

# Exhibition A: scientist at work

*Science museums are shifting their focus away from educating and elating their audiences to fostering dialogue with scientists*

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In the 19<sup>th</sup> century, exhibitions of manufactured products and industrial technology became popular throughout Europe and North America. The Great Exhibition of 1851 in London was the first of its kind, housed within a temporary “crystal palace” built for the occasion; the 1889 Exposition Universelle in Paris welcomed visitors to marvel at the newly erected Eiffel Tower; and the 1896 Berlin Industrial Exposition’s greatest attraction was a large telescope, completed only a month before the exhibition opened, and which was later moved to its own building, now the Archenhold Observatory. Despite the temporary nature of the crystal palace itself, many objects from the London exhibition continued to attract interest from the public and were eventually contributed to the foundation of the London Science Museum in 1928. The museum and its companions in Paris, Munich, New York and elsewhere have since attracted visitors in their millions to see the wonders of modern technology.

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The 1960s saw a shift in focus of these exhibits when several science centres and museums (SCM) moved beyond merely presenting collections to providing visitors with first-hand experience of scientific phenomena. After Sputnik’s launch in 1957 and the space race it triggered, SCMs sought to engage and teach the public, especially

children, about science and technology. Interactivity became the *modus operandi*: buttons could be pushed and cause and effect observed. This is still the approach taken in most SCMs today: “We put real objects in conversation with real phenomena”, explained Ignasi López Verdeguer, Director of the Department of Science at the “la Caixa” Banking Foundation that owns and runs the CosmoCaixa science centre in Barcelona, Spain. He points to an exhibit at CosmoCaixa that explains why hexagons form in nature: there is explanatory text to read and a live demonstration of the phenomena with soap bubbles forming hexagons together with examples from the natural world such as a honeycomb.

But one-way communication to educate the public has been criticised during the past two decades, as the so-called “public understanding of science” (PUS) paradigm of teaching the masses about science has come to be seen as condescending and unhelpful. “The most important public awareness [of science] is not facts and theories”, explained Brian Trench, science communication expert and author of a new book on science centres. “It is to get people to understand what it is a scientist does, what they did 50 years ago, what they do today and what they might be doing 20 years from now”. He said that many SCMs merely tell stories of scientific achievements, whereas much can also be learned by looking at past failures and mistakes.

The leading SCMs now argue that they are ideally placed to offer scientists a forum to try out a two-way dialogue with the public. Many SCMs are undergoing modernisation and refurbishment to better connect with citizens in the Internet age and to give visitors both a sense of participation

and insight into how science really works, both the good and the bad. “The leaders of the new [interactive science] movement like Exploratorium and Ontario Science Centre have evolved more towards public engagement”, said Bruce Lewenstein, professor of science communication at Cornell University, USA.

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Exploratorium, in San Francisco, USA, was one of the first to draw back the curtain on research by replicating the visible kitchens in some restaurants where guests can see the chef at work and installed real laboratories with real scientists at the bench with whom the public can interact. Other scientists who collaborate with SCMs spend their time talking to visitors about public concerns about science: not just to reassure members of the public, but also to admit that there are things science does not know and to discuss ethical issues in areas such as synthetic biology or gene editing. “This is more open, rather than secretive and mystical stuff going on behind walls. That’s the perception of science we want to defeat”, explained Dennis Bartels, Executive Director of Exploratorium in San Francisco. “Science isn’t the truth. Science is the best explanation for the physical evidence and it is always open for better explanations”, he said. “It is really difficult for the public to understand, for example, why coffee is



**Figure 1.** Visitors at the National History Museum in London can watch scientists work in the Darwin Center.

© The Trustees of the National History Museum, London, UK.

supposed to be bad for you, now good for you, now people don't know". In this vein, SCMs are also starting to deal with topics such as climate change, GMOs, fracking and synthetic biology, where there is substantial social or political controversy. Part of this shift also means a stronger focus on adult audiences.

