

The power of YouTube



Brady Haran

As one of the presenters of the hugely successful Sixty Symbols series of *YouTube* science videos, **Philip Moriarty** describes his experiences in front of the camera and how they have transformed his ideas about bringing physics to wider audiences

“No, put the pen down. No equations.”

“But. But. But...”

Asking a physicist to forgo mathematics when explaining a particularly challenging concept is always going to lead to some consternation – as is obvious from my response above to film-maker Brady Haran’s request. And this wasn’t the first time that we’d argued this point. Haran put down his camera and made his point. Again.

“Start writing equations and you might as well speak in a completely different language – you’re going to lose most of the viewers.”

Sighing, I countered that explaining physics without including at least a sprinkling of maths was selling the viewer short. “Brady, it’s like the difference between listening to a guitarist playing alone compared to the music they create as a member of a band,” I argued. The interplay of the instruments completely changes the perception and impact of the

song, I reasoned, adding that maths similarly adds that extra dimension to the physics. (I’m rather keen on the links between music and physics and maths – see box on p32.)

But Haran was having none of it. “No, it’s like explaining Shakespeare to a non-English speaker,” he replied. “Sure, they miss out on the true beauty and cleverness, but at least you can tell them the story and why it’s so important. Stubbornly reading them *Hamlet* in English will achieve nothing.”

This type of exchange is par for the course when making videos with Haran – the exceptionally talented and remarkably prolific film-maker and journalist behind a slew of very successful science-related *YouTube* channels. His films include the physics-focused Sixty Symbols series, Periodic Videos (covering all 118 known elements), Numberphile and Computerphile (about mathematics and computing, obviously) and the forerunner of them all – TestTube

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The picture above shows the author making a video with Brady Haran for *Physics World*, which you can watch in our digital edition

Where heavy metal meets maths (and physics)

Jeremy Kaigreen,
available at monstersofgrok.com

If there is one thing I have learned from the last 15 years of teaching undergraduates, supervising PhD students and co-ordinating physics postdocs, it's that a Venn diagram of physicists and fans of heavy-metal music (and its plethora of sub-genres) has quite a large overlap. I'm certainly not the first to have noticed the link – just visit the excellent *Monsters of Grok* website to see the huge range of T-shirt designs that rather niftily combine the names of famous physicists and the logos of popular rock and metal bands. I particularly like the Gauss/Kiss design, the Newton/Iron Maiden hybrid and the Sagan/Slayer crossover (see above).

Given this connection, I regularly try to brow-beat Brady Haran into doing videos that incorporate some aspect of metal into our descriptions of maths and physics. For example, we have made a music video on the Numberphile channel with the multi-talented Dave Brown, which involved writing and recording a “metal” song whose riffs, rhythms, lyrics and “sound effects” have been derived from the digits of the golden ratio, ϕ . Meanwhile, Sixty Symbols has videos on the physics of mosh pits, and the relationship between the wah-wah pedal used in rock guitar and Fourier analysis.

Another idea that we are developing (and which the UK's Engineering and Physical Sciences Research Council has agreed to fund) is a song and video based on the Schrödinger equation: what better *aide-mémoire* for students studying quantum physics than to have it as part of the lyrics to a metal song? In fact, the response to the metal-physics theme has been extremely encouraging: our videos have so far attracted almost half a million views and the comments on them have been overwhelmingly positive. Their aim is not just to preach to the converted, but to encourage an interest in maths or physics among those who may not have thought about the subject before.

We've certainly made at least one convert who posted this comment under the golden-ratio video: “I think you just tricked me into liking math. Clever bastards.”

(“videos behind the scenes in the world of science”).

Haran's motivation for making videos has always been to connect viewers with scientists much more naturally than is the norm with traditional media – to provide a “window” into a scientist's world. His videos are raw, honest and direct, lacking the “corporate sheen” that so many science films veer towards. It is an approach that has proved incredibly popular: at the time of writing, the subscriber base for all of Haran's channels is over two million, and his videos have been viewed a total of 155 million times – and rising fast. Haran has the uncanny ability to know exactly what will work, and what won't, in the videos he makes. (And he almost always wins in spats like the above.)

