THE ROMANTIC GENIUS OF EINSTEIN AND

THE SCIENCE ESSAY FILM

by

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ABSTRACT

The image of Einstein as a scientific genius, a talent so elevated it can spill over the boundaries between science and art, requires the assumption that art and science are not simply different fields of knowledge, but are polar opposites. Despite two centuries of effort, the debate on the relationship of art and science is far from resolved; the notion that they are exclusive of each other is even less established. However, there remains a tendency to treat art and science as the two extremes of a linear scale of talent. Only an exceptional person, therefore, can straddle the line between them.

The traditional science documentary aggravates this separation. Condensing the time and effort involved, through re-enactments of selected experiments, neglects the artisanal, hands-on nature of science. By spotlighting one (or at most a handful) of scientists as special, and condensing a large body of work into a small number of significant events, the documentaries give the impression that creativity in science is a rare occurrence.

A new model of science film, based on the personal essay that is prominent in popular science writing (*e.g.*, the essays of Alan Lightman), is proposed to ease the tension between art and science. The essay film, combining elements of the documentary and the personal art film, provides the opportunity to illustrate science as an inherently creative act relevant to all people.

INTRODUCTION

> *"Neither of the terms ever really prevails over the other, each keeps the other as a ground against which it stands out, each bounces off the trampoline of the other. They are held together for us by this oscillating movement, by the to-and-fro which makes us pass from one to the other without ever abandoning either."*
>
> Jean-Louis Comolli, "Historical Fiction: A Body Too Much."

Society defines science and art in such a way as to place each at opposite ends of a spectrum of thought. The subjects covered by each field are different, as are the methods used by each. Certain skills, therefore, are associated with the different disciplines, and a person's abilities, in turn, are believed to fall closer to one end or the other. For instance, science is coupled with logical analysis and art with imaginative synthesis, even though both abilities are necessary for both fields. Because the skill sets are different, it is considered rare for a select individual to embody traits from both ends of the spectrum.

It has become a cliché to speak of the "two cultures" of art and science, a phrase adopted by C. P. Snow for a 1959 lecture. In his remarks, Snow asserted that western society had developed into a bipolar state: literary intellectuals at one end of the scale and physicists at the other. The phrase, more so than Snow's evidence, has stayed with us ever since, providing an easy labeling system in which to categorize our fellows. The 1960s saw a drawn-out argument in the press between Snow and literary critic F. R. Leavis, or their supporters[1]. The argument has continued over the years, with the "Science Wars" of the late 1990s bringing another generation into what had become, at least metaphorically, a fight.

The tension between the arts and the sciences has existed since the Romantic Movement of the early nineteenth century. A new attitude regarding the imagination combined with new definitions of objectivity and subjectivity to link science with the former and art with the latter. Since then, certain personality traits of the practitioners have become polarized as well. For example, intuition and logic are each associated with artists and scientists, respectively, and therefore are often considered mutually exclusive talents.[2] The polarized trait is then identified as the essential defining characteristic of the individual. As a result, art and science are viewed as the two extremes of a linear scale of talent. An individual can be either good at art, good at science, or middling at both.

What is forgotten, as biologist and essayist Lewis Thomas writes, is that both "are all of a piece, one and the same kind of work for the human brain, done by launching guesses and finding evidence to back up the guesses" (162). The identification of an individual with a certain skill, exclusive of other, so-called contradictory skills is the rationale for, and the product of, treating art and science as two separate cultures. And if there is one thing that science (in particular psychology) and art (in particular literature) have both demonstrated, it is the disastrous effects and near impossibility of segregating and suppressing our thoughts. Instead, taking Thomas's cue that both are similar work for the brain, we should view them as coupled terms, each bouncing "off the trampoline of the other," to appropriate Jean-Louis Comolli's words.

The traditional science documentary aggravates the separation between science and art. All documentaries organize selected events and information to make a specific point. They provide a frame through which to view the subject, in this case science and

scientists. Roger Silverstone has examined how the structure of a BBC *Horizon* program acts as a "frame which invites the viewer to place both the programme [sic] and the reported theories and experiments in a specific extra-filmic and ideological location" (386-387). The standard form of a science documentary, emphasizing startling new discoveries, implies that creativity is unusual in science, and maybe even un-scientific. Imagination and creativity then become something exotic, removed from everyday science.

With the exception of the lecture-format classroom films of the Fifties and Sixties, the dominant form of science documentaries has been biographical. Stories about science are usually told through the narrative of a "hero quest," portraying a single exceptional individual teasing out the answer to a mystery. Susanna Hornig has criticized such attempts at popularizing science, arguing that they "do not reveal the private character of *science* but only the private lives of *scientists*" (12, her emphasis). Art critic Rosalind Krauss has similarly chastised the approach to art as a biography of the artist. The focus of such study is on "finding an exact (historical) referent for every pictorial sign, thereby fixing and limiting the play of meaning" (39). The accomplishments of both scientist and artist are therefore explained by some innate and mystical talent rather than hard work and skillful craft. It is these exemplary scientists alone who are permitted to be imaginative and creative.

