



We live in a media-tropolis,
our existence saturated with sounds and images,
entire worlds of information at our fingertips.

Has this resulted in an explosion of education? A new golden age of discovery? Not really.

What we have now is noise. In this hyper-commercial environment science content struggles to be heard.

There is no substitute for eloquence. This is the essence of science outreach.



Let us now consider, for a little while, how wonderfully we stand upon this world.

Here it is we are born, bred and live, and yet we view these things with an almost entire absence of wonder to ourselves respecting the way in which all this happens. Were it not for the exertions of some few inquiring minds, who have looked into these things and ascertained the very beautiful laws and conditions by which we do live and stand upon this earth, we should hardly be aware that there was anything wonderful in it.

Who said these words?



Who said these words?

- The son of a blacksmith.
- Started his career as a bookbinder.
- Introduced himself to Sir Humphry Davy after attending one of his talks at the Royal Institute.
- Served as Sir Davy's personal assistant until starting his own (very successful) career at the Royal Institute.
- Founded the *Friday Evening Discourses* and the *Christmas Lectures*, two popular events which continue to this day.
- The SI unit of capacitance is named after him... the *farad*.

Why start a presentation on multi-media with Michael Faraday?

While he wasn't the first to understand the importance of science outreach, he was the first to possess an immaculate technical understanding, a flair for showmanship, and a complete mastery of language. Consider the scene: The year is 1830, the city is London, the location is the Royal Institute Lecture hall, a dark smoky room lit by flickering oil lamps...

Michael Faraday



The audience now pours in, and soon occupies all the seats, so that late comers must be content with sitting on the stairs or standing in the gangways, or at the back of the gallery. Faraday enters, and placing himself in the centre of the horse-shoe table, perfect master of himself, his apparatus, and his audience, commences a discourse which few that are present will ever forget. (**Michael Faraday** By John Hall Gladstone)

“It was an irresistible eloquence, which compelled attention and insisted upon sympathy. It waked the young from their visions, and the old from their dreams. There was a gleaming in his eyes, their radiance seemed to send a strange light into the very heart of his congregation; His enthusiasm sometimes carried him to the point of ecstasy when he expatiated on the beauties of Nature. And when he lifted the veil from her deep mysteries his body took motion from his mind; his audience took fire with him, and every face was flushed. Whatever might be the after-thought or the after-pursuit, each hearer for the time shared his zeal and his delight.”

In his own words:

“A lecturer should exert his utmost effort to gain completely the mind and attention of his audience, and irresistibly make them join in his ideas to the end of the subject. He should endeavor to raise their interest at the commencement of the lecture and by a series of imperceptible graduations, unnoticed by the company, keep it alive as long as the subject demands it. A flame should be lighted at the commencement and kept alive with unremitting splendor to the end.”

Almost 200 years later, Faraday’s discoveries about the natural world are still true, and so too are his principles for effective education: eloquence, the necessity of enthusiasm, and the use of “imperceptible graduations” to hold the attention of an audience.

Media-tropolis



What has changed since then is the amount and quality of media. Modern educators perform within a media-tropolis, a world hyper-saturated with sounds and images. We have entire worlds of information (or distractions!) at our fingertips. I wonder how many of you will check your smart-phone before the end of this presentation? How many of you have already?

The Past

- Movies are expensive.
- Profit comes from entertainment.
- Entertainment comes from emotion.

Today

- Corporate 'news' media
- Democratization of media production

In the past, technical and financial realities made media production inaccessible to the general public. Science outreach was studio and entertainment based with a typical science show running an hour or longer and filmed at theatrical quality. Content was more about telling emotional stories than science education, as these were – and arguably remain - the most marketable kind of stories.

Today, two phenomena dominate the modern media-tropolis:

1. The rise of corporate news media with an eye for the sensational, that is to say the profitable, and
2. advancements in technology have democratized media production and empowered the public to create media.

The Big Three

- Wacky stories

- Paradoxical health effects
- “Formula for” stories

- Most depressing day of the year:

$$[W + (D - d)] \times TQ \times M \times NA$$

- Perfect TV sitcom:

$$C = 3d[(R \times D) + V] \times \frac{F}{A} + S$$

- Perfect way to eat ice cream:

$$A \times Tp \times \frac{Tm}{Ft} \times At + V \times LT \times Sp \times \frac{W}{Tt} = 3d20$$

News media coverage of science can be loosely grouped into the Big Three:

First we have...