Daunting and rewarding

Having worked with Haran since 2009 and featured in some 45 of his videos, the experience has transformed my ideas on public engagement and outreach. A big challenge when communicating physics concepts and ideas via *YouTube* is the diversity of the audience, which ranges from academics, sub-

ject experts and teachers to students, school pupils and those with no background in science at all but an intense interest in it. And from comments left beneath the videos – as well as via social media, e-mails and face-to-face conversations – we know that viewers range in age from five to at least 75.

This wide spread in backgrounds and ages, which is very different from that in a typical university lecture theatre, means that making *YouTube* videos is extremely rewarding but also rather daunting. Just how should we pitch our explanations? To make matters worse, the first time my colleagues or I get to see the final video is generally only once it has been uploaded to *YouTube*. Our lack of involvement in the editing process makes some sense – it lets Haran get his films out quickly and give them a tighter focus than if we were constantly sticking our noses in. But because the subscriber base for each of Haran's channels runs into the hundreds of thousands, once we watch the video it can easily have already picked up thousands of views and hundreds of comments. Any verbal slip-ups, perceived or actual, can be rapidly subjected to intense scrutiny by the *YouTube* audience. And they take no prisoners.

But as Haran and my colleagues at the University of Nottingham describe (see box on p34), the benefits of communicating physics via *YouTube* generally far outweigh the occasional discomfort of a small number of negative viewer comments. They also compensate for the irritations of the “trolls” who populate any online forum, and the many e-mails we receive written in various weird and wacky fonts – almost always with a liberal smattering of BLOCK CAPITALS – which claim that the correspondent has discovered a new and astounding grand theory of everything and that [insert world-renowned physicist of choice] had got it all wrong.

Nagging reservations

Yet in spite of the benefits it brings, I do have some nagging reservations about online education, both via *YouTube* channels and through massive open online courses (or MOOCs) (see “the MOOC point” pp43–46). I think we need to temper our enthusiasm for online education with some healthy scepticism about the extent to which actual learning is taking place. Enticing and engaging viewers is exceptionally important (and fun), but learning is a complex and messy business that needs at least as much effort from the student as from the teacher. Indeed, Frank Noschese – a physics teacher at John Jay High School in New York – has gone as far as describing education via video (including the work of the extremely popular Khan Academy channel) as “pseudoteaching” because students do not actively engage with the material.

This is obviously a deeply contentious issue, particularly among the growing *YouTube* education community (and I'll return to it later). But what's interesting is that when I asked Haran about his approach to video-making, he said he did not label his online videos as education, entertainment or even as “edutainment”. According to Haran, his main mission is simply to “find out interesting stuff and tell

other people about it". In other words, Haran sees his videos as essentially a form of journalism, which is not surprising given that he worked as a journalist both for the BBC and the *Adelaide Advertiser* in his native Australia before moving to Nottingham in 2002.