Albert Einstein, however, is allowed to straddle the line between science and art. He is portrayed as the embodiment of scientific creativity, fusing observation and imagination. As the archetype of a scientist, his physical features have become a standard caricature. Countless scientists have been depicted with a "wild halo of white hair, hooded eyes, characterful nose, bushy moustache, and exaggeratedly large brain-box," as art his-

torian Martin Kemp described Einstein. At the same time, biographies frequently invoke his creativity and visual imagination, abilities usually identified with an artist and not a scientist. The narrator in *A. Einstein: How I See the World*, an episode in the PBS biography series *American Masters*, says "He worked more like an artist than scientist, arriving at a theory not so much by experimental deduction, but confidently, by intuition."[3] In a similar vein, the A&E *Biography* on Einstein explains his attraction by declaring: "He had the air about him of being a poet or musician or writer, rather than being a scientist."

However, there is a cautionary element that is often overlooked. The story of Einstein also serves as a warning against bringing intuition and imagination into the sciences. In order to do so, the lesson reads, one must be a genius; one must be "an Einstein." Instead of abilities developed over time, a process anyone can emulate, our hero must have been born with great powers. For him it is no trouble to combine the characteristics of the scientist and the artist: he succeeds *in spite* of his "unusual" methods, not because of them.[4] The assumption that art and science are contradictory, that imagination and creativity have no place in science, permeates film and television documentaries about Einstein. Indeed, it is suggested to be what makes him unique. The Einstein of the documentaries, then, acts as a standard against which other scientists are measured and establishes a separation of science and art into polar opposites that can be united only by a select few.

Throughout his life, Einstein appeared in newspapers and newsreels regularly. Since his death, numerous biographies have been produced, including films and television programs (the films considered are listed in Appendix A). Spanning forty-five years, the documentaries necessarily stress different aspects depending on the year of

their production. Regardless of which part of Einstein's life receives special attention, all of the documentaries portray him through the frame of an artist. In this way, he is shown to possess the supposedly contradictory qualities of the scientist and artist.

While acknowledging the different variations of the Einstein story over the years, this essay cuts across the documentaries to reveal how their representations of Einstein reinforce the polarization of science and art. Claude Levi-Strauss advocated such a synchronic approach in order to understand mythological stories, writing: "There is no one true version of which all others are but copies or distortions. Every version belongs to the myth" (94). By reading the myth like an orchestral score, with each variant acting as a separate instrument, the overall meaning is revealed through the harmony that is produced. Likewise, the many documentaries about Einstein work together to confirm that only extraordinary scientists are capable of being imaginative and creative.

The segregation of creative scientists from regular scientists is one consequence of the traditional approach to science documentaries. Documentary films have historically created a sense of "otherness," a sense of examination, or documentation, of "them" by "us." Jay Ruby underscored this tendency in a 1977 article on reflexivity:

> "The documentary film has not been a place where people explored themselves or their own culture.… If you wanted to make films about people exotic to your own experience you made documentaries, and if you wished to explore yourself, your feelings and the known world around you, you made personal art films" (8).

Ruby noted the emergence of a genre that straddled both the art film and the documentary. Films such as Jerome Hill's *Film Portrait* (1973), Ross McElwee's *Sherman's March* (1986), and Mitch McCabe's *Playing the Part* (1995) use a style akin to documen-

tary but deal with the filmmaker's own life and family, traditionally a taboo subject for documentary.

In contrast to film and television, science writing has typically allowed a greater variety of styles. The personal essays of Lewis Thomas, Carl Sagan, and many others have been very successful at popularizing science; presenting it not as something "out there," but rather as something happening right here, a part of the world in which the reader lives. The form of the essay, in fact, mimics the actual daily practice of science, with what Phillip Lopate calls its "continual asking of questions." The essay "tracks a person's thoughts as he or she tries to work out some mental knot" and invites the reader to be "included in a true conversation, allowed to follow through mental processes of contradiction and digression" (244-45). The essay film provides a unique opportunity to connect the viewer with science and also to emphasize the artistic abilities of all scientists.

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THE POLARIZATION OF SCIENCE AND ART

"Two souls, alas! dwell in my breast." Goethe, *Faust* (pt 1, line 1112), quoted in R. Haynes, *From Faust to Strangelove*.

Romantic Roots

The split between science and art appears, in modern times, as an abyss; each side, it seems, speaks a different language and even uses a different side of the brain. At best, they are considered "nonoverlapping magisteria," to borrow Stephen Jay Gould's phrase, which is only a way of sweeping the issue under the rug. This separation is not new, but neither is it ancient. At one time, and the usual example is Leonardo da Vinci, art was considered another method with which to investigate the natural world. During the eighteenth century, however, as science became more specialized and industrialized, art and literature changed as well. Barbara Naumann reasons that the increasing positivism of the sciences clashed with the developing view of literature as "a subjectively and perspectivally directed organ of self-perception and self-reflection" (514). Goethe's efforts in the late 1700s to fuse aesthetic and scientific representation indicate that a line had been crossed. By that time the two fields were beginning to be seen as opposites, and in 1834 the term "scientist," in an analogy with "artist," was proposed to describe the new group of researchers.

