil and Environmental Engineering in 2004. Since then I have worked for nearly 10 years as a structural engineer, a traffic engineer and a transport planner. In 2013 I briefly left engineering and worked as an Information Management Officer for the Child Protection and Education sectors of UNICEF in Lebanon, for 3 years. At the strategic level that UNICEF works, child protection is very much focused on behavioural change, and most of the practitioners had a social science or psychology background. It then became evident to me that these members of staff had the tools, understanding and language that are required to elicit behavioural change, which engineers in transport planning lacked. Most of the guidance for engineers on behaviour change is based on observation and studies by engineers. To adequately engage with the needs of child protection, cross-disciplinary training was necessary. Moreover, behaviour change is also very important for other engineering applications in humanitarian response and development. For example, engineers may design and build a water point, but if a community does not value or trust the source of clean water, then it simply will not be used. For this reason, the name of the sector responsible was changed from WatSan, standing for Water and Sanitation, to the acronym WASH, meaning Water, Sanitation and Hygiene Promotion. Through this kind of experience and observation, I became convinced that engineers need to work with and learn from other disciplines. The 'Dance your PhD' competition then posed an excellent opportunity for me to attempt to do this at an early stage of my research career as I am a first year candidate.

Moreover, as a female engineer, I am aware that I am part of a minority, and I believe that the profession would benefit from being more diverse, not just in terms of gender but also background and culture. I am aware that research outlining barriers to engineering for women often points out the lack of visibility of women engineers and the lack of role models (World Economic Forum 2016). Participating in the competition was an opportunity to be both. And in addition to the evidence provided by my professional experience, at a personal level, I also believe that the worlds of engineering and the arts would benefit from greater integration. As engineering does not always provide an obvious avenue to exercise creativity, in some cases it can seem to be lacking in terms of allowing for individual expression. This