Wacky stories:

“Infidelity is genetic, say scientists.”

“Electricity allergy real, says researcher.”

“Chocolate/wine/fat/cholesterol is good for you.”

“Scientists have found the formula for”

The most depressing day of the year

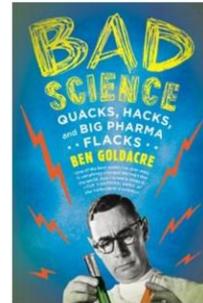
The perfect TV sitcom

Perfect way to eat ice cream, and so on.

Now, it’s not to say that all of these science stories are necessarily untrue, but they are a media trope.

Corporate News Media

- Scare stories
 - MMR vaccine & “relative risk increase”
 - World ending black holes at the LHC
- Breakthrough stories
 - All about the press-release
 - Pre-evidence
 - Scientists as authority figures
 - Artificial dichotomy



Scare stories are the bread-and-butter of most science-news coverage. Depending on your degree of cynicism, such stories are either a consequence of naïve journalists, or the willful exploitation of the general public’s lack of science education. In either case, the scientific papers that fall victim to this treatment are, for the most part, considered “good science,” but who’s results are distorted for dramatic effect.

For example, the use of “relative risk increase” to exaggerate the actual risk, and the flagrant abuse of theoretical hypotheses. Who remembers the world ending black holes at the Large Hadron Collider?

Finally, there is the Breakthrough story.

From Dr. Ben Goldacre, author of *Bad Science*:

In the aggregate, these stories sell the idea that science [...] is only about tenuous, new, hotly-contested data. [...] Often, a front page science story will emerge from a press release alone, and the formal academic paper may never appear, or appear much later, and then not even show what the press reports claimed it would (www.badscience.net/?p=159).

Without understanding (or ignoring) the correct use of evidence, journalists resort to authority figures, the very antithesis of what science is about, as if they were priests, or politicians, or parent figures. “Scientists today said ... scientists revealed ... scientists warned”; And if they want balance, you’ll get two scientists disagreeing, although with no explanation of why”. One scientist will “reveal” something, and then another will “challenge” it.

We’ve all heard the classic phrase “scientists are “divided” over X”.
<http://www.badscience.net/2005/09/dont-dumb-me-down/>

The Result

"The media create a parody of science, [...] then attack this parody as if they were critiquing science."

– Dr. Ben Goldacre, The Guardian

<http://www.badscience.net/2005/09/dont-dumb-me-down/>

To continue to quote from Dr. Goldacre:

What we're left with from the media is a parody of science, for which we now have all the ingredients: science is about groundless, incomprehensible, didactic truth statements from scientists, who themselves are socially powerful, arbitrary, unelected authority figures. They are detached from reality: they do work that is either wacky, or dangerous, but either way, everything in science is tenuous, contradictory and, most ridiculously, "hard to understand".

<http://www.badscience.net/2005/09/dont-dumb-me-down/>

Dumb it Down

Ministers, however, put off a formal decision, despite increasing concern about Portugal, whose 10-year bond yield rose 11 basis points, to 7.42 percent, on Monday.

- The L.A. Times

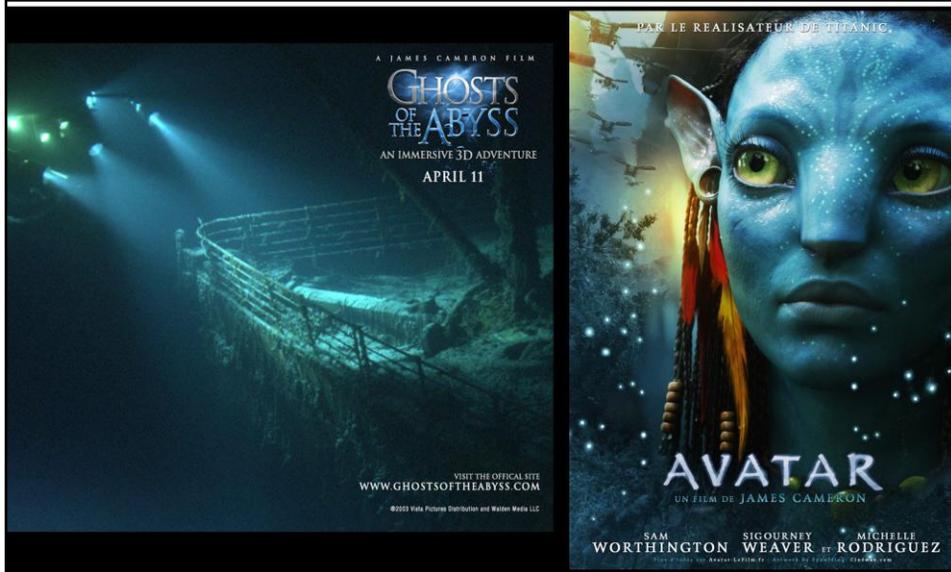
Does it have to be this way? Contrast the need to “dumb down” science articles with the free use of jargon and hard statistics in the financial section of a newspaper.