At the same time, the imagination was undergoing division into artistic and scientific types. Lorraine Daston has analyzed the change in beliefs about the imagination that occurred between the eighteenth and nineteenth centuries. The faculties of reason and

imagination, Daston tells us, have always been considered opposites. However, in the 1700's, imagination was regarded as a necessary quality for everyone, artists and scientists alike. During the eighteenth century, "the imagination, despite its perils, was as essential to philosophy and science — the pursuits of reason — as to the arts" (78). Both made use of the same imagination, and both were susceptible to its pathologies. The aim of art and science was to reveal the truths of nature, which required interpretation and judgment to uncover the ideal form obscured by the flawed specimen. The imagination, therefore, was subject to Nature's laws and to the self-discipline of the individual. The genius of the eighteenth century used reason and order to impose the sovereignty of his (and always "his") will.

The imagination, though, could suffer from disease. Daston relates the distinction made by Voltaire, who diagnosed two conditions. The finest works of physics, poetry, painting, or music were inspired by the healthy, "active" imagination, while the diseased, "passive" imagination afflicted those without "intelligence and self-mastery" (80), who were too weak-willed to control themselves. The extreme passions and delusions produced by the passive imagination indicated its power. For the imagination was a force that, unless controlled by a disciplined will, "could betray the natural and the verisimilar by breeding monsters. Its power verged on the supernatural. It could drive the brilliant scientists mad, it could trigger violent seizures, it could cure the hopelessly ill, it could distort and obliterate facts " (80-81). As long as both art and science aimed at being "true to nature," both believed in using the imagination to look past the flawed specimens and facts to find the archetypal truth.

Around 1800, the joint figure of a transcendent genius using his heightened powers of imagination, intelligence, and reason to idealize or improve nature was split asunder. The notion of genius, and therefore the imagination, was at the center of a social crisis that involved political revolution and upheaval within the academies and learned societies. Simon Schaffer outlines the relationship between the concept of "genius" and European political and social revolutions during the late 18th and early 19th centuries in his article, "Genius in Romantic Natural Philosophy." At this time, Immanuel Kant was praising originality as the fundamental condition for genius, contrasted with the "spirit of imitation" at the heart of being "true to nature." Genius was such that it could not be learned, he argued, because learning is merely another form of imitating. Kant, even though he admired Newton, refused to grant him the status of a genius. All he had done with his celestial mechanics was to codify through mathematics what the genius of Kepler had revealed.

The formation of national and international scientific societies during the eighteenth and nineteenth centuries, which emphasized collaboration and communication, conflicted with the new definition of genius. The authority of the universities and academies rested on the backing of the church and state, as well as a sort of communal "gentlemen's agreement" about the proper way to do things. The Romantic genius, on the other hand, derived his power from his personal and subjective imagination. It is only in the early 1800s that the opposition of objectivity and subjectivity, as we use them today, was established. Kant himself pioneered this usage: he defined an objective conviction as a "judgment that is valid for everyone" and a subjective persuasion as one that "has its ground only in the special character of the subject."[5] The new genius, relying on a "pro-

ductive, as opposed to reproductive, imagination," Daston writes, "could be bound neither by the rules of decorum nor those of the natural order" (84). The opposition of objective and subjective matched the split into communal science and solitary art.

A divide had opened in the early 1800s that we still feel today. The imagination and intuition that had been so important for the eighteenth century scientists became suspect and sequestered in the newly personal and subjective world of art. The early Romantic scientists, such as Goethe or Humphry Davy, could be both objective and subjective (in an anachronistic use of the terms) — *i.e.*, they could conduct experiments and write poetry, believing that both were equivalent ways to understand the universe. By the mid-1800s, however, one had to choose either objective science or subjective art. For instance, Goethe's resistance to Newton's theory of optics was perceived as an error of clouded judgment, and attributed to mixing the intuitions of the artist with the observations of the scientist.

By the end of the century there was a definite and accepted separation of the scientific imagination from the artistic imagination. John Tyndall's 1870 lecture, "Scientific Use of the Imagination," defended the "scientific" imagination as a useful, but limited tool. The once mighty role of the imagination was reduced to generating metaphors to aid teaching. The artistic imagination, on the other hand, was permitted absolute freedom to invent new worlds. Tyndall suggested that those who feared entangling science and the imagination must have observed it in "weak vessels." In the proper person, like Newton, who could employ the imagination "bounded and conditioned by cooperant Reason" (426), it was a worthwhile tool. The implication being that only a scientific genius could or should make use of the imagination.

