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IRELAND

Science in a land of storytellers

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1. Introduction

Ireland is a small country that punches above its weight in scientific terms. Or rather, it may be more accurate to say that it has tended to proclaim a larger-country status in how it communicates its science. Ireland has always been a land of storytellers. And there is a story to be told about the co-evolution of science, technology and the public communication of science.

This chapter will tell one story of science in Ireland and how it is aligned to public communication, scientific literacy, commercial technologies and, eventually, public involvement. It begins with a whistle-stop historical account of how Irish science co-emerged, as it were, with an institutional self-awareness of that science and how it was disseminated. This particular account is a familiar narrative of Enlightenment science as it pertains to Britain and Europe up to the late 20th century—a 'great man' idea of scientific exploration leading to the mathematical knowledge and technologies we enjoy in late modernity. Then the narrative changes, just as it has across the industrialised world. We see a ramping up of funding, from the Irish Government in collaboration with industry and philanthropic enterprises, that takes us away from a linear arrow of progress of science, and towards what Nowotny et al. (2001) call Mode-2 science—networked, contextualised and driven by strategic interests.

The chapter then makes sense of these changes by focusing on indicators for assessing science communication and taking a critical look at the newer discourse of impact and how it might fit into evolving models of communicating science. The chapter briefly profiles some Irish people who have been ambassadors for science communication in this story.

Through all of this, Ireland's ambitious, rhetorical approach to science and how this impacted on science communication is in evidence. The argument is further developed from the analysis in *Little Country, Big Talk: Science Communication in Ireland* (2017), the edited volume from Trench, Murphy and Fahy that focuses particularly on the scale of this ambition and the underlying realities where science and engaging in science overlap (Trench, 2017a, 2017b).

2. Historical context

We could go back a long way. The astronomer-astrologers of the Stone Age passage tomb at Newgrange, older than the Egyptian pyramids or Stonehenge in England; the metaphysical writings of Irish monks on Greek knowledge taken from antiquity, as told by 'knowledge communicators' of the middle ages such as the 12th century scholar and popular writer known as Honorius of Autun; in the 18th and 19th centuries, the quaternions of William Rowan Hamilton, essential to space travel, and the equations of George Boole, necessary for Google searches. Aedh Buidhe's writings on texts from 8th-century Alexandra from around 1415 sit in the Royal Irish Academy (Mulvihill, 2002). On the cover is a *rotula*, Ireland's oldest scientific instrument, used to demonstrate the movement of heavenly bodies across the constellations of the Zodiac. Irish science has contributed handsomely to information retrieval and astronomy.

However, an examination of any formative period of science and its communication on the island of Ireland cannot avoid a post-colonial analysis. It is within the period of British rule ending in 1921 that we can best assess the context for which modern science communication emerged. While MacLeod may say 'science has no nations; but nations have science' (1997, p. 3), the building of scientific nation-states worldwide has created different characteristics of science and how it is communicated. And it can be argued that we have different nations of science—Jasanoff (2005) and Gottweiss (1998) are excellent examples of studies where state-building is at work. In these two particular instances, state policies around biotechnology dictate the essence of the state itself, as demonstrated in the US and Germany. The emergence of a 'Protestant Ascendency' in science is often attributed to colonialism in Ireland

(Whyte, 1999), and Protestant rule over Catholics. The Ascendancy was a period in Irish history where the professional and elite classes were predominantly Protestant, aligned with large property dispossession from Catholics recorded since the time of Elisabeth I (1533–1603). While this moment has often been characterised as a time of 'no Catholics allowed', Nicholas Whyte (1999), among others, has challenged this straightforward reading although he does describe the exclusionary policy of the Royal Dublin Society towards Catholics.