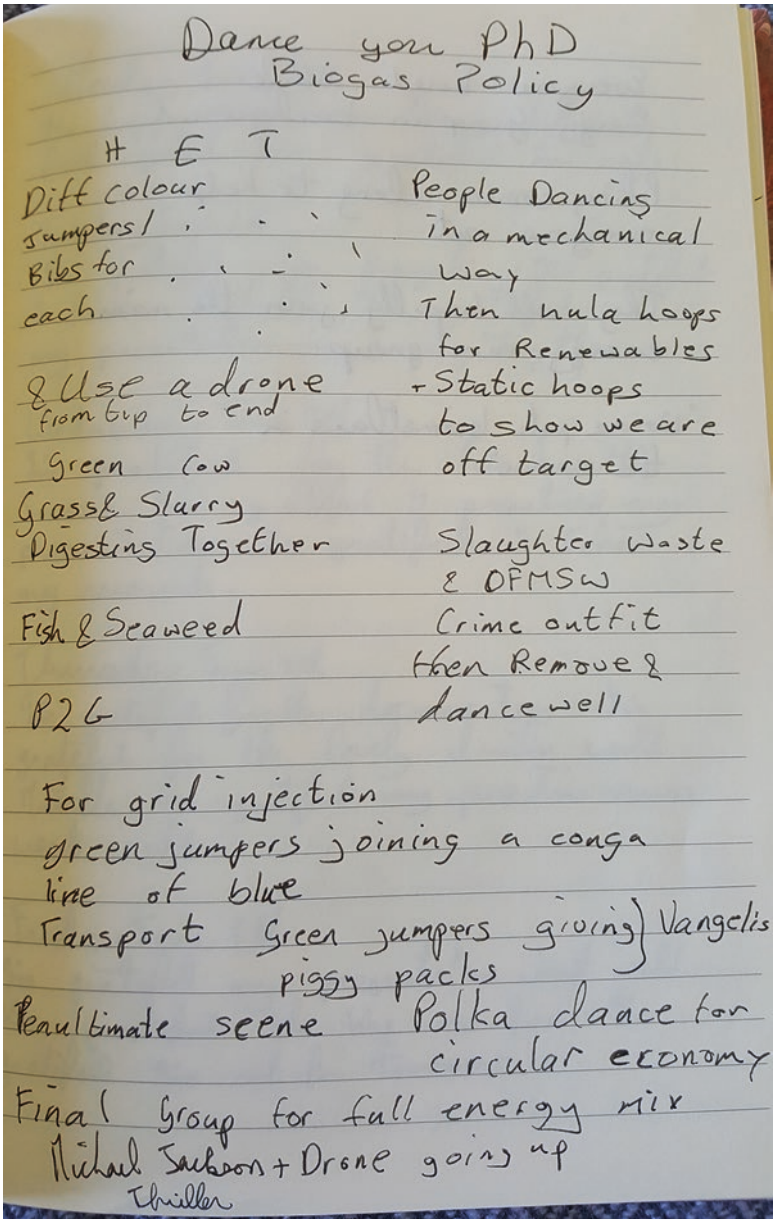

Image 6.1 Initial Draft – translating my PhD topic to dance

is at a time when creativity is needed more than ever, to address large-scale problems such as climate change and energy transitions. Aware of all these issues, the Environmental Research Institute, where the Biofuels and Bioenergy Research Group is based, has hosted artist Aoife Desmond from 2015 to 2016, who produced

a 16 mm film that featured the ERI Lee Road building and researchers. The first public display of the work was in Crawford Art Gallery on Saturday 6th May 2017. The screening event and informal discussions around the artwork provided an important context for creative projects, as well as reassurance that my participation in the competition would have institutional support.

My Research Project

The purpose of this doctorate is to develop a roadmap for introducing green gas to Ireland. The Biofuels and Bioenergy Research Group has carried out extensive research on the resource potential for renewable gas from various feed stocks (Allen et al. 2016; Murphy et al. 2004; O'Shea et al. 2016). Key sources identified for Ireland include grass and slurry (O'Shea et al. 2017), organic waste (Browne and Murphy 2013) and woody biomass (Gallagher and Murphy 2013). Power to gas technologies are also being investigated (Vo et al. 2016). Once generated, the renewable gas can be used for combined heat and power, transported or injected directly into the gas grid. The project will have a strong emphasis on the renewable heat market and the potential to achieve upcoming mandatory EU renewable energy targets. Renewable gas can play an important role in decarbonising thermal energy as part of a combination of measures, considering dwelling or industry type, location, cost and emissions (SEAI 2017). Renewable gas is also known as 'green' gas. A green gas certification scheme to quantify emissions from green gas processes and the MWh traded will be investigated as part of my research (Long 2017). Also, lessons learned from other countries will be reviewed and key stakeholders engaged. The overall aim of the PhD is to propose a policy framework to incentivise feedstock cultivation and industrial process development and deliver thermal energy via green gas to appropriate markets in Ireland. And why dance it?

Science and Embodied Knowledge

Unlike traditional academic areas, the arts are an arena in which the body is central to the process of inquiry and indeed constitutes a mode of knowing. Embodiment can be defined as 'the integration of the physical or biological body and the phenomenal or experienced body, suggesting a seamless though often elusive matrix of body/mind worlds, a web that integrates thinking, being, doing and interacting within worlds' (Bresler 2004, p. 7). Whether using a neurophysiological, cognitive, phenomenological or sociological lens for its analysis, the role that embodiment plays in learning is now understood to be quite crucial. The body 'is the main forum for learning about how to do, think and believe, and practices as apparently diverse as belief and technologies are accordingly enacted and performed through the body in similar manners' (Stig Sorensen and Rebay-Salisbury 2012, p. 1). Dancing the

PhD then becomes a way in which not only is the research theme communicated in an entertaining and accessible way but also potentially a way in which learning about it takes place while choreographing and also participating in the dance. Indeed, it has been argued that effective instruction can build on recognising the embodied nature of scientific cognition and the role of metaphor in scientific thought and learning. Understanding abstract concepts is grounded, via metaphor, in knowledge derived from sensory and motor experiences arising from interaction with the physical world (Amin et al. 2016) In this case, the video is an interpretation of the title of my research project, namely, 'Renewable Gas Systems Modelling and Policy', which explains what renewable gas systems for Ireland are and how policy is relevant. I hope everyone who participated learned something about that. I elaborate on the significance of the dance in relation to the project in the section on 'Dancing It', below.