Originality in Art and Science

The Romantic conception of the imagination put great value on creative freedom in art. The emphasis on originality and innovation resulted in the development of an "avant-garde" movement during the 1800s, which aimed to scout out new ideas for society. In a 1969 essay, James Ackerman describes how the line demarcating such an elite vanguard has since disappeared. The concept of artists working ahead of, and in opposition to, a resistant culture ceased to be applicable when "the entire army [of artists], and a good part of the civilian population, has moved up to join and surround it" (379). By the late twentieth century, public attitude of the avant-garde had shifted from rejection to acceptance. All art has now become avant-garde. Whereas before we would distinguish between an innovative minority and a tradition-bound majority, now we separate "true" artists from amateurs. A piece is considered either "Real Art" or mere *kitsch*. The main emphasis of the art-world is on originality and uniqueness.

We can see a similarity in Thomas Kuhn's division of science research into "normal" and "revolutionary" science. He explored the difference and its impact on the history of science in his groundbreaking book *The Structure of Scientific Revolutions*. Normal science, Kuhn explained, works within established borders, pursuing research "firmly based upon one or more past scientific achievements" (10). He depicted normal science as solving a puzzle, where one knows that a solution exists and that it follows certain rules. The answer may be expected, but the value lies in "achieving the anticipated in a new way" (36), for example, by developing a better spectrometer. Much of the

work of normal science involves what Kuhn called "mop-up work," akin to filling in the holes in a jigsaw puzzle.

In contrast, revolutionary science works outside of the established areas, concentrating on anomalies that develop when results fail to conform to expectations. Through a drawn-out process, which Kuhn called a revolution, the scientific community changes the expectations (by changing the prevailing theories, or paradigm) to match the anomalous result. The revolutionary episodes are "the tradition-shattering complements to the tradition-bound activity of normal science" (6). Most science, however, is normal science, Kuhn argued.

The polarization of science and art is manifested in how each field is perceived to relate to its traditions. On the one hand, society sees art as intending to find new ways to express ideas, and on the other, views science as aiming to fill in the already established boundaries. The individual practitioner becomes personally identified with this division. For instance, an artist does not just make art that is revolutionary; instead, he or she is believed to *be* revolutionary. The scientists, then, who are involved in scientific revolutions are also seen as individually revolutionary — and therefore original and creative, like artists. Conversely, creativity and imagination are perceived by society to be a detriment for the majority of scientists who are normal, *i.e.*, pursue "normal" science.

We see this emphasis on revolutionary originality in most of the documentaries on Einstein. His theories, we are told, revolutionized not just physics, but our understanding of the entire universe. *How I See the World* pronounces that his work is significant because of "its astonishing amount of originality. New ideas are what are important about Einstein's theories." Later in the program, we learn that Einstein was not interested

in the mop-up work of normal science. After publishing his theories of relativity, "he waited confidently, calling the effort to provide proof 'the detail work.'" By depicting Einstein as a revolutionary scientist — as an "avant-garde" scientist — the documentaries re-confirm John Tyndall's assertion from 1870 that the imagination is too powerful for "weak vessels." Einstein, then, becomes the yardstick by which other scientists are measured to determine if they are capable of incorporating creativity and imagination into their work.

THE TROUBLE WITH DOCUMENTARIES

> *"Traditional biography, so often presented as 'A Life,' in fact counters the errant trajectory of life with the smooth curve of dramatic narrative form. It might be more properly called 'A Story.' Its unity and closure stand at odds to the open-endedness and incoherence of life."*
>
> Bill Nichols, "History, Myth and Narrative in Documentary."

Documentary Film

Documentaries necessarily must condense history when conveying a story, by selecting certain events or documents and excluding others. The choice of which documents to use, and how to order them, is an artistic choice made by the author. Historical events exist as data in what Hayden White calls the "unprocessed historical record" (5). The historian will organize the selected data, stressing some events and subordinating others, "in the interest of constituting *a story of a particular kind*" (6, his emphasis), intended to render the historical record more comprehensible to a particular audience. History becomes a story, in other words, when it is turned into a plot. A disordered collection of "historical data" is arranged into a sequence of events that are used to illustrate a cause-and-effect relationship. Therefore, our notions of past events, along with the meaning and contemporary relevance we assign them, are created as much by the structure of their "telling" as by the events themselves.

According to Robert Rosenstone, all historical accounts are susceptible to compressing "the past to a closed world by telling a single linear story with, essentially, a single interpretation" (1174). Documentary films are limited by a time limit, as well as a reliance on visuals to illustrate the story.[6] A further requirement mandates the film not to

be either "static or talky." The result is a sacrifice of complexity to action. As Rosenstone says, "the documentary bows to a double tyranny – which is to say, an ideology – of the necessary image and perpetual movement. And woe to those aspects of history that can neither be illustrated nor quickly summarized" (1180). While moving pictures can provide a different experience of history than written accounts can, they are still only a selection of images and events carefully arranged to tell a story or make an argument.