Planet Earth



Moving from news media into the entertainment world, the classic documentary formula remains popular. A perfect example is the Planet Earth series from Discovery. In these types of films, the influence of technology is relegated almost entirely to advancements in image quality, with the development of higher quality lenses, stabilizers, high definition sensors, and digital broadcast networks. These are big studio and big budget productions, but are still made to be shown on a flat screen, be it an HD TV in your living room, or on a 7 story IMAX screen.

Ghost in the Abyss



While it was little more than a fad in the 50s, the refinement of digital filmmaking has resurrected 3D films. James Cameron was the first to release a digital 3D feature with his 2003 documentary *Ghosts of the Abyss*, and is also the most successful 3D filmmaker, with 2009's *Avatar*, a 250 million dollar movie that has so far grossed nearly 3 billion dollars worldwide.

Unexpected Allies



"I think that mathematics is really an aesthetic situation, a challenge to your intelligence, and even your creativity, but emotionally it's difficult."

- Paul Verhoeven

While we're here, I'd like to mention that there are some unexpected overlap between the world of Hollywood and the world of science:

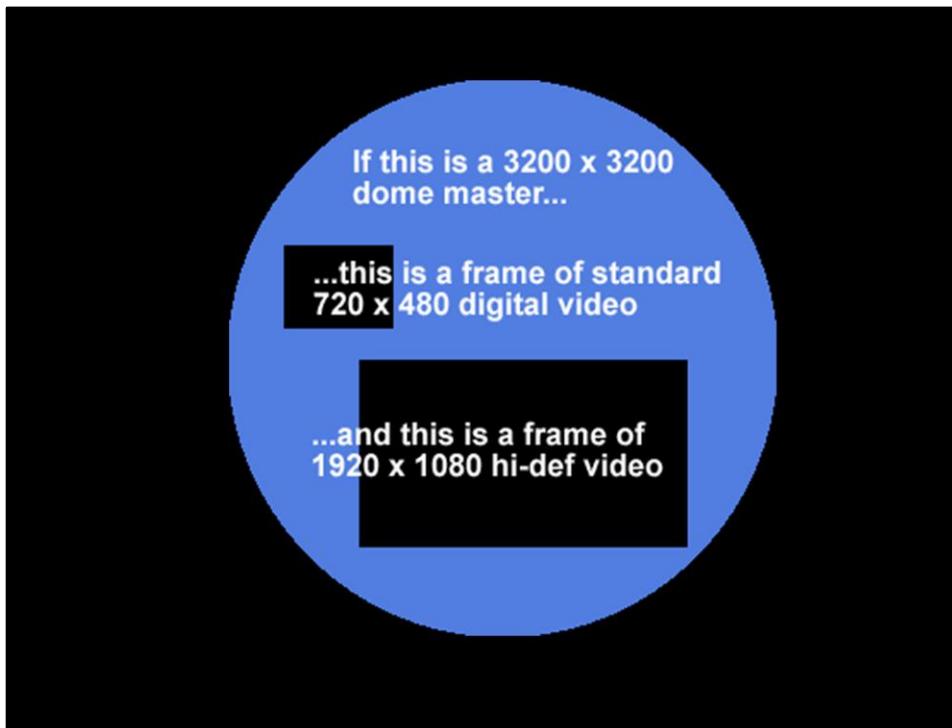
James Cameron studied physics before transferring into English. Has invented many deep sea technologies, and holds several patents with his brother, a professional engineer. And, for the record, James Cameron is not a dual citizen, but remains exclusively a Canadian citizen (even though he works and lives in L.A.).