Explaining the true nature of science as a permanent quest for answers with many

wrong turns along the way is perhaps the most important function SCMs can serve. To address this new role, many of them have followed Exploratorium's lead and now let visitors watch or work with scientists to offer them a realistic picture of research as a struggle for understanding. At the Natural History Museum in London, for example, visitors can look into laboratories in the Darwin Centre (Fig 1), while the Deutsches

Museum in Munich, Germany, hosts a fully equipped laboratory within its exhibition area. The Deutsches Museum's laboratory is the workspace for two PhD and two Masters students from different universities in the city. The students are conducting surface science research projects—mainly the self-assembly of monolayers on semiconductors—and spend some of their time answering questions from visitors. The museum has also installed visitor laboratories for molecular biology (Figs 2 and 3) and plans similar laboratories in chemistry and technical sciences. Nemo, in Amsterdam, the Netherlands, has opened its museum floor to research where visitors can take part as experimental subjects.

SCMs have a distinct advantage of trust when discussing controversial science with adults, according to Andrea Bandelli, researcher at the Vrije Universiteit in Amsterdam, who worked on a network of citizen debates on controversial topics called "PlayDecide" ([www.playdecide.eu](http://www.playdecide.eu)) with Ecsite, the European network of SCMs. In Bandelli's view, "The public trusts the museums more than the media and certainly more than politics, and at the same level if not more than scientific institutions themselves. They can be fundamental players in establishing good relationships between different stakeholders involved in science". The European Association of Rare Diseases also used SCMs to engage thousands of people in policy consultations and handed the results to the European Commission.

López Verdeguer, at CosmoCaixa, is spearheading an EC project called RRI Tools—a consortium of 26 institutions, 11 of which are science centres and another being Ecsite, the European Network of Science Centers and Museums—which fosters the implementation of Responsible Research & Innovation, an approach to assess potential implications and societal expectations of science and innovation. "The participation has to start very early on. A science centre can allow that to happen, to provide a neutral place for dialogue", he said. The results can be instructive for the public and policy makers, but also for researchers and science generally.

However, Bandelli believes that these sorts of consultations and the involvement of SCMs still miss the opportunity to truly engage the public. "What would be even



**Figure 2.** The DNA visitor laboratory at Deutsches Museum in Munich “floats” above the exhibition area.  
© Deutsches Museum, Munich, Germany.