Documentaries are commonly advertised as "stories of real life,"[7] but they are not an "unprocessed" description. In the end, the documentary must convince the viewer. By comparison with fiction films, Bill Nichols, in *Representing Reality*, has given a thorough examination of the rhetorical strategies of documentary films. Where fiction films tell a story about an imaginary world, documentaries make an argument, either explicitly or implicitly, about the real, historical world. The evidence for the case[8] may be factual proof or what Nichols calls "artistic proof," the various "persuasive strategies deployed by the author or speaker on his or her own behalf" (134). The use of such strategies moves the viewer to the author's viewpoint, which is constructed through technique, style, and rhetoric. All three are components of "the voice of documentary," which speaks a language shaped by ethical, political, and ideological concerns. In the end, documentaries strive to persuade:

> "It is a proposition about how the world is — what exists within it, what our relations to these things are, what alternatives there might be — that invites consent. 'This is so, isn't it?' The work of rhetoric is to move us to answer, 'Yes, it's so,' tacitly — whereby a set of assumptions and an image of the world implant themselves, available for use as orientation and guide in the future — or overtly — whereby our own conscious beliefs and purposes align themselves with those proposed for us" (140).

The traditional science documentary reinforces the view that science and art are opposites, with science focused on the "mop-up work." The slow processes of trial and error, with an emphasis on error, are reduced to quick and undeniably correct experiments. Because the vast majority of science films are descriptions or explanations of previous work, we do not see an on-going process. Instead, we are shown re-enactments of previous experiments. Harry Collins has described how a documentary, through re-enactments, produces order and certainty despite content that is necessarily disordered and uncertain. The re-constructions of laboratory scenes show "work being done in such a clear way as to render its conclusions unquestionable" (701). Equipment does not need to be tested or calibrated, everything works on the first try, and most importantly, there is no need to interpret results; scientists only need to explain them. The time and skill that it takes to perform an experiment is collapsed in the documentary, minimizing or erasing the traces of production,[9] and thereby presenting science as unambiguous and decisive knowledge.

Creativity and Biography

The stories we tell about creativity also collapse the time involved. We may speak of the creative process, but instead of emphasizing the slow construction of ideas, we refer to a sudden moment of insight. The most common description is the phrase, "eureka moment," or what Howard Gruber calls an "aha experience." The standard narrative of the creative spark treats it as a rare event, happening only a few times, at most, in a lifetime. Along with being rare, the event is portrayed as occurring rapidly, like a flash of light, after which everything is perceived differently. The legend of the apple

falling onto Isaac Newton's head is a prime example of such a singular event: it happened once, it happened quickly, and nearly coterminously with the impact, Newton "discovered" gravity. The rest of his work then flowed from this one "tradition-shattering" moment.

The history of science is filled with these legends, all the way back to Archimedes stepping into his bath. Gruber analyzes several cases, showing in each instance how it is truly a process. Ideas are formed and forgotten, remembered and re-organized, until a moment when an answer seems to come out of nowhere. The examples Gruber cites show that it only seems so because thinking about the problem had become second nature. The "eureka moment" appears to be sudden, rapid, and new, he writes, because it "is a summation of work already done, a re-cognition. Important summaries are often overtures to new phases of work, and in the end all that may remain in memory is a series of such summaries" (50). Our memories and our stories erase the traces of how we produce our thoughts, condensing a drawn out process of active thinking into a spontaneous, and somewhat passive, moment of inspiration received in a lightning-like flash.

The significance accorded to the sudden flash of insight links the narrative of creativity to that of biography. The standard biographical form assumes a narrative arc where a single event (or small series of events) serves as the spark that ignites the hero, propelling him or her to greatness. Similar to the flash of creativity, the biographical incident acts as a rupture with the past and the basis for future success. For example, most documentaries about Einstein use the gift of a compass to explain the origin of his belief that "something deeply hidden had to lie behind things." The film *Albert Einstein* establishes the compass as the tool that awakens his creativity, eventually leading to his

groundbreaking theories: "The boy who was puzzled and fascinated over the compass is still puzzling over questions." Because of the expectations created by the narrative structure, the sudden break is foreshadowed and made to seem both inevitable and necessary.

The biography promises to uncover the private life of its subject, to pull back the curtain and show the "real" personality. The private identity is given a privileged position and used to explain the acts of the public persona. Therefore, we measure the value of a biography by how well the private character is unmasked. James Combs found a defining characteristic of television historical biographies to be the belief that "the wellsprings of greatness flow from the hero's personal, not public, virtues" (17). The PBS documentary, *Einstein Revealed*, was heavily advertised as being based on "newly discovered letters" between Albert and his first wife, Mileva, which were said to "shed light on his bold thought experiments and forbidden loves." Revealing the private life of the subject, a hallmark of the "Great Man" biography, serves to emphasize his uniqueness, by the very need to personalize him. Combs referred to this as the "domestication of greatness."

