Galaxy Makers Exhibition: Re-engagement, Evaluation and Content Legacy through an Online Component

Best Practice

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For the Royal Society Summer Science Exhibition 2016, Durham University's Institute of Computational Cosmology created the Galaxy Makers exhibit to communicate our computational cosmology and astronomy research. In addition to the physical exhibit we created an online component to foster re-engagement, create a permanent home for our content and allow us to collect important information about participation and impact. Here we summarise the details of the exhibit and the degree of success attached to the online component. We also share suggestions for further uses and improvements that could be implemented for the online components of other science exhibitions.

Introduction

Every summer, a carnival of science descends on London's Royal Society. Exhibitors from universities and science organisations around the UK are selected to display their world-leading research to the public at the Summer Science Exhibition. In 2016 the week-long festival featured twenty-two curated exhibits as well as an extensive programme of talks and activities for all ages.

Our exhibit, Galaxy Makers, created by fifty members of staff and students from Durham University, showcased the wonderful imagery and science of a recent revolutionary set of computer-simulated universes — the EAGLE simulations (Schaye et al., 2015) (Figure 1)[1]. By using the dazzling images and movies produced from the simulation we were able to draw in the younger generation and capitalise on their love of all things digital. We could demonstrate that the same tools used to make their favourite video games also have a use in world-leading research and hopefully inspire them to pursue a computing-focused career in scientific research, or some other field. In an effort to inspire both young and old audiences we built Galaxy Makers as an interactive educational experience that combines science, technology, and art.

Why communicate computational cosmology and astronomy?

Computational cosmology and astronomy allow us to address fundamental questions about the Universe, from how it formed to its eventual fate. The question of origins is relevant, and thus of interest, to the wider public. In other disciplines, scientists can run experiments to gain new information; however, we do not have this luxury — there is only one Universe! Therefore computers have become the laboratory bench

