SPORE* SERIES WINNER

The Periodic Table of Videos

A YouTube project, started on impulse, has become a chemistry resource in daily use in classrooms and homes worldwide.

Brady Haran and Martyn Poliakoff†

"I know nothing about hassium. Shall we make something up?" A somewhat unusual opening, but what else can one say when trying to film separate videos about each element in the periodic table?

Our project was devised by Brady Haran, a BBC-trained video journalist, who had spent a year filming University of Nottingham scientists at work (*1*). Inspired by his time working with chemistry researchers, he suggested making a periodic table of videos (PTOV, www.periodicvideos.com), and within days, filming had begun.

The approach was unconventional: no scripts or storyboards, but a passionate desire to appeal to a general audience. An effective format rapidly evolved: Haran interviewed "The Professor" (Martyn Poliakoff) or lanthanide and actinide chemist Stephen Liddle in their offices, with separately filmed laboratory experiments carried out by chemists Peter Licence or Deborah Kays. More ambitious experiments were performed outdoors with the help of long-suffering and usually silent technician Neil Barnes. A key decision was made to avoid collaboration between the participants; each person filmed sections alone with Haran, and no vetting took place before "publication." The first time anyone saw the finished videos was when they had been edited and uploaded to the video-sharing Web site YouTube (*2*).

The result of this unusual process was a collection of videos (*3*) with spontaneity and freshness—a feeling of "live" chemistry. Collaborating with trained journalist Haran resulted in professional production values and editorial standards. Even before all 118 elements had been finished, PTOV's approach had caught the popular imagination. Stories appeared in the UK national media and on blogs worldwide (*4*, *5*). By the end of 5 weeks, when all 118 videos were finished, PTOV already had a strong subscriber base (*6*). The surprise was the breadth of the audience, which ranged from Nobel laureates to a 6-year-old boy in Nova Scotia. Also, our audience clearly expected more. As one viewer said, "I don't care what they do, as long as they keep making videos!" A spontaneous project was to become an ongoing enterprise. So, how to continue?

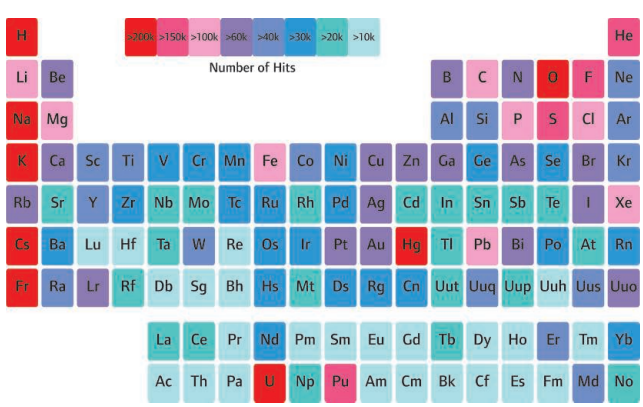
At the site of hassium's synthesis. Haran and "The Professor" shoot the updated hassium video at the GSI (Gesellschaft fuer Schwerionenforschung), Darmstadt, Germany, where element 108 was first synthesized.

An obvious route was to update some of the more hastily produced videos with more experiments, new information, and, in the case of hassium, a visit to Darmstadt, where the element was synthesized (see the photo, above). Subtitles were added to the element videos to make them easier to understand for non-native speakers of English, and an additional opportunity was identified: linking chemistry to topical events. Themed videos were produced about the 2008 Olympic Games (gold, silver, and bronze); the announcement of Nobel Prizes; and, more lightheartedly, the chemistry of pumpkins for Halloween. Soon PTOV had almost become a chemical news channel, covering events such as giving the name copernicium to element 112 or the *Science* paper in which helium was disguised as $H^{4.1}$ (*7*).

As of May 2011, the site boasted 320 videos with content covering molecules as well as elements, and each new video attracted several thousand views within hours of publication. The PTOV team had grown to include 10 presenters, all professional chemists, with Haran still handling all of the filming, editing, and production. The videos had been viewed more than 15 million times, and the YouTube channel had over 44,700 subscribers in more than 200 countries and territories, surpassing even the channel of Britain's royal family (*8*), until the recent wedding. PTOV now has followers on Twitter, Flickr, Facebook, and other social media sites (*9*).

PTOV has also spawned a successful "sister channel," Sixty Symbols (*10*, *11*), in which physics and astronomy are presented by Nottingham scientists; it already has 29,600 subscribers and 138 videos, all filmed and produced in a format similar to PTOV's.

Overall, 26 of the individual PTOV videos have had more than 100,000 views, and a further 45 have had more than 50,000. The most-viewed video, in which a cheeseburger



Success by the numbers. The periodic table (*14*) colored according to the number of views of each element as recorded on YouTube, 14 and 15 February 2011.