Paul Verhoeven, the director behind RoboCop, Total Recall, Basic Instinct, and Starship Troopers (among others) earned a Master's degree in math and physics from the University of Leiden in the Netherlands before devoting himself fulltime to filmmaking.

"I think that mathematics is really an aesthetic situation, a challenge to your intelligence, and even your creativity, but emotionally it's difficult." (Pg 173) – Paul Verhoeven, *Film voices: interviews from Post Script*, by Gerald Duchovnay



After 3D, fulldome films are ‘the other immersive experience.’ Essentially, a re-purposing of old optical-mechanical planetariums, a fulldome film wraps full motion digital video 360 degrees around the audience and 180 degrees above them. In this way, a fulldome film fully engages the peripheral view of the audience, creating a powerful immersive effect. Because planetariums are almost always located inside a museum space, science content reigns supreme. However, because the medium is so new and production is technically challenging, the majority of fulldome content is still very experimental.



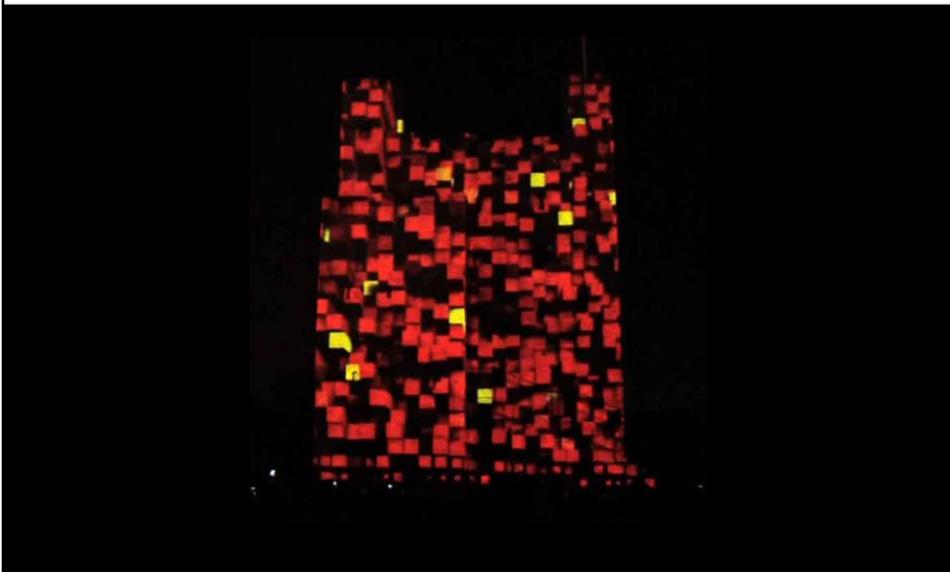
To give you an idea of the production challenges involved in producing fulldome content, this graphic gives a good illustration of the relative size of different video formats. While it is true that high-end HD movie cameras such as the Red One operate at resolutions up to 4k, these cameras have all been designed to make movies that fit the “window-into-a-world” paradigm, and not the immersive style of fulldome. Traditional filmmaking allows you to hide your cast, crew, and hardware behind the film plane, out of site of the audience. Because a fulldome film offers a full 360x180 degree view, the only safe place to hide is directly underneath the camera. Because of these challenges, fulldome films are almost always completely computer generated, an environment where lights, cranes, and equipment are invisible.

Full dome example



Notice the fisheye distortion:
<http://vimeo.com/4163933>

Shoot to Thrill



Even newer, and even more technically challenging, is “architectural projection mapping.” In this technique, ultra-highpower digital projectors paint a moving image onto any surface. Once a site has been chosen, a 3D model of the building is made. The filmmaker then prepares video content that makes use of the building’s architectural features as individual screens. Because of its scale, complexity, and high ‘wow’ factor, this market has been dominated almost entirely by commercial work. These commercials, which should really be called “sponsored experimental films”, completely demolish the boundaries of the traditional ‘theater’ space. The educational potential of such techniques can yet only be imagined.

Columbia Records and Paramount Pictures commissioned the British media-house seeper to create an anamorphic music video to promote the Iron Man II soundtrack. Here is a video recording of a one-time only performance of AC/DC’s *Shoot to Thrill* projected onto the 800 year old bricks of Rochester Castle.