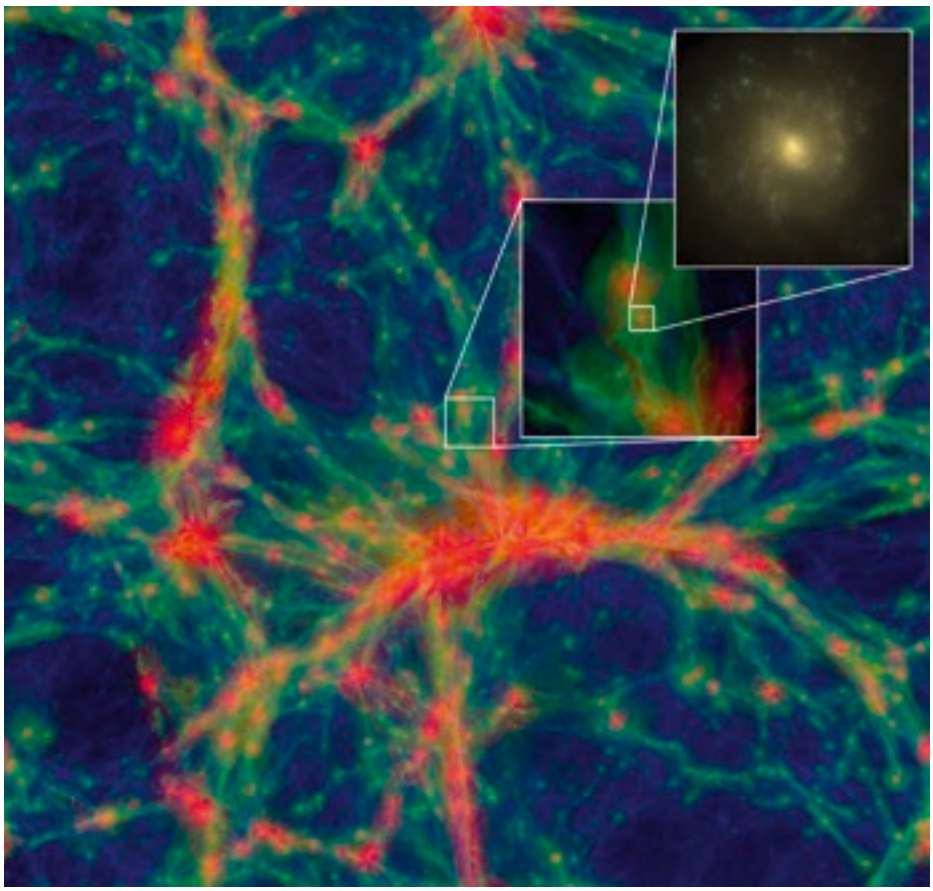

Figure 1. *EAGLE (Evolution and Assembly of GaLaxies and their Environments) is a simulation aimed at understanding how galaxies form and evolve. The simulation took three months to run on a supercomputer and hence is highly detailed; the above picture shows a zoom-in from the cosmic web to an individual galaxy. Credit: EAGLE Project Consortium/Schaye et al.*

Figure 2. *Three machines were presented at the Royal Society Summer Festival: the Universe Creator (left); Tour the Cosmos (top right); and Galaxy Maker (bottom right). Credit: Josh Borrow*

of cosmologists and astronomers, in which simulated universes can be created and "observed" again and again. This technique of simulation allows cosmologists to develop and refine their ideas about the physics that shapes galaxies, is a great application of computational methods, and is a popular way to introduce such methods to the public. Furthermore, astronomical imagery is inspiring and captivating and is therefore incredibly useful for cultivating interest. Computer simulations can produce fantastic animations of the large-scale Universe that are impossible to recreate from observational data; we can watch how galaxies form, speeding up billions of years of cosmic evolution into a few seconds of video.

The UK's school curriculum is now being updated to introduce programming, but this is not the case everywhere and it is important that we keep "pushing from the top" to ensure that the public is informed that computational methods are a key aspect of research in many fields. It is not the case that all scientists wear a lab coat, wield a flask, and use a pencil, but this is often the public's perception. Computational cosmology and astronomy lets us show the younger generation the wide range of possibilities that learning the initial concepts of programming can lead to.

The exhibition

Our week-long exhibition centred on the display and use of three machines — the Universe Creator; Tour the Cosmos; and Galaxy Maker (shown in Figure 2) — which used computer technology to allow users to explore and "create" galaxies. The machines were available over 64 hours in total. The 14371 visitors to the exhibition included the media, school groups, families, invited guests like Fellows of the Royal Society, and other members of the public.

The machines were worked to nearly full capacity for the whole week, with four to six demonstrators at a time constantly engaging with participants. By recording how many times each machine was used, we established that around 2000 people used the machines, with still more approaching the stand and engaging in conversation with the demonstrators about the project. Overall more than 3000 individuals engaged directly with the Galaxy Makers exhibition.

The Galaxy Maker — what is a galaxy?

Our Galaxy Maker activity (Figure 2) allows participants to make their own "holographic" galaxy by following various galaxy model instructions (or "recipes") to weigh out the components (or "ingredients") of different galaxies. After measuring out these components and pouring them into the various chutes of the Galaxy Maker, a projected movie appears in a pyramid, giving the illusion of a hologram. Some of the messages we aim to portray with this activity are that galaxies are vast collections of stars, gas and dark matter and that galaxies come in different shapes and sizes.

Tour the Cosmos — what happens during the life of a galaxy?

Our virtual reality Tour of the Cosmos (Figure 2) allows participants to submerge themselves inside our computer simulation using the virtual reality hardware Oculus Rift. This unique experience flies the "passengers" through space and time while the audio commentary talks them through some of the key events in a galaxy's creation.

Create a Universe — how do we simulate galaxies?