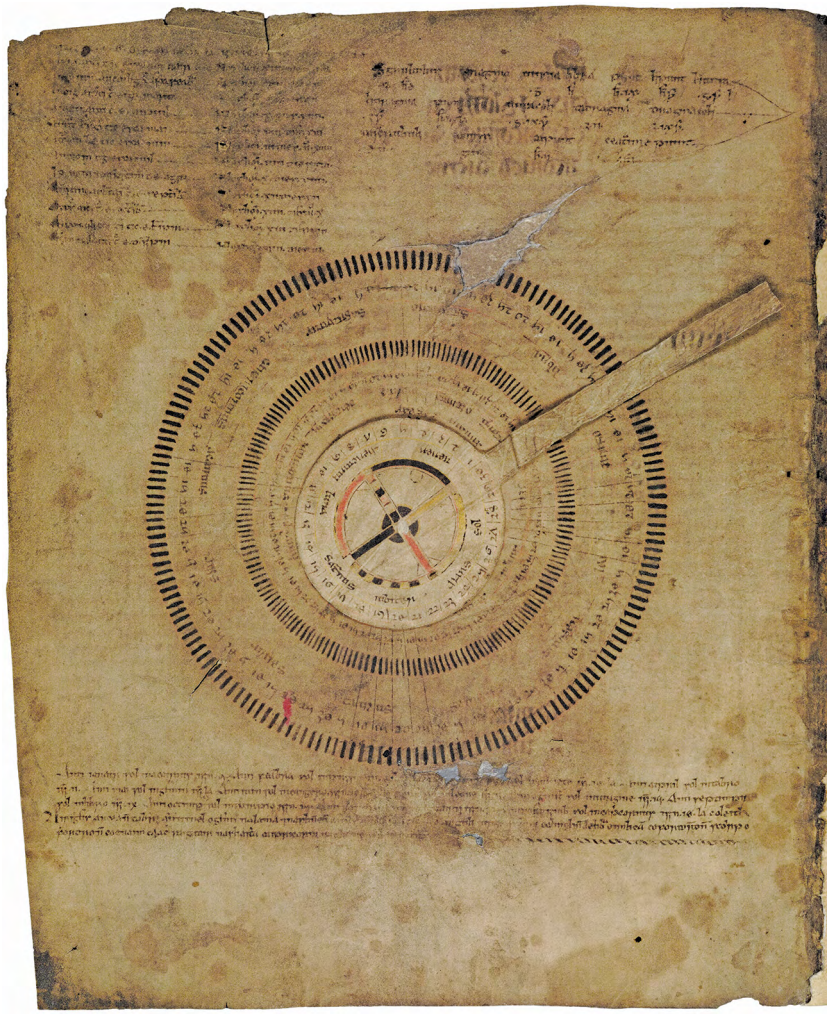

Figure 18.1: The rotula, an ancient astronomical instrument, from Astronomical and Medical Tract a 15th-century text from Aedh Buidhe O'Leighin of Fermoy.

Source: Royal Irish Academy.

There was also open hostility towards Catholics in the Royal Society and British Association for the Advancement of Science (Bennet, 1997). Whyte places greater emphasis on the exclusion of the poor. And the underprivileged were, as is ever thus, the majority in this landscape as we move into the 1800s. The Irish Potato Famine, or Great Famine, devastated the country and almost halved the population of 8 million through death by starvation, or emigration. This was a defining moment for the development of the Irish diaspora worldwide. Jonathan Swift's essay *A Modest Proposal* famously satirised British attitudes to the Irish poor, writing during an earlier period of devastating poverty in Ireland (Swift, 2008). Swift was actually a cogent and compassionate communicator of the horrors that ensued during his time. However, as an elitist science continued, these cataclysmic events did not seem to impact on what could hardly be claimed as an 'Irish science'.

On the other hand, while the Roman Catholic church did renounce Darwinism (Duddy, 2011), there hasn't been sufficient evidence of outright Catholic rejection of science. Whyte also refutes Robert Merton's 'ascetic Protestantism' thesis, which sustains scientific beliefs more readily than the Catholic dogmatic tradition. In fact, Nicholas Callan, a contributor to our knowledge of electromagnetism and batteries, is an example of a Catholic priest and scientist, and there were many more during this Ascendency time.

Wyse Jackson's (2000) edited volume chronicles the science that was taking hold as revolution against the British Crown was happening in Ireland around 1798. Davis reminds us that his tenants in Ireland did the science for Robert Boyle, a founding member of the Royal Society, and that he was their landlord in the heart of the Empire. McNeven, a medical doctor who dabbled in mineral science, associated with Irish Catholicism in 1790s and joined the United Irishman, the rebellious forces against the British in Ireland.

The first recorded group of Irish natural philosophers was the Dublin Philosophical Society (Mulvihill, 2002), founded in the 1680s (Bennet, 2004), a time when ideas from the centre of the British Empire had spread from the tree and taken root in a slightly different way—in this case in Dublin just across the sea. The Royal Dublin Society (RDS), established by the Dublin Philosophical Society members in 1731, has become central to the legacy of Victorian science in Ireland. From this society we have the Botanic Gardens and the Royal College of Science, which once shared buildings with the Irish Government, before evolving into the neighbouring National Museum of Ireland (Whyte, 1999). We also have as its legacy the RDS grounds themselves, and the Boyle Medal, the highest accolade for scientific excellence in Ireland.

In 1785, James Caulfeild, the First Earl of Charlemont—who owned significant property in the Dublin area, including the neoclassical curiosity that is the Casino Marino building, a scientific pleasure house built as part of his 'little Venice' in Dublin—established the Royal Irish Academy (RIA) as an Irish model of the Royal Society, but included in equal parts representations of the humanities and social sciences and the physical sciences. Duddy (2011) recalls how Darwin was elected as honorary member of the RIA. Under its royal charter, which continues to this day, there is a three-year presidency rule where a representative of each of 'the two cultures' alternate the chair. The fauna exhibits were moved to a special site built in 1856—the Natural History Museum. This building is another historical curiosity, taking a cultural-historical approach to science communication. The museum itself is a museum piece, left exactly as it was then, with the same exhibition design preserved from late 19th-century evolutionary taxonomy knowledge of the time.

Northern Ireland's history in some ways parallels the Republic's. The Church of Ireland Primate of Ireland, Richard Robinson, was the founder of the Armagh Observatory in 1789 and a huge contributor to world astronomy, as was Dunsink Observatory in Dublin. The globally famous physicist William Rowan Hamilton worked in Dunsink from 1827 until 1865. This observatory, like many others on these islands, are excellent spaces for communicating the past. Mary Mulvihill (2002) has alerted Irish tourists to look for Broom Bridge in Dublin where Hamilton inscribed his famous quaternion equations.