The shape we give biographies influences how we measure a person's life.[10] The emphasis on a small number of isolated incidents provides a frame with which to judge creativity. We look for isolated, spontaneous moments of awareness that shape the rest of the person's life. As Rosalind Krauss explained for art, a focus on specific events limits the meaning we can derive from the work. A similar limitation arises when the story of a person's complex life is reduced to a few moments. The same problems exist for any multifaceted subject, for instance, creativity. Giving creativity the shape of quick flashes of insight leads to the belief that it is a rare occurrence and that it is a rare ability. It is

easy, then, to lose sight of the purposeful work that occurs in creative thinking. It is too easy to forget the extent to which everyone does such work every day, and that creativity is not reserved for the Great Men.

THE ROMANTIC GENIUS OF EINSTEIN

> *"We mythologize. We want to read and believe the myth of the hero-scientist, singlehandedly overcoming obstacles. We desire hagiography; in a corrective fit of seeming realism, catering to jealousy as well as hero-worship, we even want our heroes and heroines to have rough edges. But the archetypical myth is what we crave, oh so strongly."* Roald Hoffmann, "Do Mythic Heroes Pervert the Beauty of Basic Research?"

Einstein as Mythic Hero

The documentaries about Albert Einstein position him as a scientist who is like an artist. He had a prodigious visual imagination and created astoundingly innovative work, which are characteristics commonly associated with artists. By combining the supposedly contradictory qualities of a scientist and an artist, he achieved a near mythic status. Claude Levi-Strauss, in his essay "The Structural Study of Myth," writes that the intent of a myth "is to provide a logical model capable of overcoming a contradiction" (105). The opposing elements are united in the mythic hero, who acts to bridge the split. In Christianity, for instance, Jesus unites the disparate natures of human and divine. The figure of Einstein functions to unite the fields of science and art, which have been separated since the Romantic era.

The impact of a myth is due to its continual relevance, Levi-Strauss claims: it is an explanation of the past, a description of the present, and a template for the future. Most often, myths tell variations on origin stories, about how a group of people came to be.[11] The myth provides the description of an originating event and guidance for the future. It may relate the origin of a religion, a nation, or even the re-birth of a discipline. In

this way, Einstein is a modern myth, the founding father of twentieth century physics.[12] Just like the old heroes of Greek myths, Einstein has been placed in the heavens as a constellation after his death. As the "Person of the Century" for *Time* magazine, he was depicted floating in a sea of stars (see Figure 1), and the 1979 documentary, *Images of Einstein*, ends with a shot of his statue reflected in a pool of stars.

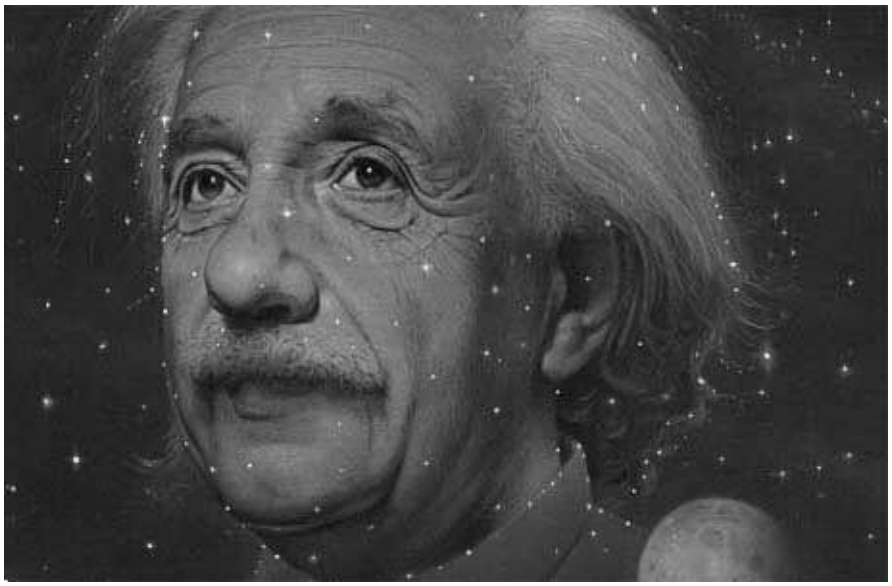

Figure 1: A black and white version of the portrait of Einstein, by Tim O'Brien, that accompanied *Time* magazine's "Person of the Century" article, 12/31/99.

The continued appearance of Einstein's image in advertising ("the folklore of the industrial age," according to Marshall McLuhan) is a testament to the influence of his myth throughout society. That his picture appears on coffee mugs and T-shirts is used explicitly in both the A&E *Biography* episode and The Science Channel's *Exploring Einstein* to indicate his fame. The phenomenon of the *Baby Einstein* videotapes is another example. The series offers videos to teach children not only "science" (*e.g.*, numbers, shapes, animals, etc.) but also "art" (*e.g.*, the instruments of the orchestra and colors). It

is significant that *Baby Einstein* is the name of the entire series, covering both fields, while babies Monet, Wordsworth, Newton, Bach, Galileo, and da Vinci are each only single entries.