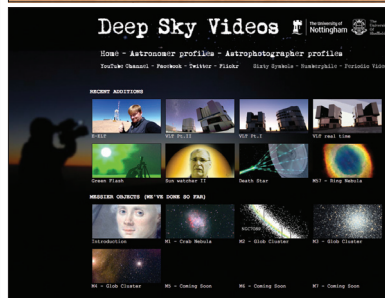
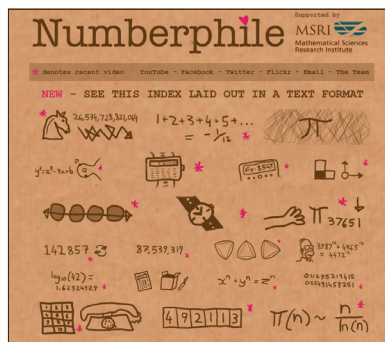
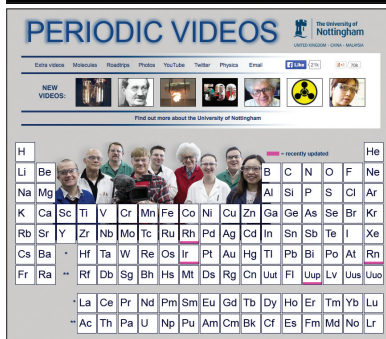
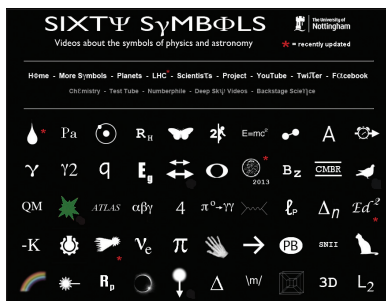
This journalistic bent gives rise to a none-too-subtle tension when making *YouTube* videos in the Haran style. As academics, our approach to explaining a concept is arguably the polar opposite of what journalists like to do: we prefer to painstakingly lay the groundwork, carefully building up an explanation in as precise a fashion as possible, with a sometimes rather too intense focus on the minutiae of the science. Journalists instead want to get to the headline as quickly as possible – to grab the audience from the start and compel them to read, watch or listen to their story via a strong “hook”. It took me some time to get used to this approach, and it can still be uncomfortable to let go of the detail, particularly when you know that at least some of the Sixty Symbols audience will call you out for it in the comments section under the video.

Indeed, the ability of viewers to give instant feedback to *YouTube* videos is both a blessing and a curse. You're glad that people have responded to your videos and want to read what they have to say, but you have to be braced for the worst. The universal advice regarding *YouTube* videos, which is to ignore the comments entirely, can be pretty well impossible to follow. I too usually disregard the wise counsel of PhD students and postdocs in my research group, many of whom think *YouTube* comments are nothing more than the condensed collective stupidity of humanity.

Haran's channels tend to buck this trend: the comments can often prompt a well-informed and, at times, quite erudite discussion. Still, you do have to learn to put up with some unpleasant stuff. My astronomy colleague Meghan Gray, who has featured in many of Haran's videos, points out that there is an infuriating gender bias that often taints the comment threads, with the comments she gets often being far more focused on her appearance than those received by male colleagues. “Whether the intention is to flatter or be nasty, it can be uncomfortable and unpleasant, and the scientific message becomes secondary,” she says. “Fortunately, other viewers will tend to quickly censure those who express views of this type, which is heartening – we do have some lovely fans.”

Getting the balance right

Although Haran is not a scientist by training, and has no formal education in physics, chemistry or mathematics beyond secondary school level, he has an abiding interest in – and passion for – science and mathematics. This plays a pivotal role when it comes to engaging the audience. “Perhaps my most important role is to represent the viewers,” he says. “I try to think about what they'd ask if they were in the room. Not necessarily what the scientists want to say, but what do the viewers want to know? Nothing makes me happier than when a viewer writes to say ‘Thank you Brady – that was just the question I was hoping you would ask next!’”



For us academics on the other side of the camera, however, this aspect of film-making can be daunting: whatever “narrative” we may have developed for a particular topic can be shot down in flames by a single unanticipated and perceptive question from Haran within seconds of the record button being pressed. “We don't know what Brady is going to ask, and he asks some really good, pertinent and challenging questions that can leave you a bit flummoxed,” says my Nottingham colleague Ed Copeland, a cosmologist whose appearances in Sixty Symbols and Numberphile have rightfully won him a dedicated following on *Facebook* and *Twitter*.

Copeland admits getting the balance right is “very challenging” – to make explanations neither too verbose and technical nor too short and shallow. “Brady plays a crucial role there, pulling me back from getting too technical but giving me enough leash to discuss some technical aspects,” he says. Even Roger Bowley, an emeritus professor in physics and astronomy at Nottingham who's been a member of the Sixty Symbols team right from the start, admits that “simplifying complex ideas into a single, logical storyline that can be understood by the general public” is the most challenging aspect of the process.