The giant reflective telescope at Birr Castle was erected by the Earl of Rosse, the first Leviathan in our story of Irish science. For half a century until 1917, Leviathan of Parsonstown was the largest telescope in the world. The interpretive centre currently at the site is testament to its stature, but its fame was recovered by the great astronomer and science communicator Patrick Moore on the TV series *The Sky at Night*. In reflecting on the role of these buildings, structures and instruments of science, Carroll (2006) has brought a material culture view into the history of Irish science, bringing this 'pre-modern' period into a category of 'meters (barometer, hydrometer etc.), scopes (telescopes, stethoscopes, etc.) graphing technologies (cartographic instruments) and chambers (e.g. hydraulic and pneumatic technologies)' (p. 23). These are the objects that contribute to a history, and now to the communication of that history. Indeed, during this period, scientists with Irish blood or Irish addresses enjoyed something of a mini-Renaissance.

And if we go back a couple of centuries there was another, earlier artefact that spurred a new wave of science and presented science scholars with a different look at the enterprise of science—the humble air pump, or vacuum pump. The epistemological nature of Robert Boyle's work in the 1660s, in collaboration with Robert Hooke, and his disputes with Thomas Hobbes, was brilliantly captured in Simon Shapin and Steven Schaeffer's (1985) *Air-Pump and the Leviathan*—the second Leviathan of our story, that of constitutional state and the body politic. Boyle, in this reading, was not only the prime mover for a new empiricism that became modern science by demonstrating against his old foe Hobbes that creating a vacuum in a room was not only possible but necessary for it to be a testable, *witnessed* science.[1] But the act of creating this vacuum (and in the process killing animals!) also marked the beginnings of a type of upstream engagement that characterises our contemporary, more networked, 'Mode-2' science (Gibbons et al., 1994). A select audience needed to witness it, and the gathering (male) natural philosophers needed to replicate it, while women and children reputedly looked on in astonishment, taken by the spectacle of the new magic of science they had seen. However, Boyle was unhappy to be in a 'barbarous country where chemical spirits are so misunderstood and chemical instruments so unprocurable' (Silver, 1998, p. 119).

Irish scientists in early 'science' were influential in disseminating to the elites of Georgian and Victorian Britain. They were part of the 'Big House' scientific endeavour of Britain through the Royal Society, and subsequently through the emergence of Royal Dublin Society and the Royal Irish Academy. These 'influencers' were also orators and writers. John Tyndall, for example, was not only a scientist whose work led to a better understanding of the properties of air, infrared and greenhouse gases, but also wrote a regular newspaper column. Tyndall was also the main Irish pro-Darwinist, a passionate supporter (Duddy, 2011) who took seriously his role as a defender of science, sometimes against religion, and a science communicator. His lectures to the Royal Institution were the stuff of legend, such was their oratorical power, and his US tour generated great interest. It is Tyndall who is credited with finding the answer to the question every child asks: 'Why is the sky blue?' (He was partly right, by today's accumulated knowledge of light and the Earth's atmosphere. He used a special apparatus to conclude that the blue light on the electromagnetic spectrum is most likely to scatter off particles and show visibility. But it is also because blue has the shortest wavelength in the visible spectrum (Royal Institution, 2018).)

1 The vacuum created by these early air pumps was often demonstrated to a live audience by killing a bird, as provocatively captured in Joseph Wright of Derby's painting *An Experiment on a Bird in the Air Pump* (1768).

Then there is a school of thought that states that the Irish embrace of culture and the arts was a way to drive a wedge between this new state called Ireland and the Empire. With the separation came a rejection of science—a separation on cultural and political fronts. For the poet William Butler Yeats, a Protestant, along with the first President of Ireland Douglas Hyde, another Protestant, and others, this new nation needed to define itself as being *not-Britain* as much as *being Ireland.* They spearheaded the Irish Literary Revival, often referred to as the Celtic Twilight. The thinking behind this thesis is that this constructed Ireland resisted the science that represented British Empire—Ireland would instead be a land of artists, singers and poets. Economically, agriculture thrived. The Literary Revival created a hostility to the scientific heritage (Patten, 2003) of William Rowan Hamilton, Robert Boyle, John Tyndall and Joseph Callan. Exclusion cannot be accounted for on grounds of religion or wealth alone: Irish history has regrettably forgotten the great 19th-century women of science, at least until Mary Mulvihill wrote about them; scientists of stature such as Mary Ward, Kathleen Lonsdale, Lilian Bland and Cynthia Longfield. While it cannot be understated how influential this Revival was—it was the imaginary through which banshees, wild spirits and Irish literature flourished (one could almost see the motif woven into the dance costumes of Riverdance)—this is not the full story as the earlier accounts of Irish science advancement demonstrate.

Interestingly, while Ireland became a central point of astronomy during the years of the Earl of Rosse and Leviathan, the Irish state attempted to reclaim leadership again in the mid-20th century, this time as a focal point for physics. In some ways, this was a bizarre occurrence in history. Eamon De Valera, the third Irish president, having earned his legacy from the 1916 Rising, established the Dublin Institute for Advanced Study to attend to his own twin loves of Irish and mathematics (the institute had two schools of study: Celtic studies, and theoretical physics). Suddenly both 'cultures', to brashly reuse the C. P. Snow phrase, were privileged in Irish political thought. De Valera extended an invitation to Erwin Schrödinger to lead the physics part with a Professor's Chair. Others, such as Walter Heitler, continued this great theoretical work on quantum field theory and thermodynamics. The inspirational series of 'What is Life?' lectures Schrödinger delivered in 1943 were hugely significant science communication moments not just for a learned audience, but for the various developments happening within biology, and particularly the new field of molecular genetics. Earlier, Ireland had been home to its only Nobel Laureate, Ernest Walton, for his work on splitting atomic nuclei—again under the proud gaze of De Valera. After that period, Ireland became relatively isolated once again from the discourses of science

in the 20th century, although several high-profile Irish scientists contributed, most notably Jocelyn Bell Burnell's discovery of radio pulsars. These pioneers of the past are interwoven into the cultural fabric of Ireland's story.