Although I have no formal training in dance, I greatly enjoy it and regard it as an important part of human expression. I became familiar with dance as a means to tell a story through attending the ballet performances that my mother brought me and my sisters to see when I was a child. My approach to the group dance scenes is informed by my participation in a flash mob for the short film Moore Street Masala, in which the producers asked participants to learn a dance that was uploaded to the internet for viewing, and on the day a professional dancer was hired to lead the crowd. I proceeded in the same manner, recruiting participants through an email sent to colleagues at the ERI.[2] I also started taking dance lessons in an informal way, taking part in open training sessions and workshops run by The Circus Factory in Cork and also hooping classes. The informal space of The Circus Factory was beneficial to develop ideas for the dance and practice skills.

Translating Research Project into Dance

The idea became a reality once I found a drone operator. My theory that there were people out there with hobby drones who would love to put them to good use was proved correct when I met Ciaran Usher at a social event. He worked in a technical role and was interested in the opportunity once I explained the idea to him. As an added bonus, he also turned out to have a background in television. From there I pitched the storyboard to my research team and supervisor in one of our regular meetings. Although I had given many presentations before, this was the first time I had a 'call-to-action' and genuinely cared about the result.

I outlined the requirements of the competition and also the 'story element'. I knew that researchers at the University of Alberta had modelled over 2000 stories and found that they all fit into 6 broad categories. I was familiar with this from general science reporting in the media, but one of the advantages of being an academic is that I can now look up reported studies on science direct. The six categories are

[2] See 'energy dance' at https://youtu.be/xnEwtpiH2YA

'rags to riches' (rise), 'tragedy' or 'riches to rags' (fall), 'man in a hole' (fall-rise), 'Icarus' (rise-fall), 'Cinderella' (rise-fall-rise) and 'Oedipus' (fall-rise-fall) (Reagan et al. 2016)[3]. As I was translating my research into a story, it was important for me that it fit into one of these patterns, which describe the emotional arc of the story (as opposed to the plot). My dance would be a Cinderella story. The reason I chose this format was to start with the excitement of possibility and then follow with the reality that what is possible is not in place. This then frames policy support as a saviour that can realise potential and end on a positive note again.

The group endorsed the project and agreed to participate. As mentioned above, the next step involved recruiting a chorus of dancers. I started recruiting 3 weeks in advance of the filming date as I wanted to have enough time to recruit but not so much that momentum would be lost. I also assigned hula hoops to people in the research group and close friends, so that they could learn hooping overhead. This would be representing the renewable energy targets.

Dancing It

Act 1: Framing the Problem

The opening scene features drone footage of the River Lee, which is a central feature of the city, before the drone rises up over the building and into the car park. The reason for this is that I wanted to pay homage to the opening scene of 'The Sound of Music' (Robert Wise 1965), where views of Salzburg feature in the opening credits. Also, as my research project is about Ireland, I wanted to make the video about Cork, and the Lee Fields are a popular walking spot. From the overhead drone footage, the next scene features the drone panning across the dancers in proportion. Electricity is represented by a dance well known as 'staying alive'. For heat, dancers started low and rose up with their arms waving, to represent rising heat and fire. Transport was represented by a driving motion.

The next scene features dancers standing in the car park, with some hula hooping a small hoop overhead. Initially, this scene was to be a pie chart with people to show the Irish energy use proportions of 20% electricity, 40% heat and 40% transport (Energy Modelling Group 2016). Given the renewable energy targets of 40%, 12% and 10%, respectively, I would have needed around 50 people for this scene. As I did not recruit this number, I instead used the car parking spaces to show proportions. The hula hoops represented the renewable energy supply targets within each energy type; as the targets are not yet reached, some hoops were dropped towards the end of the scene. The next transition scene is a photo of myself at my desk in the

[3] While these stories all come from a Western literary background, an added advantage of dancing science is that it can potentially reach audiences across cultures, with the steps, the rhythms and the choreography not primarily reliant on the written word.

research institute, asking what the overall aim of my thesis is: how do we meet our renewable energy targets for heat and transport?