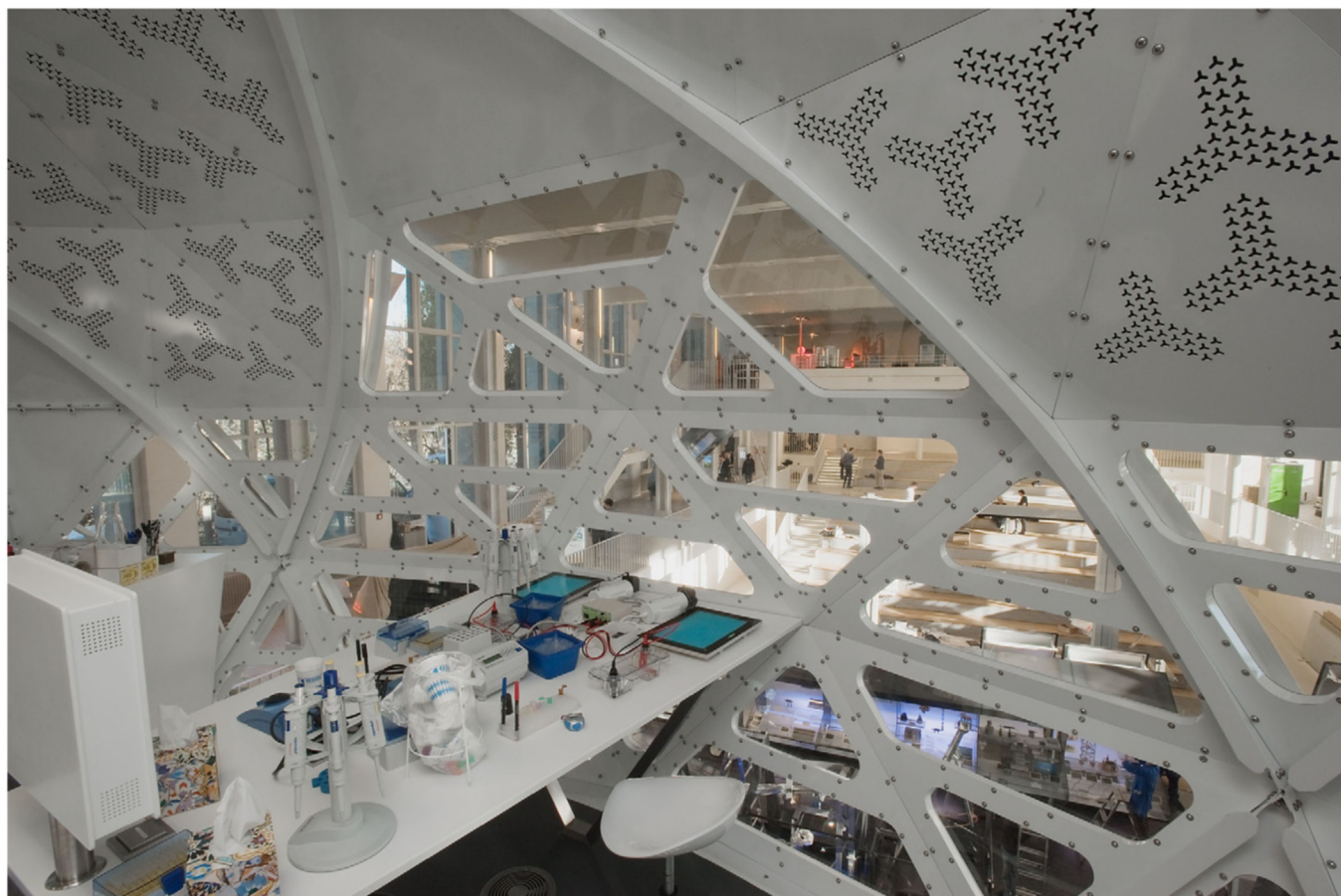
better would be if members of the public felt they could go to a science centre and say we have an environmental problem or something we don't understand, help us solve it”, he said. Bandelli has argued that SCMs must therefore do more to include citizens in their governance structures and allow them participate in the design of exhibits, rather than just consume or comment afterwards. After all, seditious questioning of authority lies at the core of what SCMs can do.

In many ways, the Exploratorium pioneered this kind of two-way approach to designing exhibits and experiences. “The goal of Exploratorium was never to glorify science, but to use science, art and human perception so that people become more self-aware of the world around them and better inquisitors, to generate their own knowledge and opinions”, Bartels explained. The centre's recent move towards the central business district of San Francisco

allowed it to move closer to the adult audience it wants to attract. Adults now pay \$15 a ticket to mix with friends and socialise on a Thursday evening. “We want to be forums for adult conversations: what does it mean if we extend life by two or three times, or what does it mean if we have performance enhancing drugs that are for mental performance?” Bartels said. “It would have been interesting to talk about nuclear policy before the bomb. Life sciences and genetics are producing all sorts of amazing bombs, and where do people have a chance to understand the science but also have adult conversations about this?”