Powerful impact

The key to a successful *YouTube* video, according to Mike Merrifield, an astronomer at Nottingham, is to put yourself in the position of the viewer and avoid confusing or jargon-filled explanations. “You need to simplify things to a point where they are understandable in this format without compromising the underlying science”, he says. Yet keeping things simple without fundamentally compromising the description of the science is an exceptionally difficult balancing act. Indeed, last year I decided I wasn't getting this balance right and grew ever more concerned about the perception we were creating by trying to put across physics in easy-to-digest, video clips lasting just a few minutes. Physics is not easy and we shouldn't pretend it is – it needs hard work

Let me edutain you

Some of the science channels created by film-maker Brady Haran – but do they really help students to learn?

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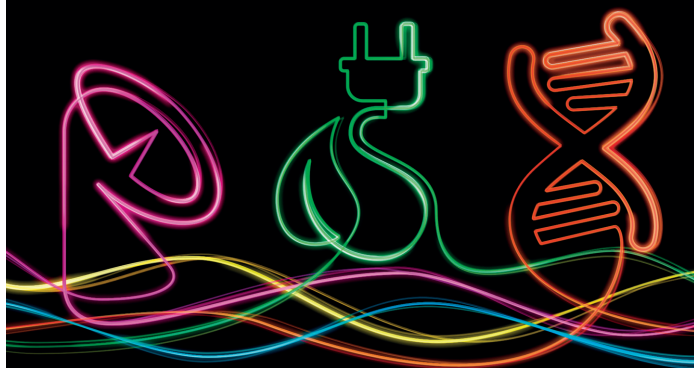
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YouTube science – from those who’ve taken part



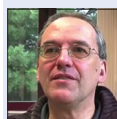
Laurence Eaves, semiconductor physicist
Appears in: [Sixty Symbols](#), [Numberphile](#)

It’s rewarding that people come up to me in a railway station, museum or cinema foyer and tell me that they are fans of our videos. It’s like Alvy Singer being recognized by a fan in Woody Allen’s *Annie Hall*!



Meghan Gray, astronomer
Appears in: [Sixty Symbols](#), [Deep Sky Videos](#)

It’s wonderful that by chatting to Brady Haran for half an hour in my office, I can reach tens of thousands of people around the world, many of whom kindly take the time to get in touch and express their appreciation.



Mike Merrifield, astronomer
Appears in: [Sixty Symbols](#), [Deep Sky Videos](#), [Backstage Science](#)

A rewarding aspect of the *YouTube* experience is when the DHL delivery man says “Nice videos, by the way” as he’s leaving.



Tony Padilla, cosmologist
Appears in: [Sixty Symbols](#), [Numberphile](#)

Making videos about stuff you aren’t as expert on as you’d like to be is challenging. When you really stray away from home, you have to put in much more preparation time, and it can be a bit like revising for an exam. And the examiners are the viewers. They don’t miss a trick.

but the rewards are great if you put the effort in.

When the great physicist Richard Feynman was asked to describe how magnets work, he made an exceptionally important point about explaining physics to a general audience. Feynman believed that not everything can be, or should be, reduced to an explanation of just a few minutes and a simple, but potentially misleading, real-world analogy. As he famously said when asked to briefly explain his Nobel-prize-winning work on quantum electrodynamics: “Listen, buddy, if I could explain it to you in a minute, it wouldn’t be worth the Nobel prize.”

To me, Feynman’s comments illustrate the inherent tension between the journalistic and academic approaches to science communication – and it is a point that I have debated at length with Haran and a number of other colleagues involved in *Sixty Symbols*. Indeed, so concerned was I at having misrepresented important physics in a couple of videos that last year I decided I would bow out of contributing to *Sixty Symbols*. What changed my mind was a message from a 16 year old in Dublin who said that the *Sixty Symbols* videos are what had inspired him to pursue a career in science. Since watching them, he had ended up getting an A in his Junior Certificate exam, having previously scraped Bs and Cs.

Perhaps it’s the Irish connection (I did my undergraduate degree and PhD at Dublin City University) but I found that message affecting and humbling. When *Sixty Symbols* has that type of influence, I can live with a few qualms about the nature of *YouTube* edutainment. ■