<http://vimeo.com/11160666>



- 2 billion views a day
- 24 hours of video uploaded every minute
- 'Monetizes' over a billion videos per week
- #1 video has 462+ million views
- #1 user generated video has 281+ million views
- youTube directors
 - ShaneDawson
 - 2.3 million subscribers
 - \$315,000 per year (estimated)
 - AnnoyingOrange
 - 1.6 million subscribers
 - \$288,000 per year (estimated)

Sources :

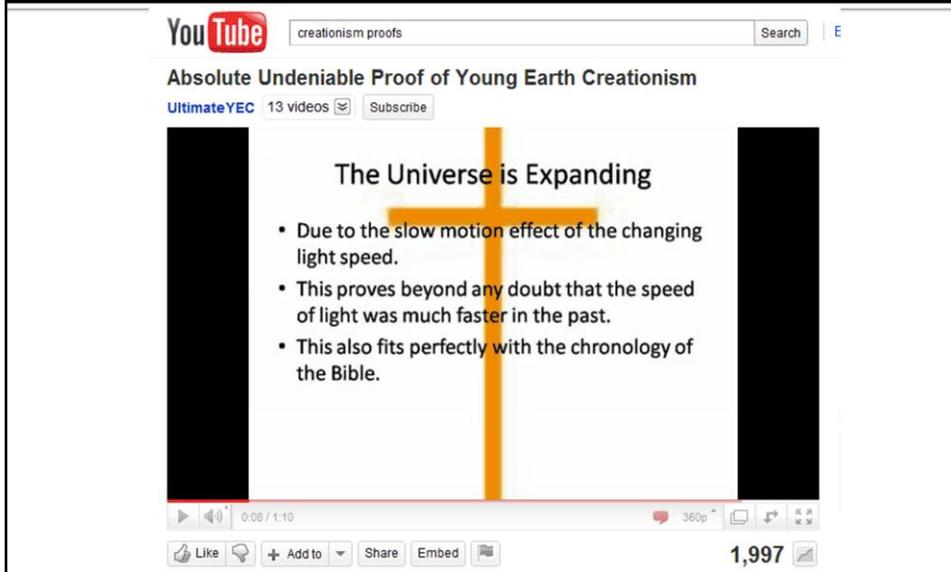
<http://www.website-monitoring.com>

<http://finance.yahoo.com/>

In complete contrast to the big-budget media world, is user-generated content. Witness youTube, clearly the big success story of user-generated media:

- 2 billion views a day. That's double the prime-time audience of all 3 major us networks combined.
- 24 hours of video uploaded every minute.
- Google 'monetizes' over a billion videos per week, with 'monetizing' being a euphemism for adding advertisements.
- #1 video is Justin Beiber's "Baby" with 462+ million views. Uploaded February 19 2010 that's nearly half a billion views in ONE YEAR. It is still, however, studio generated content. In fact, the top 4 videos on youTube are all major-label music videos, an interesting turn for a medium that was considered dead only a few years ago, a relic from the 80s.
- "Charlie bit my finger" is the number one user generated video with 281+ million views.
- The yearly revenue of a youTube "Director" such as ShaneDawson or AnnoyingOrange is a closely guarded secret. But, with their videos earning millions of hits, estimated revenue from their youTube views alone are about \$300,000 per year.

The Result



The strength of user generated media is in its diversity and volume. However, this freedom has a downside. With a few notable exceptions, the miracle of “user generated media” has resulted in little more than a wash of deafening noise.

Consider this example, one of many of its kind on YouTube, offering Absolute, Undeniable Proof of Creationism “Due to the slow motion effect of the changing light speed.”

Now my point here is not to ridicule anybody’s beliefs, only to illustrate that a certain diversity of opinion is to be expected in a public forum.

Khan Academy

<http://www.khanacademy.org/>

The Khan Academy is a not-for-profit 501(c)(3) with the mission of providing a world-class education to anyone, anywhere. We are complementing Salman's ever-growing library with user-paced exercises—developed as an open source project—allowing the Khan Academy to become the free classroom for the world. [Log in to the Khan Academy web application for user-paced practice and instruction](#)

Browse 2000+ videos by topic:

Math Science Humanities & Other Test Prep Talks and Interviews

Algebra
Topics covered from very basic algebra all the way through algebra II. This is the best algebra playlist to start at if you've never seen algebra before. Once you get your feet wet, you may want playlist.