These debates on big societal issues have helped SCMs to attract additional visitors. The Museum of Science in Boston, USA, engaged around 30 million people in a nanotech outreach project supported by the National Science Foundation. Now, it is pursuing a similar project on synthetic biology. “This paternalistic stance [of the PUS

approach] has been criticised by many who suggest that applying science and technology to society requires scientists to understand things about personal and social values and priorities that publics know and scientists may be ignoring because they are so deeply embedded in the scientific culture”, explained Larry Bell, Senior VP for strategic initiatives at the Boston Museum. The new synthetic biology project has two main activities. First, museum educators are matched with a scientist so they can work together and learn from each another. Second, the museum provides a forum where visitors take part in a structured dialogue in small groups about a question: “should we engineer the mosquito?” is one example. Bell notes that funding comes from the NSF, not the Department of Education: “The target audience includes both the informal educators and the scientists. The goal is for both of these groups to learn how to do a better job of engaging the public in



**Figure 3. View into the The DNA visitor laboratory at Deutsches Museum in Munich.**

© Deutsches Museum, Munich, Germany.

these kinds of dialogues and discussions”, he said. “We think scientists will make better decisions about their own work if they have these kinds of conversations with the public”.

Similarly, the laboratories in Munich, San Francisco and elsewhere are not just a new way to teach the public. Researchers can spend time talking to visitors, answering questions and gaining insight into the potential social implications of their work. “We are talking about a small number of students, but the lab is changing the practice of research at universities”, Bandelli said. He noted that scientists who are more aware of public views and concerns are better at writing grant proposals, for instance. “At the NHM, it was observed that researchers who engaged with the public were able to better contextualise their research: i.e. as a result of the conversations with the public they were able to build stronger arguments for the societal value of their research which

often has a very, very narrow scope”, he explained. “Researchers who, for instance, study some very specific aspects of a small insect in some remote island were able to broaden and justify the societal significance and relevance of their research in a much stronger way”. He added: “Similar observations were done also during the JCOM masterclasses in Trieste where researchers in theoretical physics realised how the dialogue with the public allowed them to build much better narratives about the value of their research. As a consequence, they feel much more confident in writing competitive grant proposals where, nowadays, justifying the societal relevance of research is essential”.

**T**here are other benefits for scientists that come from public engagement of this kind, including just enjoying talking about science. “I started doing public engagement because of the Science Gallery”,

said Aoife McLysaght, a geneticist at Trinity College Dublin, Ireland, who participated in the Dublin Science Gallery. “I didn’t know what public engagement meant before that and I hadn’t realised it would be such fun”. McLysaght is clear that she is not trying to encourage people to “do science” or to persuade people to her point of view. “People can make up their own minds as long as they are informed. I’m trying to inform them”, she said. McLysaght has since written for newspapers and contributed to radio programmes in Ireland and the UK.

When Science Gallery opened in Dublin in 2008, it used the arts to attract visitors who might not otherwise visit a science museum—especially teenagers and young adults who might not consider science a key interest. Since then, Science Gallery has offered researchers at the adjoining Trinity College the chance to try out public engagement and experience the public’s reaction when they talk about what they do. It



**Figure 4. Visitors at the *Infectious* Exhibition at Dublin Science Gallery.**

© Science Gallery at Trinity College, Dublin, Ireland.

welcomes emerging and controversial science and operates via an open call for exhibits around a theme. One of its earliest exhibitions was the *Infectious* (2009) show (Fig 4). “It was truly trans-disciplinary, with artists, technologists, immunologist and economists”, explained gallery founder and director Michael John Gorman. “We find the real magic happens when scientists come and are willing to discuss how we don’t have all the answers, especially when it comes to ethical or social questions related to science”.

Immunologist Luke O’Neill in Trinity College Dublin was involved in Science Gallery from the start and was a curator for *Infectious*. He was initially sceptical about mixing the arts and sciences: “In my mind, and for many of us, they would have been quite distinct”. But, he was struck by how positive the public reacted to this mix. “There was also hard core science—it was very important to me to have real science

too. We had people extracting their own DNA. People’s faces lit up when they saw the DNA spooling out of solution. It really got their imagination”, O’Neill recalled. “Then we examined a gene my lab had discovered linked to malaria, called Mal. This allowed visitors to log-on later and see their risk of malaria”. He also took many lessons home himself. “I thought I wasn’t too bad at communication, but then I realised—hang on a minute—there is a better way to do this and engage with the public”.