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was plunged into hydrochloric acid, has attracted nearly 458,000 views. The number of views of each element's video is presented graphically in the figure (p. 1046). The most popular videos, such as Caesium and Oxygen, are of reactive elements, and surprisingly, even a synthetic element like hassium has attracted 32,000 views. Even the least popular, protactinium, has garnered over 12,000 views.

We think the impact of PTOV is best judged qualitatively from the many thousands of comments and unsolicited e-mails received from viewers (*12*). A substantial proportion of these suggests that PTOV has made a real difference to aspiring scientists. For example: "My name is David. I am a senior in High school. I have been watching your videos for quite some time. The videos are so interesting and have inspired me to be a Chemistry Major in college. Because of the inspiration you and your team created through the videos, many kids from around my area have also decided to take the interesting and complex journey to becoming chemists as well."

From the other side, we receive messages from teachers who use the videos. "I wanted to write to you to personally thank you for the wonderful work that you and your students have done. My colleagues and I, in Visalia, CA, use them in the classroom with our chemistry students. They are short and to the point. Our students enjoy watching them."

Some of the viewers see us as friends, turning to us for advice in times of need. "I'm very depressed. I love chemistry and I would like to study in Faculty of Pharmaceutical Sciences. Sadly, I failed the admission examination. It's such a very hard examination! What should I do?"

Undoubtedly, part of PTOV's appeal is that of a soap opera or reality TV (*6*). Each presenter attracts a personal following, whether it is the technician's apparent nonchalance or the professor's eccentric hairstyle and endless selection of chemistry-themed neckties. The viewers come to trust the presenters, who know their subject and tackle even the most obscure topics in creative ways. PTOV does not hesitate to show scientists as human, sharing their moments of happiness and grief with the viewers. When demonstrations fail, they still appear in the videos, especially if they are amusing. Shortcomings are never glossed over or edited out, which ensures that the team is seen as honest—they are not "selling" anything apart from a shared love of chemistry.

YouTube remains an ultracompetitive environment, as thousands of videos are uploaded every hour. However, there are several factors that probably help PTOV to stand out from the competition. The videos look professional because they are produced with broadcast-quality equipment used by Haran, yet they deliberately retain an amateur flavor and raw appearance. Like the TV news, PTOV can work fast when necessary, sometimes with a 3-hour turnaround time from filming to uploading. This can be crucial when responding to breaking news, such as our explanation of the recent nuclear crisis in Japan (*13*).

Viewers feel they are watching a "true record" of life in the chemistry department. The presenters are real scientists who are often caught off guard, forced to answer unexpected questions from the interviewer. Their hesitations and occasional admissions of ignorance reinforce the bond with the viewers.

Editorial control has been ceded to the nonscientist Haran, which ensures that interviews are conducted from the perspective of our layperson viewers. In effect, the viewers accompany Haran on his exploration of chemistry, sharing his wonder while being spared the bits he finds boring. All of this probably works because the participating scientists have done something that is increasingly unusual—they have trusted a journalist to tell their stories.

We have also been lucky. With the right team and the right approach, we have been able to exploit YouTube to the benefit of chemists and chemistry students across the world. However, there are new opportunities on the Internet. Undoubtedly, some of these tools could also be adapted to deliver science to the public in new ways. Try to imagine how you could use these technologies, as well as other innovations that will shortly be going live, to communicate your passion for science to the world. There is an audience out there waiting for you.

About the Authors

Brady Haran (fourth from left) is a video journalist specializing in science communication. He previously worked in newspapers and for the BBC. Born in Adelaide, Australia, he has lived in the UK for the past 9 years. **Martyn Poliakoff** (fourth from right) is a research professor in chemistry at the University of Nottingham. His research interests focus on "green" chemistry at the interface of chemistry and engineering, particularly the application of supercritical fluids. He is a Fellow of the Royal Society and, currently, a Council Member of the Institution of Chemical Engineers, IChemE. Shown here with supporting cast of PTOV.

CREDIT: L. GILLIGAN-LEE

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15. We thank P. License, N. Barnes, D. Kays, A. Khlobystov, S. Liddle, J. Moses, R. Stockman, S. Tang, and D. Walsh for their enthusiastic participation in PTOV and J. Gamble, M. Healy, C. Johnson, B. Nerlich, and C. Rudd for their help. We are grateful for funding from the Engineering and Physical Sciences Research Council, COST (www.cost.esf.org), the DICE project (Driving Innovation in Chemistry and Engineering), the Anamax Charitable Foundation, Briggs of Burton PLC, and the University of Nottingham.

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Editor's Summary

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