Act 2: Feedstock to Energy

The feedstock to energy series of dances show the different potential sources of renewable gas in Ireland and how they can be converted to energy. I wanted my research group to play a starring role in this section and they kindly obliged. There were three elements to each dance, the 'before' to represent the feedstock, the 'process' dance and the 'after' or 'energy dance'. The energy dance was to be a common and hopefully recognisable theme throughout. I wanted it to look energetic, and as this would be the set-piece dance at the end, it also needed to be simple and easy to learn to encourage participation.

The first feedstock is residues represented by me and Tara Reddington. The punching-style dance represents the harm that residues such as food waste and slurry would cause if not processed correctly. The double turn represents the anaerobic digestion and then goes on to the energy dance. The double turn for anaerobic digestion represents two-phase continuously stirred tank reactors. This is the most common form of anaerobic digestion (Jerry D. Murphy and Thamsiriroj 2013). Grass was represented by a simple foxtrot, followed by double turn for anaerobic digestion and then the energy dance. I chose foxtrot for grass as marsh foxtail is a common grass variety in Ireland. I had thought of using a hula, but I felt that was not an Irish representation. The final feedstock for anaerobic digestion was seaweed. The partner dance represents the proposed cocultivation of fish farming and seaweed. The idea is that the seaweed can prevent eutrophication caused by fish farming, which would in turn lead to a higher seaweed, and therefore gas yield (Czyrnek-Delêtre et al. 2017). The partner dance ends before processing as the seaweed is harvested and transported for anaerobic digestion. Similar to the two previous scenes, the double turn represents anaerobic digestion before the energy dance to represent the transformation to energy.

The by-product of anaerobic digestion is called digestate; this can be spread on land as fertiliser and can replace slurry, which causes harmful emissions. In dance form this is represented by me and my sister performing a spreading action at the start before ending up in a 'tree' pose, representing growth as a result of fertiliser.

The next technology is gasification. The tree pose represents woody crops. Willow is proposed as a gasification feedstock for Ireland. There are a number of different types of gasification, and updraft gasification is suitable for willow, based on its water content (Quaak et al. 1999). For this reason, the hula hoop moves up my body to represent the process. After this I perform the by-now familiar energy dance.

The last technology represented is Power to Gas. The part I danced represents excess renewable electricity, which can be used for electrolysis. The turning movement represented the renewable element. Truc Vo and Richin Lin played water, with the arm movement representing the ripple of water, with Shane McDonagh as

carbon dioxide, using a punching-style dance to represent the harm caused by this gas. I break through the water to split, and then the turning, shot overhead, represents the chemical reaction of hydrogen and carbon dioxide to form methane. Finally, Truc Vo and Shane McDonagh perform the energy dance to represent conversion to energy. Both are studying Power to Gas for their respective doctorates. As a follow-up activity, it will be interesting to find out to what extent embodying the metaphors for energy and gas behaviour that I devised to stage the dance also had a bearing upon their own research.

The circular economy is represented by the Irish Polka, a dance familiar to many Irish people, and often performed at weddings and social events. I chose it because it is a circular dance and also as a way of being distinctly Irish in an international competition. Renewable gas has important applications as part of the circular economy, as the resources are used and valued as much as possible (Wall et al. 2017).

Act 3: Uses of the Energy

The conga line, with people dressed in black to stand for fossil fuel, represented the natural gas grid. I was fortunate that there was good light shining on the hill down to the research centre. Renewable gas, which can be upgraded to the same standard as natural gas, was represented by the people who had been doing the feedstock to energy dances wearing green t-shirts. These were all part of the Biofuels and Bioenergy Research Group, including the Principal Investigator. The green represented renewable gas. For transport I chose a hula hoop dance to 'The Wheels on the Bus', a popular nursery rhyme. The hula hoop represented the turning motion of wheels.

Act 4: Energy Dance

The framing of the story, followed by the potential energy sources and uses, was meant to convey the 'rise' stage of the story. The 'fall' or the emotional low point was the next scene, where the potential for renewable gas has not yet been reached and we are sitting on the sidelines while everyone else is having fun. We look bored and are not participating. The second 'rise' of the story occurs when policy, played by Serena Lee O'Sullivan, comes along, in a flamboyant way, to rescue us. Policy gives some of us a hand up and the others get up of their own accord, as the industry is established. The silent movie text reads 'Nobody puts renewable gas in the corner', referencing the famous line from 'Dirty Dancing' (Emile Ardolino 1987): 'nobody puts Baby in the corner'. Without policy support, renewable gas is in the corner. In the final scene, both renewables and fossil fuels are all part of the energy system, performing the energy dance in an ongoing loop.