3. Milestones of science communication in Ireland in the 20th century

This section will outline some of the key moments in Irish science communication. We will see in the next section the changing contexts of science communication, and how conceptually these moments became an 'Irish' version of what international scholarship attempts to categorise as science communication. While some version in Ireland emerged from the late 1990s and early 2000s, in this section the story goes back earlier in the 20th century and the formations of modern science communication in Irish society. They were the rare ways that the public saw, heard and witnessed up close science in action.

The Young Scientist Exhibition was founded in 1963 by Father Tom Burke, a physics teacher and also a priest. It has become the most enduring and arguably the most important public celebration of Irish science on the calendar. It is open to all secondary schools in Ireland. There can be as many as 600 entries and winning is highly prestigious, for both student and school.

When Ben Sherry opened the children's educational TV program *Teilifís Scoile* (1964) [School Television] in native Gaelic on the new national broadcaster Teilifís Eireann (now RTE), he pondered slowly and philosophically to his young audience 'What is Physics?'. He perhaps didn't realise he was starting a new genre in Irish broadcasting, science television. While the answer to his own question perhaps did not take hold on the genre as it might have, there was a little of the future Carl Sagan about it: 'The question is so big and has so many ramifications. It requires a superhuman effort … to answer it. But let's try and at least give an indication of what it's about.' From the 1970s, imported TV shows such as BBC's *Horizon* and *Tomorrow's World*, David Attenborough's *Life on Earth* and Sagan's *Cosmos* appeared on RTE, as more Irish TV receivers picked up international stations. These became influences for the magazine format of Irish-produced shows of the 2000s with Science Foundation Ireland (SFI) support for programs such as *Scope*, *The Science Squad* and *10 Things to Know About.*

A major milestone was the establishment of the Irish Science and Technology Journalists' Association (ISTJA) network in 1985, linked with the European Union of Science Journalist Associations (EUSJA). While ISTJA went into

hiatus for a few years, it has become a vibrant organisation again since 2018, and its awards have been running since 1996. Since 2017, the Mary Somerville Medal has been presented by the Institute of Physics in Ireland to the country's top science communicator or spokesperson for the greater public engagement or understanding of science.

The mid-1990s period was a coalescing of areas that saw the move towards an emphasis on science connecting with society. The same year as the White Paper on Science Technology and Innovation (Government of Ireland, 1996) was published, the first science week was launched. The MSc in science communication, also launched in 1996, was a joint program between Dublin City University (DCU) and Queen's University, Belfast. It was the first north–south cross-border course, benefiting from funds from the peace process on building links between the two jurisdictions. Founded by Brian Trench and Ian Hughes, the MSc is still running but at DCU only, and added a health communication strand in 2018.

The next milestone was the 'turn to science' at the beginning of the millennium. The Programme for Research at Third Level Institutions (PRTLI) began the first of five tranches of funding for Irish higher education institutes in 1998, totalling €1.2 billion (HEA, 2004). This was a national government program that also had extra financial support from private industry, EU structural funds and Atlantic Philanthropies to create collaboration potential among different scientific sub-programs based in Irish universities. It represented a significant increase in expenditure, given international recognition that Ireland—despite its historical context—had fallen well short in science spending. Part of the PRTLI remit was support for science communication with dedicated funding for 'education and outreach'. SFI was established in 2003 to oversee policy in science and technology in Ireland, and the Discover program, which funds the majority of Education and Public Engagement (formerly Education and Outreach) programs also comes under its remit.

With PRTLI funding, researchers at DCU linked to the MSc program began to establish themselves as a potential hub for science communication research. They were led by Brian Trench, then chair of the MSc and current president of the international Network for the Public Communication of Science and Technology (PCST). Trench and others were awarded funding from the Framework Programmes in European Commission research. An early success was the European Network of Science Communication Teachers (ENSCOT), training hundreds of researchers in science communication across Europe from 2000 to 2003, with partners including University College London, Pompeu Fabra, Barcelona, as well as DCU and others (Miller et al., 2009). Not long after, the first PhD student in science communication came through.

Dr Fiona Barbagallo successfully defended her thesis 'Public participation and controversy involving science: an Irish perspective' in 2003. There have been six other PhDs in science communication awarded since then, ranging from research on environmental audiences and science TV programming, to celebrity science and young perspectives on biosciences in culture. That first wave of PRTLI funding kick-started the progenitor for the Celsius research group, then called BioSciences and Society, the first research team in Ireland dedicated to science communication research and based in DCU. The Celsius group is now involved with multiple research projects funded nationally and by European Commission Horizon research framework programs in communication, engagement and responsible research and innovation (RRI). Some projects are collaborations with several European and global partners, including the US, South Africa and China.

Perhaps the most significant milestone in terms of Ireland's culture of science, and a demonstration of a new confidence in the intertwining of science and science communication, was the opening of Science Gallery Dublin in 2008. This was a departure for the representation of science in Ireland and arguably the first practical step in UK-style engagement for the country, away from traditional deficit-model marketing. Here was an interstitial public space for the clash of ideas at the edges of science and the arts. Because of private and government funding, as well as its dedication to young people, Science Gallery perhaps cannot venture too far into controversies of science, but the gallery has a unique licence for edginess within the SFI ecosystem. There are now Science Galleries following the same template in London, Bengaluru, Melbourne, Venice and Detroit.