He lists three valuable experiences from his interaction with the gallery. First, he learnt how to pitch information, describe things in a simple way and be less didactic. Second, it was an eye opener for him that real science could be performed in the gallery. Third, PhD students and postdocs from his laboratory can work in the gallery as demonstrators, talk to the public and put science communication on their CVs. “It is

really beneficial for getting our students and postdocs and helps them do a better job of science communication”. He has since been involved in more shows and sees the mission as making the science interesting, whatever way you can. The gallery sometimes does this by tackling controversial issues, but O’Neill sees benefits in its fusion of science, arts and design.

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“This is about seeing science not in isolation, but as part of a broader cultural matrix”, Lowenstein commented with regard

to the Science Gallery. “Science Gallery is a meeting place for ideas, and it allows companies to connect with a future workforce”, Gorman explained. “30% of people coming into Trinity College have been to the science gallery and 8.5% of incoming students directly attribute their experience of the Science Gallery to studying at Trinity”. One of its big achievements has been its ability to access a demographic that SCMs usually struggle with: teenagers and early tweens, who tend to avoid places seen as being for children.

Nonetheless, children remain a major target audience for SCMs. CosmosCaixa, with its huge exhibition hall and a drowned rain forest with live birds and mammals, can evoke a sense of awe in children. Similarly, Heureka, in Finland, is proud of making even complicated phenomena understandable to a 10-year-old child. The centre is ushering in major changes, but will stay focused on kids. “People want to do things with their hands or participate in science, making it part of their everyday life. Introducing these environments is one big shift for science centres”, said Tapio Koivu, CEO of Heureka. “Kids need to learn about science and understand it can be a cool thing”. The centre invites researchers to come and disseminate results or get involved in interesting projects. One current attraction is rats that

play basketball: actual research being done by University of Helsinki biologists to demonstrate reward-conditioned behavioural changes.

In the 21<sup>st</sup> century, SCMs are seeing increased competition for attention from the Internet and the lure of shopping and entertainment centres. One response to this has been for SCM directors to favour blockbuster exhibitions on crowd pleasing topics, such as dinosaurs. Another move has been towards more temporary exhibitions of various formats. The Science Museum in London is currently running the *Cravings* exhibition on obesity and the research into it. The exhibition combines stories, objects, videos, animations, images and interactive elements to communicate how appetite is shaped by interconnected mechanisms regulated by the brain, the gut and gut bacteria. Such dynamic exhibitions are very different from the original object-centred approach of the original Science Museum set-up in 1928.

*Cravings* is not a public health message, which would be “a major turn-off”, explained Felicity Paynter, contemporary science manager at the Science Museum. “We want visitors to ‘feel’ the exhibition rather than ‘learn’ it”. Paynter said that the exhibition aims to be revelatory and to inspire self-examination. “Exhibitions are more experiential now. They involve artists more and they mix up the interpretation”, she said. “We also provide unforgettable social experiences”.

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Museums and science centres can still offer a range of phenomena and specimens that simply cannot be found in schools or on the Internet. “You can learn about blue whales in school, but you can only see one if you go to a museum or science centre”, commented John Dillon, education expert at the University of Bristol, UK. Moreover, SCMs can inspire. “Scientific vocation is certainly not the only mission we have with kids, but it is one of them. We need more scientists in Europe, but also responsible citizens”, López Verdequer said. The mixed goals of educating and stimulating interest in children, engaging scientists and adults in conversation and entertaining visitors has led to an industry-wide rethink of what an SCM should look like and how information is presented. And as the Science Gallery in Dublin shows, there is still room for different models, quirkier approaches and innovation. What the best 21<sup>st</sup> century SCMs will look like is a work in progress, but it will be very different from the object-centred museums of yesteryear.