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Introduction

Man is unique not because he does science, and he is unique not because he does art, but because science and art equally are expressions of his marvelous plasticity of mind.

Jacob Bronowski, Scientist/Science Historian

Science arose from poetry ... when times change the two can meet again on a higher level as friends.

Johann Wolfgang von Goethe, Writer/Statesman

Science delivers “Wow!” moments like nothing else on screen. For viewers, science not only grounds a story in the natural world, it adds a special thrill that comes from the possible, the plausible, the believable, and the “what if?” While magic can be spectacular, no matter how hard we wish, there are no magic swords, magic wands, or cloaks of invisibility¹. On the other hand, a crashed spacecraft looming out of the mists of an alien planet, a patient snatched from the jaws of death by a risky medical breakthrough, or a smug murderer betrayed by a few molecules left at a crime scene—why not? Screen magic does exist, and science can be one of its key spell casters.

Screenplays that rely heavily upon science must, therefore, be written with care, or the result may not be an “Oh, wow!” moment, but rather its arch nemesis, the “Oh, please!” moment. An “Oh, please” moment happens when events unfold on screen that are so at odds with how the real world works, or how the viewer perceives the world works, that they exceed the limits of artistic license. The viewer’s willing suspension of disbelief is, itself, suspended. When an “Oh, please” moment occurs, viewers are forcibly expelled from the screenwriter’s creative vision and emotionally cast adrift. No longer immersed in the narrative on screen, viewers become painfully aware that they are watching a cast of actors stomping around on sets where the paint is barely dry, and the craft services table just out of shot.

¹ Actually, the jury is still out on that last one.

In recent years the accuracy of the science portrayed in productions for both big and small screens has come under increasingly close scrutiny. There are no shortage of scientists, authors, science writers, bloggers, popular culture reporters, and even Monday Morning Quarterbacks, who have written about scientific accuracy (or, typically, its lack) in Hollywood productions. Sometimes the quarterbacking starts even before the final reel, as happened when astronomer Neil deGrasse Tyson criticized 2013's *Gravity* (Fig. 1.1) via Twitter. At science conferences, science fiction conventions², and science fiction conferences³, presentations and panel discussions on the accuracy of science portrayed in Hollywood productions are ubiquitous. Some colleges and universities offer courses on "Hollywood Science"⁴.

The National Academy of Sciences has even gotten into the science accuracy fray. Chartered by Congress in 1863 under an Act signed by Abraham Lincoln, the National Academy of Sciences' mission is to provide scientific advice to the nation. Located on the campus of UCLA, the National Academy's Science & Entertainment Exchange provides scientific consultation to the entertainment industry professionals with highly-trained scientists and engineers. The goal of the exchange is to "...use the vehicle of popular entertainment media to deliver sometimes subtle, but nevertheless powerful, messages about science"⁵.

Still the issue of scientific accuracy in Hollywood productions is a very complex one, and not every scientific inaccuracy is an "Oh, please!" moment. Not only is the definition of what constitutes an "Oh please!" highly subjective, fictional shows and movies are not intended to be documentaries. Simply hiring a science consultant on the production is no guarantee of perfect scientific accuracy: one of the operational principles of the Science and Entertainment Exchange is that, in a conflict between story and science, story wins every time. The Exchange even counsels new science consultants that, "We are not the science police."

In fact, a wonderful irony is that while many have lamented the inaccuracies of the science in Hollywood science fiction, it is a genre defined, in part, by the inclusion of at least one key science inaccuracy—often many more in the case of TV and film science fiction. Nearly all science fiction stories rely upon at least one discovery or invention that *doesn't exist* in the annals of

² Author SAC moderated *Discover Magazine's* first "Science in Science Fiction" panel at San Diego Comic Con in 2007. A popular panel, it has been standing room only every year since.

³ A science fiction conference, like the Eaton Conference held alternate years at the University of California, Riverside (<http://eatonconference.ucr.edu/about.html>) is an academic conference that discusses science fiction as a serious academic discipline. UCR is also home of the Eaton Collection (formally the J. Lloyd Eaton Collection of Science Fiction, Fantasy, Horror and Utopian Literature), the largest publicly-accessible collection of speculative fiction on planet Earth.

⁴ Author KRG even created and taught one of these at UCLA.

⁵ From their web site, <http://www.scienceandentertainmentexchange.org/>.



Fig. 1.1 Mission specialist Dr. Ryan Stone (*Sandra Bullock*) installs instrumentation to the Hubble Space Telescope in *Gravity* (2013). (Copyright © Warner Brothers Pictures. Image credit: MovieStillsDB.com)

today's knowledge. If this isn't the case, then the story at hand isn't science fiction, it's just a science-themed thriller, drama, comedy, et cetera.

So when scientists complain about how they and their fields of study have been portrayed by Hollywood, such complaints should be tempered with an understanding of story goals and constraints, as well as several different classes of common psychological biases that all people tend to share. Most scientists are not storytellers. Accomplished storytellers understand how to take a viewer into a fictional world and provide both plot and characters that viewers care enough about to watch for an hour or two—much longer in the case of serialized stories.