In 2012, we see a return to Schrödinger. Dublin's winning of the significantly competitive bid to host the EuroScience Open Forum (ESOF) City of Science 2012 allowed the country to once more boast what it has to offer. J. Craig Venter, a synthetic biologist venturing into the production of new life-forms, delivered a keynote entitled 'What is Life 2.0?' But there was something else on the minds of the many prominent Irish scientists present, above and beyond this old-school, great-man pioneer replicating Schrödinger from decades earlier at the same institution (Murphy, 2014). The SFI had recently shifted policy even further from 'pure science' to 'applied technology' based on the most recent rounds of funding; and, indeed, the STEM policy had contributed to a greater emphasis in engagement since PRTLI and the establishment of the SFI. Here now, publicly at this grand forum, local scientists were voicing concerns that the days of Boyle, Hamilton, Bell Burnell and Tyndall were numbered if scientists could no longer be allowed to tinker, explore and do creative science alone in the lab. Perhaps the small changes towards a science-for-society had come at a cost to scientific inquiry itself.

There has been a recent demonstration of Irish science communication fitting in with global trends: while the Celsius group has held small conferences and seminars each year since 2008, the launch of the annual SCI:COM Conference in 2015 was a landmark for Ireland as an international player in how it communicated science.

4. A closer look: The Irish turn to science at the turn of the millennium

The period described in this section is a consolidation of science communication activities in Ireland, a new direction based on the changing aims of government for science. We zoom in at the turn of the millennium and see for the first time that policymakers were making a coherent effort to communicate science, albeit initially in a strategic top-down way. This was an improvement, even if these steps into science communication were less about *connecting* and more about *strategic economic interests*: getting an acceptable level of information about the science that the Irish state funded and pleased investors; and simultaneously making efforts to supply a pipeline of future engineers. It was a supply-and-demand type of science communication.

Experts from science and academia were appointed to a government advisory group, the Science, Technology and Innovation Advisory Council (STIAC), established in 1995 (eventually the Irish Council for Science, Technology and Innovation, ICSTI). STIAC's Tierney Report (1995) was the torch that lit the paper, signalling what has often been characterised as 'Ireland's turn to science' and the major changes to science funding that happened with PRTLI, including dedicated science communication funding. Science communication was an add-on, a small but necessary awareness-and-persuasion element of the overall program. STIAC was set up to create a more coherent innovation plan for Ireland. The Tierney Report, in Bodmer Report[2] fashion, highlighted the need to upgrade knowledge and skills in a post-industrial society. Within this text, 'innovation' becomes the new organising phrase. Policy papers and government briefings begin using the acronym STI (science, technology and innovation) to emphasise that 'innovation' was the direction for science. The Tierney Report recommendations included doubling the level of R&D undertaken by the business sector by 1999; increasing funding for basic research from £1.5 million to £6 million (which eventually occurred with PRTLI); looking to universities and the rest of third-level education and encouraging greater interaction between universities and business;

2 The Bodmer Report of 1985 was the genesis of concerns about science literacy in the UK.

establishing a National Task Force to achieve greater awareness of the value of STI for the achievement of national social and economic objectives. All were implemented.

The White Paper (Government of Ireland 1996), influenced by Tierney's recommendations, became the first framing paper for STI in Ireland. Suddenly new buzz phrases appeared, with emphasis on 'contextual' and 'societal' indicators for 'STI'. There were references to Denmark's 'open dialogue model'—a cue to Nordic engagement, seen as being way ahead of Ireland on matters of science communication. Here was a toe dipped in the water of engagement, reflecting discussions that had progressed rapidly in the UK, the one-time colonial ruler. 'There are three simple but profound questions we can ask of the scientific and technological community which seeks public funding,' the White Paper asks. 'What does your project do for jobs? What does it do for society? What are its implications for the environment?' In some ways, this seemed like the beginning of a Rosseau-like contractarian questioning of science's role for society, but the questions were never answered by policy nor asked again. Irish science policy glanced across Europe to note these engagement ideas but never itself engaged. Included in the White Paper also, as if to demonstrate that 'scientists are human too', were snapshots of scientists' lives.

The concept of a modern, 21st-century 'foresight' process enters the conversation three years later with the Technology Foresight report (ICSTI, 1999). The report assessed the best strategic investment for the development of science and technology in Ireland. Eight disciplines were represented by a separate foresight panel, ranging from the life sciences to the construction industry to logistics. A 'stakeholder' analysis was carried out. The foresight exercise concluded that Ireland should be a 'knowledge-based economy', a 1990s buzzword for intensive, post-industrial activities. It could be argued that this was a change from a democratic idea of how knowledge might work for society to one that presented society as analogous to markets (Bell, 1999; Castells, 2000).

Although research support for indigenous companies was mentioned, foreign direct investment was greatly emphasised and this became a theme all the way through: this small country out on the Atlantic moved quickly from post-colonial shock to an agricultural economy, only to move quickly once again to a 'knowledge-based', *open* economy. Again, Ireland wanted the world's scientific leaders to visit, and perhaps stay a while. This report also suggests that working in these new knowledge institutions of universities as researchers should have an attractive career structure, an environment conducive to innovation with more investment in the physical and human infrastructure supporting them. As with other deficit model approaches, the report expects 'citizens [to be] well informed on scientific issues in the

context of an innovation culture' (ICSTI, 1999, p. 6). Foresight required a form of prediction, but to control the outcome of this prediction messaging was important. At this point, communicating science was about positive messaging.