Our Universe Creator activity (Figure 2) enables participants to experience what it is like to run their own computer simulations. The participants use various knobs and levers to make their own assumptions about various aspects of astrophysics. For example, it is possible to change the amount of energy released by supermassive black holes and the amount of dark matter in the Universe. Once these decisions have been made the computer simulation is projected inside a large pyramid, giving the illusion of a hologram. If these assumptions are unrealistic the participant may end up with a universe that is too hot or perhaps one containing no galaxies at all! Through this, participants learn how scientists use similar experiments to understand how the Universe works.

The online component

During the in-person exhibition, attendees who created a galaxy or universe on our computers were given small pyramids (Figure 3) which could be used to view the "hologram" movies at home on a smartphone or tablet through the Galaxy Makers website (Figure 4)[2]. Users were given a unique code that represented their universe/galaxy to type into the website. On entering the code, the user is provided with a movie which, when played through their smartphone or tablet with the pyramid attached to it as shown in Figure 3, plays the "holographic" universe they created as a short movie. Additionally, further information is provided about their universe or galaxy so they can learn more about what they have created. The website also allows anyone who wanted to continue learning or could not attend the exhibit in person to learn more about the science and make new universes and galaxies.

Figure 3. *One of the hologram pyramids in use with a smartphone. Note the floating simulation. Credit: Josh Borrow*

The pyramids were an incredibly cost-effective way of ensuring that attendees re-engaged with our content. Google Analytics was set up on the website to analyse its usage; this showed that of the people who were given a pyramid, 40% (around 700 people) entered the website with 75% of those making repeat visits. In total, 898 unique users visited the website during or soon after the exhibition (as of 19 July 2016) from 22 different countries, with the majority of non-UK users being directed there through social media. Existing University websites related to the project also saw an increase in traffic during the exhibition period with the EAGLE project web pages having a 20% increase in page-views.

Creating the parallel online component of the exhibition required relatively little effort, needing only two team members. However, the benefits were many:

1. We re-engaged with hundreds of people;
2. We ensured that our content had a meaningful, lasting presence;
3. We created educational resources for future use;
4. We could obtain vital statistics on participation and impact;
5. We created online advertising for the institution;
6. We could engage people who could not visit Summer Science in person.

Re-engagement

As well as reinforcing important concepts, re-engagement allows interested participants to gain deeper insights into the subject matter. We aimed to achieve this re-engagement through our website, by providing more information for interested readers through text and extra videos. This was particularly important for the Royal Society exhibition because participants only had a very limited time in which they could engage with the exhibition, given the extremely busy nature of the festival.

As many users visited the website more than once and engaged with the content at least three times, we are much more confident that we have made a lasting impression on hundreds of people than we would be had we only utilised our in-person opportunity for engagement.

A record of materials

As with all exhibitions, a large amount of effort was put into developing materials; in our case, these were the videos for the exhibition computers. It would have been a huge shame, both for the exhibitors and the public, if those materials had only been available in one place at one time.

There are plans to show the Galaxy Makers exhibit at various events in the future — even so, the range would have been extremely limited compared to a web-based exhibition. As our analytics have shown — with our visitors originating from 22 countries — there is also a worldwide audience for public engagement materials that should not be neglected and who cannot always be reached in person.

Further education

As previously discussed, our online experience allows us to engage with a considerably larger audience and expose them to more material than the in-person exhibit alone. In the future, we plan to produce educational resources for use by teachers with the Galaxy Makers website so that classroom users can engage with the content as well. Because the Galaxy Makers website was developed in parallel with the in-person exhibition, developing the educational resources is considerably more straightforward than it would have been had we needed to "convert" the exhibit into a classroom-friendly format.

Measuring and recording impact

It is becoming more and more important to collect statistics and metrics to quantify the impact of outreach activities. With an in-person exhibition, particularly when it is incredibly busy, it can be difficult to collect useful metrics and feedback. This means that public engagement evaluation reports can only consist of very simple, broad information such as numbers of people reached.