The mythic Einstein and his contradictory qualities are the subject of "The Brain of Einstein," an essay by Roland Barthes. Popular depictions of his brain as inexhaustibly fruitful gave the impression that it was an unstoppable mechanical "apparatus which transforms cerebral substance into power" (68). Yet the more that Einstein's genius was localized in his brain the more magical it became, encoding the secrets of the universe into a single equation. At once both mechanical and magic, Einstein's abilities included both logic and imagination. The more that documentaries portray this combination as unusual, the wider they force the gulf separating science and art.

Einstein as Romantic Genius

The figure of Einstein established by the documentaries is described as being "like an artist." He was a scientist because of what he worked on, *i.e.,* theoretical physics, but characterized as an artist because of how he worked. *The Education of a Genius*, for instance, goes to great lengths to describe the important role that his visual imagination played in developing his theories. The link forged in the early 1800s tying the imagination to artists was illustrated earlier. This connection was nearly exclusive, with the exception of those few scientists, like Einstein, who were perceived to be revolutionary in their thinking. As an indicator of their creativity, they are often represented in an analogous fashion to artists. Robert Jones has analyzed the representations of scientists

in post-World War II British films. He found the model of an artist to be one of the three main depictions of scientists.

It is not surprising then that Einstein, the epitome of imagination in science, would be compared to an artist. Reaching back to the roots of the separation between art and science, the documentaries frame him as a Romantic Genius. This is not unexpected because, as Jones says, the Romantic artist is viewed "as an heroic outsider dedicated solely to his work" (140). This is in keeping with the special status accorded to the subject of a biography. Our notion of genius implies the elevated status of the "Great Man," further reinforcing, of course, the restriction of creativity to select scientists.

The picture of the Romantic genius is that of an unfettered free spirit, scorning social institutions and norms. Art critic Rosalind Krauss points to the "nineteenth century view that artistic greatness is the function of an ecstatic imagination" (186). John Berger, in an essay objecting to the myth of the artist as "a wild, unoriented man," quotes another critic: "It was the madness of Van Gogh as it is the folly of lovers to be caught up in a fiery passionate, relentless attempt to discover a self that always invites but ever resists possession. Folly perhaps, but once tasted, a transcending obsession" (20). We see in society's depiction of the artist, and more broadly in the figure of the genius, an incredible passion, a determination to follow a set path despite any possible consequences.

Einstein's courtship with Mileva is a symbol of his passionate spirit. *Einstein's Big Idea* dramatizes their early years together, portraying them as "two young, radical, bohemian experimenters." He anticipated a life devoted to physics, writing that after marriage, "we'll diligently work on our science together so we don't become old philistines." A&E's *Biography* highlights the "playfulness" that is exhibited in their early let-

ters, and also underscores the dual focus of their lives. They were "passionate about each other, but also passionate about physics," swinging from love poetry to discussions of thermodynamics.

The image of a passionate, unfettered Einstein, with complete confidence in his theories, is projected in all the documentaries. In some instances, like *Einstein's Big Idea* or the A&E *Biography*, the focus is on dramatizing a young bohemian rebel — "a young, energetic, dynamic, even sexy Einstein." *Einstein Revealed* instead depicts an old Einstein reminiscing about his youth, but drawing attention to the twinkle in his eye as he relives his youthful ardor. While the publication of the Albert-Mileva love letters has given the filmmakers more to draw from, the portrait of Einstein as a bohemian was prominent back in 1974 in *The Education of a Genius*. His regular attendance at the local coffeehouses is contrasted with his irregular attendance of university lectures.

His distaste for school ties in with the belief that genius can be neither learned nor taught. Several of the documentaries highlight his disregard for his teachers, who appeared to think "that physics had stopped seventy years ago" (*Einstein Revealed*). He is continually referred to as a "rebellious and independent thinker," starting from a young age, who refused to be "cowed by authority" (*How I See The World*). Both the 1979 *A. Einstein* and the 1996 *Einstein Revealed* say he went "his own way," regardless of the criticism of his colleagues. Alberto Elena has surveyed the ubiquity of scientists "fighting the system" in biopics, and George Custen has demonstrated the trend for other professions as well. Einstein's struggles against authority is captured in his famous quote: "great spirits have always encountered violent opposition from mediocre minds," which

is used to open *The Life and Mind of Albert Einstein*. Innovation, and the inevitable resistance from others, is what marks the main character as unique.

To accentuate his individuality, the hero is often portrayed as an outsider of some kind. This is not an easy feat, given Einstein's active advocacy; but the documentaries characterize him as isolated politically, scientifically, and socially. Of course, there are the obvious Nazi attacks on the "Jewish science" of relativity, but also the unpopularity of Einstein's pacifism in both WWI era Germany and post-WWII America. We are told in *A. Einstein* that political differences caused a split with other German scientists, most of whom had signed a pro-war manifesto. His very public refusal to testify before Joe McCarthy's House committee set him apart in the 1950s, prompting *How I See the World* to declare, "he was somewhat out of tune with the spirit of the times."