- Simple Equations
- Equations 2
- Equations 3
- Algebra: Linear Equations 4
- Algebra: Solving Inequalities
- Algebra: graphing lines 1
- Algebra: Slope and Y-intercept intuition
- Algebra: Slope
- Algebra: Slope 2
- Algebra: Slope 3
- Algebra: Equation of a line
- Slope and Y-intercept intuition
- Averages
- Integer sums
- Age word problems 3
- Level 1 multiplying expressions
- Solving a quadratic by factoring
- I and imaginary numbers
- Complex Numbers (part 1)
- Introduction to the quadratic equation
- Quadratic Equation part 2
- Completing the square
- Quadratic Formula (proof)
- Quadratic Inequalities
- Quadratic Inequalities (Visual Explanation)
- Introduction to functions
- Functions Part 2
- Conic Sections: Hyperbolas 3
- Identifying Conics 1
- Identifying Conics 2
- Conic Identifications 3
- Foci of an Ellipse
- Foci of a Hyperbola
- Proof: Hyperbola Foci
- Partial Fraction Expansion 1
- Partial Fraction Expansion 2
- Partial Fraction Expansion 3
- Parabola Focus and Directrix 1
- Focus and Directrix of a Parabola 2
- Two Passing Bicycles Word Problem
- Passed Bike Word Problem

While technology has made film production available to the layman, just like in science, there is no technological substitute for knowledge, experience, and professional discipline. Enter the Khan Academy:

It is impossible to do justice to the Khan Academy in a single slide, so, here is a one sentence summary: “2000+ lessons on everything hard to understand, plus the admiring support of Bill Gates”

<An example video to give you the flavour:>

<http://www.khanacademy.org/>

Walter Lewin



<http://ocw.mit.edu/index.htm>

If anyone has taken the educational techniques of Michael Faraday to heart, it is Walter Lewin. His complete, uncut, lectures in physics are available online, for free, at the MIT open-courseware website. <Here is an excerpt from Physics I. We join the class 47 minutes into a lecture on the motion of projectiles...>

<http://ocw.mit.edu/index.htm>

Why is outreach important?

- Reputation
- Identity
- Integrity
- Collaboration
- What is a Scientist?
- Up to \$75,000 for documentation

Why is science outreach important?

- To make your reputation, to take control of your public identity.

In essence, establish a brand identity, either for you or for the institution you represent. More than anything else, this is what will attract the brightest students. If I say “Nike” what comes to mind? Lexus? What about when I say the name MIT? Or McGill? University of Lethbridge?

- To fight misrepresentation.

Science cannot take for granted its place in society. The public has demonstrated a willingness to marginalize science. As technology improves it becomes increasingly indistinguishable from magic. What happens when the “search for truth” isn’t good enough? What happens when science is completely devoted to the production of new and more intoxicating diversions?

Most consider “outreach” as something that is directed to the public. But what about communication between scientists? New media is a natural extension to scientific journals. Collaboration requires communication, after all. And eloquent communication is effective communication.

The Numbers:

I’m not sure about Canada, but in the USA, the National Science Foundation has a new category of grant, “outreach grants,” which award up to \$75,000 to current grant recipients for the exclusive purpose of documentation.

AMETHYST

...to make the University of Lethbridge into a pre-eminent institution for both imaging arts and imaging science, [...] with a focus on creativity and tools in imaging.

The AMETHYST program itself is a perfect example of how institutions recognize the value in collaborations between arts and science, especially when it comes to reaching the general public.



To summarize:

Advances in imaging technology have redefined the theater space: 3D capture and projection systems bring depth to flat screens, ultra-high resolution digital projectors exploit the unique anamorphic properties of the planetarium, architectural projection mapping transforms entire buildings into moving, morphing, volumetric canvases, and virtually every digital device available today comes equipped with a movie camera making film production accessible to millions.

Corporations control the news media with an eye for the sensational, and the democratization of production technology has empowered the public to create media, a lot of media. With so much to choose from, there is renewed demand for coherent, professional content. Modern science educators have learned to combine their scientific expertise with personal charisma and media fluency to produce new kinds of educational media.

Just like in science, there is no technological substitute for eloquence. 200 years later, Michael Faraday is still right.