During the mid-2000s there were several ICSTI reports on such issues as public awareness of science as well the commercialisation of 'modern biotechnology'. One of these reports appears to attempt to start a 'national conversation' on biotechnology, outlining some ethical issues and risks. While an online forum was set up, it was quickly closed down. This closure was never explained, but if there was no political will for deep engagement with science and technology beyond a deficit approach, then it is clear that such a forum would not last long. In 2004 a statement on nanotechnology by ICSTI was issued, *The Science of Small Things*, coinciding with influential report by the Royal Irish Academy and the Royal Association for Engineering (2004) that progressed the language of dialogue and engagement in the conversation about science policy. However none of the language of the UK report is present in the ICSTI statement.

The ambitious pre-recession *Strategy for Science, Technology and Innovation, 2006–2013* (Government of Ireland, 2006) committed to an R&D spend at 2.5 per cent of GDP, around €2.7 billion at the time, and prioritising food, health, environment, marine and energy as well as biotech and ICTs. It sought to double the PhD output by 2013. The global downturn and particularly the Irish banking crash ensured that these steps did not occur.

Innovation 2020 is the most recent SFI strategy to date. As a crude first-step analysis: when one searches two reports that might be expected to promote public engagement with science and technology (PEST) initiatives in Ireland—*Innovation 2020* (Science Foundation Ireland, 2018) and a recent *SFI Barometer* report (Science Foundation Ireland, 2015)—for the presence of four common words that denote engagement with science and technology, the following is revealed:

- **Communication:** 0 references in the *Barometer*; references only in the context of ICT in *Innovation 2020*.
- **Engagement:** 0 references in the *Barometer*; references only in relation to engagement with IP, industry, global researchers and markets, and funding stakeholders in *Innovation 2020*.
- **Public:** *Barometer* references 'public awareness', 'public trust', a sense of 'public value' of STEM and, promisingly, approaches to 'democratise' science for the public; for *Innovation 2020*, only in relation to public investment and public awareness of this investment and outputs.

- **Participation:** 0 references in the *Barometer*; references in the context of gender and international mobility of researchers in *Innovation 2020*.

Communication, engagement, public (or indeed publics) and participation are common parlance for science policy that is serious about connecting with citizens. Only the word 'public' appears, which may demonstrate a lack of serious consideration for a deeper form of science communication.

While SFI has been slow to catch up with engagement and RRI discourse, it has been proactive in bringing to fruition science communication initiatives under the Discover program, such as the TV series *Scope*, *The Science Squad* and *10 Things to Know About*, the radio series *Future Tense*, co-sponsorship of SCI:COM and Science Gallery Dublin and Smart Futures, Science Week and Discover Primary Science and Maths.

SFI Discover Centres were established in 2005. They include Birr Castel, Armagh Observatory and Planetarium, as well as the Blackrock Observatory in Cork, the National Botanic Gardens, Fota Island Wildlife Park, Dublin Zoo, Airfield Park, the Ailwee Caves and the Imagonisity fun centre for children (the closest Ireland has so far to a traditional science centre). More centres have been added around the country, such as the Arigna Mining Experience (Co. Roscommon), which explores ways in which people use the earth's resources and the themes of energy past, present and future; Bricks 4 Kidz Creativity Centre (Dublin City and Wexford Town), which provides LEGO Technic workshops focused on imaginative and multi-sensory fun; Laois Outdoor Education nature and science walks; Cool Planet Experience (Powerscourt Centre, Co. Wicklow) where students learn the science behind climate change; and the National Reptile Zoo (Co. Kilkenny). Other initiatives include the Festival of Curiosity, Alchemist Café, both funded by SFI, and a science-themed St Patrick's Day parade to mark ESOF City of Science in 2012.

However, there is something else within the Irish science policy system that has not been as successful: the failure, after decades of effort, in establishing a dedicated science centre. The Irish Science Centres Awareness Network (iSCAN) set the groundwork. In 2006, these plans, with support from various commercial interests, crystallised into Exploration Station, with a board chaired by former DCU President Danny O'Hare. Development is finally underway for Exploration Station, the National Children's Science Centre in Dublin. With over 30 years of planning and lobbying, €13 million is still needed to complete the project. It demonstrates the fragility of Irish science culture, and Irish science's inability to engage, that this relatively modest amount of funds (in development terms) cannot easily be raised

for what the Irish Government and SFI have declared a priority, namely an 'engaged public … one that understands the role of science' (Science Foundation Ireland, 2020).

The SFI and its current director Mark Ferguson (also the Chief Scientific Advisor to the Irish Government) have expressed satisfaction with public attitudes to science, citing the *SFI Barometer* report results (Science Foundation Ireland, 2015) that demonstrated a healthy respect for how SFI's work is progressing. An earlier Eurobarometer report showed a slightly different Ireland with some ambivalence towards science as well as positive attitudes (European Commission, 2013).

But the discourse of attitude research is a legacy of strategic communication: controlling the thinking around science, while reneging on a public responsibility towards involvement and public ownership as befits a social contract.