Choreographing the Research/Dance

For the energy dance, I wanted a simple dance that would be easy to learn but that would also take up space and look energetic. It also needed to be manageable in a group, so that participants would not be bumping into each other. I recorded a video of myself dancing to the music in the back garden and mirrored it, so you could learn it facing a screen. To record the consent of participants who responded to the email that I mentioned above, I created a google form as a sign-up and also had manual sign-up on the day.

Although several colleagues initially signed up, some were put off by the dance, which they felt was fast and complicated. To address this I filmed a second step-by-step version. To cast a wider net, I also sent the recruitment email, giving details of the competition and a link to the dance to the entire UCC staff email list of 4000 people. I got no volunteers from this. I also reached out to dance groups through any contacts I had. This did not yield any participants either. Most were a result of direct conversations. In the end the energy dance participants were approximately half researchers from the ERI and half family and friends.

It was a requirement of the competition that I would be dancing in the video. As producer, I also wanted a starring role. I assigned tasks according to the personalities of the people taking part, in terms of how willing and comfortable they were to take on prominent roles on camera. I knew Michelle Healy as someone with high energy and enthusiasm, so I asked her to lead the conga line and also to lead the final energy dance off-camera. Knowing that I would not be in a position to greet people fully as they arrived, they were sent to her for a rehearsal before filming started. This served two purposes: to get to know the dance if participants had not learned it fully and also to mitigate the awkwardness that they might feel when initially arriving at the event. Many participants commented afterwards that they thought Michelle was an aerobics instructor or that it was what she did for a living.

From my own research group, some were enthusiastic about the project, but not willing to participate on camera. I assigned Karthik Rajendran the role of first assistant director. His role was to greet people on arrival, to assign energy type for the opening scene and to assist with organising the dance group. He was also responsible for the clipboard, i.e. my storyboard, in order of shooting sequence. Karthik Rajendran had an interest in photography and a good camera and offered to document the day. This resulted in some lovely ‘behind the scenes photos’ that feature in this chapter. Dawn O’Sullivan had also agreed to assist, but not on camera. I assigned her the role of second assistant director, playing the music according to a list I had prepared to match the storyboard and also helping with organising the large group. Síle Griffin was my phone camera person, who provided insight on the quality of scenes and also had great patience, and finally Ciaran Usher was the drone camera person. Apart from general briefings, I found that I worked through my team, who then managed the large group.

Image 6.2 Briefing participants on the shoot requirements and research

I asked people to arrive between 8.45 and 9 and advised that we would not be there longer than 11 (see Image 6.2). Before filming I started with a briefing. The group was not all familiar with the research and that was one of the aims of the day. Before each group scene, I explained what the scene would represent.

I started filming with the conga line scene, as it was less dependent on a large crowd compared to other group scenes, and it would wake the group up and get everyone into a dancing mood. This was inspired by a humanitarian UN Civil-Military Coordination training I had participated in. Each morning there were learning activities meant to reinforce the material covered the day before. One day the game was a conga line. While initially I despaired of the exercise, by the end I was fully enthusiastic. I hoped to achieve the same result by starting with a conga line and it did work (see Image 6.3). The following scene was where renewable gas is on the sidelines and rescued by policy. Policy was played wonderfully by Serena Lee O'Sullivan, a trained dancer and model. This was the set-piece dance and final scene, and at that point, all dancers were fully engaged and enthusiastic.

The final group scene was the opening scenes, representing the energy types and proportions. By this time everyone had arrived. Shooting this scene was led by drone operator Ciaran Usher. This scene also took the longest as it was difficult to synchronise the timing of the drone speed with that of the dance. When the group scenes were finished filming at 11, tea/coffee prepared by David Wall was served in the building reception. After a short break, we continued filming the smaller group scenes and then finally the solo scenes. In total, filming took from 8.30 a.m. to 12.30 p.m. (see Image 6.4). Editing took approximately two weekends.