Online, it is a different story, thanks to analytics programmes like Google Analytics[3]. Google Analytics allows us to study user behaviour and flow, as well as more basic metrics such as the number of users on our site. Furthermore, this includes details of the region and country the user is visiting the site from, their age bracket and the number of times an individual visited the website. These insights cannot be directly translated onto the exhibition but they do give us key insights into the most popular aspects of the exhibition, show us what users were most engaged by, and help track the long-term health of the exhibit.

As well as more information about the content of the exhibit, the Galaxy Makers website will allow us to catalogue the progress of the in-person exhibit with photos, updates and supplementary information about the exhibit that will be incredibly useful when approaching potential exhibition hosts or other organisations, or simply discussing our experience. The website allows us to give our metrics immediate context through the associated images and online exhibits that are available there.

The power of Social Media

Social media is often over-appreciated in public engagement communities. It is quite clear that tweeting about research is no replacement for getting out there and directly engaging with the public. This does not, however, prevent social media from being a highly useful tool.

Two months after the in-person exhibition had ended, an independent game developer found the Galaxy Makers website and tweeted it to his 5000 followers with the message "A wonderful lesson for all the #gamedev-s out there on how to gamify science." This tweet gave the website its single largest traffic spike (there were over 1100 engagements with the tweet) — a spike bigger than any during the exhibition.

Even now, users of the website are still sharing their experiences on Twitter and other social media platforms. Whilst some may be tired of the incessant cries of "use social media" from public engagement professionals, interactions like these show us just how powerful social and new media are, and just how important it is to cultivate relationships on these platforms. This sharing has allowed our content to be continually reused and allows it to remain visible. See Table 1 for metrics.

Advertising

The website proved useful during the in-person exhibits for advertising the exhibit to members of the public through social media. The ability to play around with an online experience before making the trip to the exhibition is certainly an interesting concept from an advertising point of view; this is a clear improvement over the traditional photos of people milling around the exhibition centre.

Further potential of online material

In some ways, we did not fully utilise our opportunity to collect information about the exhibition through the online component. For example, we could have produced a questionnaire on the website for qualitative and quantitative feedback. Consequently, we had a lack of participant evaluation, although some responses were collected through social media and email.

Another interesting possibility would have been to include participant information in the code that was given out to attendees. This could have been used to track which groups were most interested in the website and could have been made more interesting still by giving out different codes to different demographic groups (for example splitting by gender or age group) and tracking their use on the website. Including this information would have significantly bolstered our demographic data and is certainly a compelling opportunity for future exhibitions.

Social media could also have been used to greater effect during the Galaxy Makers exhibition. For example making the Twitter handle visible on all of our materials would have increased activity. Additionally, had the website received some attention from

Metric	Exhibition (1–17 July)	Lifetime (to 1 December)
Sessions	1580	3603
Users	892	2270
Page-views	5639	12486
Average Session Duration	3:18	2:47
Sessions by Return Users	43.5%	37.0%

Table 1. *Metrics have continued to grow over time, showing that the content produced for Galaxy Makers is continuing to be used. A large number of these interactions post-exhibition are due to users sharing their experiences on social media.*