Possibilities for greater engagement with science can arise from different initiatives. For example, each higher education institution in the country signed the Campus Engage charter in 2013 (Campus Engage, 2017). Engagement was also a central principle in the Irish Universities Association Charter in 2018, and higher education is still the dominant source of science communication. The Irish University Association Campus Engage initiative launched the *Engaged Research* report (Campus Engage, 2017), a new template for communication and involvement that brings in reflexive techniques and multiple-impact indicators from many disciplines including contemporary science communication (Stilgoe et al., 2014). The two main research funders in Ireland, SFI and the Irish Research Council are now taking on board the concepts of engaged research where publics are invited at various stages of the research and development cycle to be involved and to influence outcomes. The PPI Ignite projects (Public-Patient Involvement) funded by the Health Research Board present models for deep engagement such as user-created diagnostics, where end-users co-design outputs with technologists and co-research with researchers. If using patient groups as co-researchers is a long way from Robert Boyle's air-pump, then maker fayres, hackerspaces, citizen science and DIYbio are actually new ways of getting people in that drawing room to create a vacuum, without killing animals.

From the mid-2010s onwards the term 'education and outreach' was replaced with an official, professional title: Education and Public Engagement (EPE). Here now at last we see—ironically preceding Brexit—an alignment and adoption of an Irish approach with British science communication, re-branded as 'public engagement' as distinct from marketing, persuasion or increasing science literacy.

Box 18.1: Examples of science communication pioneers

Mary Mulvihill

The late Mary Mulvihill was a giant of Irish science communication and her impact continues to grow. This goes far beyond the public communication of science: Mary was a champion for women in STEM a long time before this was part of anyone's agenda in Ireland, and she was an innovator in how she re-imagined Dublin as a city with science at every corner, and Ireland as a country with a cultural heritage of science. Although trained as a geneticist at Trinity College Dublin, Mary went on to study journalism at the institution that became Dublin City University (DCU) after spending some years as an agricultural advisor in a state body. These experiences shaped Mary's craft as a gifted writer and communicator, working as a science journalist and broadcaster. She was editor of *Technology Ireland* and hosted several radio shows on RTE, the national broadcaster, such as *The Goldilocks World*, *The Quantum Leap* and *Left Brain, Right Brain*. She was the go-to science historian for pieces in the *Irish Times*. In 1990, she helped found WITS – Women in Science and Technology. She taught on the MSc in Science Communication at DCU and she developed science communication training programs. Perhaps her most enduring legacy is *Ingenious Ireland*, regarded by many as a definitive book on Irish scientists, which also became a walking tour with the same name of scientific sites of interest in Dublin, demonstrating how science has been an integral part of Irish culture.

Dick Ahlstrom

When Dick Ahlstrom was appointed science editor of the *Irish Times* in 1998, he was the only journalist with such a role in Ireland. In fact, he was the only science journalist employed as staff in an Irish publication. When Dick retired in 2017, this still remained the case. While this may be an indictment of science journalism in Ireland, what it also means is that, during this period, Dick was the principal science writer in Ireland. Over the years, the *Science Today* page has varied with Dick at the helm, organising the main written outlet for science news in Ireland. Dick has honorary life membership of the Royal Dublin Society and has also been appointed honorary fellow of the British Assocation of the Advancement of Science.

Aoibhinn Ní Shuilleabháin

Aoibhinn Ní Shuilleabháin's star has risen quite sharply as one of the faces of science communication in Ireland. She first came to national prominence when she won the international Rose of Tralee Contest in 2005. She is an Assistant Professor in Mathematics Education at University College Dublin (UCD) and is heavily involved in the management and implementation of public engagement projects. Aoibhinn was a champion for the Project Maths initiative, which radically changed the maths curriculum for junior cycle at secondary schools, making the subject more relevant to everyday life. Aoibhinn also co-hosts the annual SCI:COM Conference with Jonathan McCrea.

Leo Enright

For many of a certain generation in Ireland, Leo Enright was the voice of astronomy. As the science correspondent on RTE during the 1980s and 1990s, he covered exciting developments and discoveries of the time: the Space Shuttle program, the Pioneer and Voyager probes and exploration of Mars. Leo continues to be a broadcaster, having appeared on BBC as well as RTE. His later career has concentrated on a greater role for his passion for the public understanding of science: he was Chairman of the Irish Government's Discover Science and Engineering Programme, and was science advisor to centres such as the Blackrock Castle Observatory.

Brian Trench

It is likely that Ireland would only recently have heard of science communication as a practice or a discipline were it not for Brian Trench. Because of him, the country has had a head start in the field. He was founder of one of the earliest science communication master's programs in Europe, as well as board member and campaigner for Exploration Station and, before that, Science Gallery Dublin. He is one of the latter's hallowed 'Leonardos'. Brian started his career in the early 1970s as a journalist, covering cultural and social issues, socialism, politics, jazz and technology. A trip to Carnsore Point, Wexford, the proposed site for Ireland's first nuclear power station, to cover the massive protests there, oriented him towards studying and researching the power and politics of communicating science to publics and publics speaking back. As journalist and editor, he broke some significant stories that are milestones in Irish history. He was the driving force behind the founding of the MSc in Science Communication at DCU, one of the earliest in Europe. The master's degree commenced as a jointly run program between DCU and Queens University Belfast, making it the first cross-border degree program.