Image 6.3 Conga line – first scene of the day to energise the group

Image 6.4 Reviewing the film footage with Serena Lee O' Sullivan and Síle Griffin

Challenges Faced

The first challenge for me was to be able to overcome some personality traits. While I do not consider myself shy, I am not particularly outgoing either. It was a large undertaking to ask everyone I saw for 3 weeks whether they might be

interested in my 'Dance your PhD' project. Moreover, I got quite ill while still in the recruiting process. Being far out of my comfort zone may have been a contributing factor, because although I was confident I would get enough participants, I was also very aware that every participant was hard won. Early on I decided to focus my gratitude on those who agreed to participate rather than be disappointed with those who committed and then declined or who were not interested. This was important to maintain mental momentum and enthusiasm for the project.

I also learned that very few people fill out an online form, especially if asked over email. Every form sign-up was a result of direct conversations. With hindsight, I should have been more aware of this from my time working in data collection, so it was an interesting refresher. Moreover, following on from email requests, the project demonstrated the importance of networks. All participants were from my own network or knew people joining in. There was no response from the general request or reaching out to dance groups. A good idea is not enough and there needs to be trust. This is an important lesson learned to apply to building links between disciplines, on either a professional or personal basis.

Having respect for the participants was important, ensuring that they were comfortable, starting on time, providing access to toilets, keeping people in the loop as to the 'why' with briefings and also ending on time. I managed to achieve this, which was important to the success of the day. Before the end of the filming day, I sent a thank you email to all participants, with a 36 s trailer. This served two purposes: first, it was a tangible outcome to show for the day, and second, it was an indication as to when the video would be ready. I credited everyone that participated and also dance instructors that I had met along the way. Finally, after the video was done and uploaded, I followed up with thank you cards, acknowledging the contribution that each person made.

I also gained some interdisciplinary training in the sense that I became familiar with the process and practicalities of making a video. From a directing point of view, I learned about the importance of management structures, having a team and trusting them in their role so that the day ran smoothly. It was tempting to try and assume full control of the day, but I would not have been able to manage everything at once. Those who volunteered to be behind the scenes were highly valuable to the success of the day, so team work was and is absolutely crucial.

Understanding social media platforms and networks was important for spreading the word, and participating in the competition provided an invaluable opportunity to become engaged with these. In the social media training mentioned previously, we were advised that it is not a good idea to post a YouTube video on Facebook, as the companies are rivals and Facebook would bury the video in newsfeeds. For this reason the video was uploaded directly to Facebook on the MaREI Facebook page and on my own YouTube account. Most of the views were on Facebook. At the time of writing, momentum is slowing down, and without advertising or promotion in traditional media, the video has approximately 2500 views on Facebook and 500 on YouTube, over 3000 views in total and counting.

Overall, the video has been well received. It was seen as something fun and informative. From informal discussions with people who participated and friends, they now understand my research from a general point of view. To quote one participant 'Now I finally know what you're doing!'

Conclusions

While this video was shot out of sequence, to manage time and the availability of participants, the dance could be reformatted into a dance workshop if done in sequence. This would continue the storytelling element and engage people who may not have a primary interest in science.

Finding a way to build relationships between disciplines is important for trust and collaboration. This project depended very much on my personal contacts, and it showed how weak relationships did not have a positive outcome for involvement in the project.

There is no doubt that the project has been beneficial for me as an engineer, to improve my ability to explain what I am doing to a non-technical audience, both at the event, through the choreography, and writing the script for the video. As a first year researcher, I spend most of my time perpetually confused as I am reading about my topic. Working on the video gave me an opportunity to focus on the big picture as well as the detail of my work. Moreover, to follow up on the insights I gained this year, I intend to continue designing dances for my PhD every year regardless of the competition, to integrate the knowledge I gain from the construction of metaphors and the physical acting out that the process involves.

I have been at dance performances which tell either no story or a terrible story. Scientific research essentially tells a story. As Hans U Fuchs has demonstrated, narrative framing is an essential component of scientific modelling in physics and beyond (Fuchs 2017). Translating science stories to dance performance can have a benefit for society and contribute to the cultural fabric of the city community as well. Science is full of potential stories, waiting to be told.

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