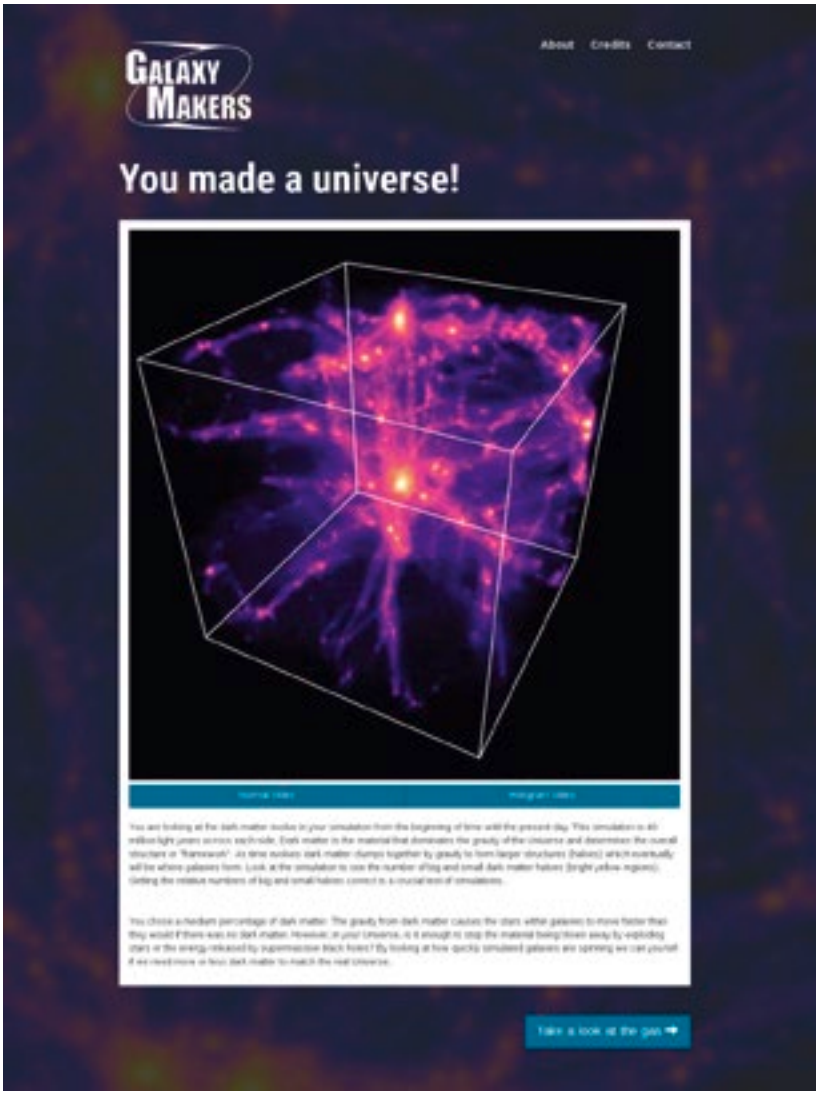

Figure 4. *The Galaxy Makers website. This is the view that users are presented with after creating a universe.*

more high-profile social media users, the engagement with the website would have certainly been higher. In future we will work harder to cultivate these relationships.

Conclusion

Much like some of the most interesting scientific breakthroughs, the success of the online exhibition came as a real surprise. The fact that nearly 40% of those who received a hologram pyramid went away and re-engaged with our content was astounding. Our expectation was that around 10% of users would go away and visit the website. It is clear that the younger generation loves all things digital and that this is a productive route to go down to foster re-engagement.

The material created for Galaxy Makers is already having a much farther-reaching impact than an in-person exhibition could have. We have been contacted by other universities who are using Galaxy Makers for their undergraduate labs, schoolteachers who are interested in using the project, and of course users stumbling across it on the internet. The content created for the Galaxy Makers exhibit is now also being commissioned for permanent display at Leiden Observatory.

When creating an exhibition, a parallel online experience is certainly something to consider. With only 4% of our total team (one person out of 25) working on the website, we have managed to re-engage hundreds of attendees and gain a large amount of valuable data for evaluation. We have also created a lasting, permanent home for our content that is now no longer relegated to a one-week experience; it is free to be shared around the world forever.

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Notes

[1] More information about the EAGLE simulations and its creators are available here: http://icc.dur.ac.uk/Eagle/

[2] Galaxy Makers website: www.galaxymakers.org

[3] Google Analytics: www.analytics.google.com

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Biographies

Chris Harrison, following a PhD and post-doctoral position in Durham, UK, is now a Research Fellow at the European Southern Observatory. He uses multi-wavelength observations to establish how galaxies formed and evolved with an interest in the role of supermassive black holes. Chris also works in the new ESO Supernova Planetarium & Visitor Centre in Munich.

Josh Borrow is a first-year PhD Student at the Institute for Computational Cosmology, Durham University, and is a keen communicator of science. He runs the local Café Scientifique and built the website for Galaxy Makers.