5. International indicators for assessing science communication

The story of how science communication emerged as an area of study include debates about whether or not it deserves the status of 'discipline' (Gascoigne et al., 2010; Lewenstein, 2015; Stilgoe et al., 2014; Trench and Bucchi, 2010). These have covered the area of science communication and how it has understood itself internationally through the quite reflective and reflexive works of Lewenstein, Horst, Davies, Trench, Brossard, Irwin and many others. Cultural contextualisation, dialogue, inclusivity and RRI now dominate the discipline. As reported at the 'Big challenges for small countries in science communication' roundtable at PCST 2018 in Dunedin, chaired by Brian Trench, Ireland has found itself being pulled in three directions: the pull of internal national directives to boost the economy and respond to foreign direct investment (FDI), keeping science communication promotional only; the increasing pressures from below from the practice and scholarship of science communication on the grounds that current S&T engagement is not fit for purpose given the positive influences over the last 20 years of upstream engagement in Britain; and finally the related RRI and open science agenda of the largest funder, the European Commission. The first part of the triangle is the most likely to give way.

6. Concluding remarks

Ireland only became a player in this game recently. Brian Trench was a lone voice for a long time, but when funding emerged for engagement initiatives, they tended to be 'deficit model' in approach. The MASIS Report established a framework for assessing science communication across Europe and has become the 'gold standard' for assessing the scientific culture of a country in Europe and its relationships globally (Mejlgaard et al., 2012). RRI (or consideration for ethics, gender, open access, public engagement and good, inclusive governance embedded into technological assessment processes) became the new language; and Ireland measured up as quite 'fragile' in this assessment of the culture of science. For RRI, two-way communication is at the core of its conceptualisation and operation. The opening of Science Gallery Dublin, and the creative 'STEAM' (science, technology, engineering, art and mathematics) movements may change this. Ireland has had a history of culture and science intertwined, and this is the time to make them work together.

Ireland has, at last, staked a claim within the emerging models of science communication and the new paradigm of engagement. Science communication has become embedded in Irish research institutions with the launch of the Programme for Research in Third Level Institutions. Funding developed on an institutional level to avail of infrastructural and personnel support was required to demonstrate a commitment to, and demonstration with validation of, public communication. A percentage of funding needed to be dedicated to what was known as 'education and outreach' (E&O). The latter word has certain ivory tower connotations: borrowing a semiotic idea from the UK again, 'education and outreach' was subsequently changed to 'Education and Public Engagement'.

The familiar 'deficit to PUS to PEST' story came to Ireland later than the UK and the rest of Europe. However, Ireland is now positioning itself within various elements of this mapping out of engagement models and activities. Care needs to be taken that the impact indicators coming with the new concepts of evaluation (and that necessarily capture 'communicating', 'engagement' and 'involvement') do not create extra-strategic communication objectives that ignore the unexpected and, in particular, ignore large-scale public input. The Campus Engage initiative is an example of a cross-sectoral approach, using engaged research as a way that benefits science, universities and communities surrounding those institutions. Ireland has at last reached something like critical mass for science communication research (for example DCU), practice (broadcast radio and TV, Science Gallery Dublin) and the showcasing of best practice (SCI:COM).

Ireland is now positioning itself for engaged research, open science and RRI. The pull of three sides of a triangle—with Irish economic policy itself, UK-inspired public engagement and the European Commission—is getting ever tighter. Ireland's economic policies will continue to progress as an open economy that will also be a driver for how science and technology is both imagined and enacted. This is not necessarily the best for our culture of science. Would that the Royal Irish Academy or the Royal Dublin Society had input into democratic processes aligned with participatory NGOs there might then be challenge-based research as well as ring-fenced blue-sky research. This type of policy would foster the individual 'crazy ideas', but also commit to address real Irish problems such as homelessness, heart disease, cancer, mental illness and local climate action. Although language and emphases are slowly changing, science communication is still equated with STEM education within national policy. Global policies demonstrate significant overlap, but where emphasis is on literacy only, the value of contemporary communication, RRI and engagement theories—participation, inclusivity, dialogue, knowledge exchange—can be neglected.

The hope is that external pressures will lead to a science that fits public policy rather than a policy for Irish science. Impact is important, but blue-sky research and creativity is still a part of Irish science, as our history, so entwined with Britain and British science, shows us. Aligning these objectives of science—the need to address world problems, keep creativity and 'out-there' research, and still include as many non-experts and publics as possible as guides and co-innovators—is not easy in the context of the growing international trend for challenge-based research. But this is how the story should end—a multifaceted science for the doers, the dreamers, the outsiders and all those great women and men of future science.

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Timeline

Event	Name	Date	Comment
First interactive science centre established.	Science Gallery opens	2009	
First national (or large regional) science festival.	Euroscience Open Forum, Dublin	2012	
An association of science writers or journalists or communicators established.	Irish Science & Technology Journalists' Association (ISTJA)	1985	
First university courses to train science communicators.	MSc Science Communication	1995	Jointly with Dublin City University and Queen's University Belfast
First master's students in science communication graduate.	MSc Science Communication	1996	DCU/QUB
First PhD students in science communication graduate.	Fiona Barbagallo, an Australian	2003	Thesis on public participation and controversy
First national conference in science communication.	SCI:COM 2015	2015	Science communication conference held in Athlone
National government program to support science communication established.	The Programme for Research in Third Level Institutions	2000	
National Science Week founded.	Science Week	1996	

Event	Name	Date	Comment
First significant radio programs on science.	Possibly *Future Tense* or *Spectrum*	2001	
First significant TV programs on science.	*Teilifis Scoile Horizon* (BBC)	1964	
First awards for scientists or journalists or others for science communication.	ISTJA Awards	1996	2017: Institute of Physics Mary Somerville Medal
Other significant events.	Young Scientist Exhibition	1963	

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