Conversely, good storytellers also know what will cause viewers to lose interest. It is often the case that screenwriters are being neither thoughtless nor stupid when they take shortcuts around fundamental truths depicting aspects of real world science—for example, the reality that scientific advances occur on the back of vast amounts of mind-numbingly detailed and tedious labor. Just as dramatic crime series rarely include scenes of detectives carefully filling out the mounds of paperwork essential to a successful prosecution⁶, or arguing with their IT department over a broken printer, so, too, the practice of science must be compressed and condensed—especially on television where the writer for an hour-long drama has, in actuality, a mere 42 minutes to tell a complete story—one with a beginning, a middle, and an end—and which includes five act breaks for commercials. Just as the drama of human relationships is often heightened and accelerated, so too are scientific phenomena or the rate of technological processes often exaggerated. (If you can accept that, say, two ex-lovers can resolve major emotional conflicts over the space of a few hours or days while being shot at by international terrorists, then give a

⁶ A notable exception being 2007's *Hot Fuzz*, which actually managed to make police paperwork funny.

break to the screenwriter who has a doctor administer a drug that works in 20 minutes of screen time, rather than in 20 hours.)

In this book, we will examine the science that appears in Hollywood productions from both the scientists' and the storytellers' points of view (we will also make the occasional foray into UK productions like *Doctor Who*, *The Hitch-Hiker's Guide to the Galaxy*, the under-appreciated *Space:1999*, and the vastly under-appreciated *Blake's 7*). One of us (KRG) has spent a career as a professional scientist and science consultant; the other (SAC) has spent a career observing scientists and engineers, and reporting on their advances to non-specialists.

It has been said that, "It takes a library to write a book." In addition to our research⁷, we've also spent nearly 24 hours interviewing numerous writers, producers, directors, and top science advisors—the people who create the shows you love. We've also interviewed psychologists and pop media experts. One of the most enjoyable aspects of creating this book has been when our research has revealed that the biases we've brought into the project were erroneous, and we've been led into other fascinating, and often counterintuitive, directions. One delightful surprise that we've encountered is that observations we make as consumers of TV and film today, observations we think are unique to the high-tech VFX-laden productions of the twenty first century, often can be found in critiques of film from the early twentieth century. Sometimes everything new is old.

Our primary goal is not to excoriate the creators of movies and shows for errors⁸, but to celebrate when they get it right. After all, despite mutterings from academics about how inaccuracies in shows and movies promote scientific illiteracy, more than a few scientists and engineers working today cite productions such as *Star Trek* or *Contact* as the initial inspiration—the inciting incident if you will—for their careers. These shows must have been doing *something* worthwhile. We are quite certain that, in a few years, university laboratories will be occupied by a cadre of students who were inspired to explore the limits of the known, and push the boundaries of what's possible, by the likes of *Eureka* and *Fringe*.

We will also explore the nitty gritty that goes into balancing science and story in a screenplay, and will examine ways in which paying attention to science leads to better storytelling. We'll teach you the difference between a *trope* and a *MacGuffin*, why a screenwriter can have as many of the former as they like, but not the latter, and the many and varied ways in which scientific concepts and terminology are incorporated into scripts.

⁷ Which, admittedly, meant (re)watching many of our favorite series, films, and DVDs which totally didn't suck.

⁸ Though we will be pointing out some of Hollywood's most egregious scientific goofs early and often.

In doing so, this book is, admittedly, a piece of naked propaganda for having screenwriters and producers pay as much attention as they can to science. Science can be a tremendous well of inspiration, for both the big themes and the smaller twists and intricacies of a story. For example, the life cycle of real wasp species led to the chest-bursting antics of the eponymous extraterrestrial in 1979's *Alien*. The iconic scene in 1969's *2001: A Space Odyssey*—when astronaut David Bowman disconnects HAL 9000—owes a debt to an early demonstration of digital speech synthesis, even down to the choice of *Daisy Bell* as HAL's "closing number." The premises of several episodes in the reimagined *Battlestar Galactica* (2004–2009) were deeply informed by real astronomical phenomena, such as the dangerous levels of radiation that can be found in globular clusters (this threat was then used to motivate characters to perform desperate acts as they attempt to traverse a cluster). Medical and forensic procedural dramas regularly dip into real case studies to inspire and inform the plots of episodes.

Hopefully, this book may also help eradicate the one kind of inaccuracy that *is* guaranteed to drive us up the wall and leave us grumbling on our Twitter feeds and Facebook status lines. This kind of inaccuracy occurs when a writer simply repeats a myth that sounds like science, but isn't and, often, never was. Examples include: humans only use 10 % of their brains⁹, people exposed to the vacuum of space will instantly explode or freeze, or that computers produce showers of sparks because of malicious or flawed software¹⁰. When these type of things show up, it's often not because a writer made a conscious judgment as a storyteller, but often because they were simply lazy—learning their "science" from previous works of science fiction, and propagating scientific myths in their own works.

Finally, we'll be spending a lot of time looking at how much screen science and technology overlaps with real science and technology, as well as how well Hollywood portrays scientists. By explaining some of the underlying scientific ideas and concepts that appear on screen, our wish is to give you, the viewer, the tools to recognize for yourself whether a production is depicting good science or bad. For scientists, we want to provide insight into understanding why Hollywood storytellers make some of the choices they do. After reading this book, you may find yourself being more critical of the science Hollywood serves you, resulting in a few more "Oh, please" moments, but we also hope you will gain a much deeper appreciation for the "wow" moments that remain that make them truly "Wow!"

⁹ Known, literally, as the "Ten Percent Myth".

¹⁰ Okay, true, once upon a time, when monitors were primarily made out of glass and metal—particle accelerators known to old folk as "CRTs"—it was possible to kill some displays by programming incorrect values directly into a video card, but the *computers* were fine.

Hollyweird Science

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