Much is made of the fact that Einstein's fame in the Twenties allowed him to mingle with a select group of artists, writers, and even Charlie Chaplin. Yet, they barely mention his activities within the science community. Einstein is depicted as being cut off from the scientific community many times in his life: during his time in the patent office, while he worked on Special Relativity, and later while working on his Grand Unified Theory, it is said that he did not read science journals or keep up with new developments like quantum mechanics. The image we are left with is an individual "scientist sitting at his desk, divining the laws of the cosmos" (A&E *Biography*).

The solitary nature of the genius is responsible for what Caroline Jones calls the "romance of the studio," which is the perception of the artist's studio as a sanctuary. The studio, whether a real site or a metaphorical inner place, functions as a shelter to ward off the "constraints of the age" (4). It is a place safe from commercial drudgery, where crea-

tivity can be loosed. The artist retreats to the isolation and security of the studio. The mythical Einstein, too, is given a haven. His country house in Germany, "which he called his hut" (*How I See the World*), was a place where he could retreat to nature and "work undisturbed." The documentaries also point out his fondness for sailing alone, which was "Einstein's way of escaping all intruders. With relaxation would come solutions to his epochal thought experiments" (*The Education of a Genius*). The long walks through the woods, another oft mentioned retreat, reveals the real location of Einstein's private studio. As he tells the students in *Albert Einstein*, "Don't worry about interrupting me, my work is waiting up here in my head. As soon as you leave, I can go right back to it." This mental retreat was in evidence as a young boy, who was "self-sufficient and thoughtful" (A&E *Biography*), and as an old man, whose final years were "spent in solitude and reflective thought" (*Einstein Dead*). It is a factor in the mystique of the patent office, with Einstein as the daydreaming employee, attempting to "ferret out the mysteries of the universe" (*Einstein Dead*).

The ambition of the Romantic Movement, according to Maurice Bowra, was "to find through the imagination some transcendental order which explains the world of appearances" (22). Einstein's search for the harmony hidden in nature is repeatedly mentioned in every documentary; usually it is attributed to his fascination with the compass he received as a youth. The documentaries all use the same language, presumably derived from Einstein's own writings. The phrase, "something deeply hidden had to be behind things," is used in several of them. The idea that "there were things in nature that could not be seen, could not be touched, could barely be imagined" (*Albert Einstein*) is

then used as motivation for his lifelong quest "to grasp the hidden design, the underlying principles of nature" (*How I See the World*).

He believed there was an order to the universe, and therefore he "sought to bridge the polarities in nature" and find the presence of "unity behind divergent phenomena" (*The Education of a Genius*). His search for the underlying unity and order in the universe, we are told, was focused on simplicity, beauty, and generality; that is why he believed his theories of relativity were correct. The meaning of Einstein's simplicity, as shown in the documentaries, is that he remained a child at heart, with an innocence and curiosity that allowed him to ask the simple questions and provide the "deceptively simple formula [which] revealed a hidden unity, buried deep in the fabric of the universe" (*Einstein's Big Idea*). *The Education of a Genius*, says it best: "The secret of Einstein's genius may well lie in his simplicity, his childlike curiosity, his complete concentration, his playful visual imagination and his openness to the symmetry of nature.

The untainted genius, who retains the innocence of childhood, is capable of seeing the world in a new way. Creativity, in the sense of originality, is premised on this very ability. Rosalind Krauss has examined this connection in her study of the avant-garde and its myth of originality. "More than a rejection or dissolution of the past, avant-garde originality is conceived as a literal origin, a beginning from ground zero, a birth" (157). The artist is not, however, a regular new-born; he arises from an act of "absolute self-creation." In a sense, it is the power of his own genius that provides the originating spark of creation. With this act he cleaves himself from the flow of time and transcends the course of history — and the true artist will do this again and again. "The self as origin,"

Krauss writes, "is safe from contamination by tradition because it possesses a kind of originary naïveté" (157).

If the essence of genius is such that it cannot be communicated, then it cannot be taught; and if it cannot be taught, then it cannot be learned. Genius, therefore, is an innate talent: one must be born a genius.[13] Simon Schaffer's article on genius investigates how the Romantic philosophers built on Kant's idea that genius was something "given to a man at birth." Irving Babbitt, in his essays on creativity, argues that this development culminated in an opposition between imitation and spontaneity. From the concept of spontaneity, he argues, grows our notion of creativity.

An earlier chapter explained how creativity is depicted via the "eureka moment," the sudden and spontaneous flash of insight. Spontaneity, and therefore creativity, acts a signifier of genius for both artist and scientist. There is the legend of Newton's apple; for a long time Monet was praised for his spontaneity. Rosalind Krauss cites an admirer who praised several paintings "as 'the work of an instant,' the specific instant being 'that flash' in which 'genius collaborated with the eye and the hand' to forge 'a personal work of absolute originality'" (167). Krauss describes the meticulous efforts made over days, if not years, to achieve a rough, sketch-like effect. The result appeared to be "an instantaneous and originary act" of genius. Caroline Jones also has investigated the fetish of spontaneity. The paint itself, she contends, is a signal of genius: the "lack of finish conveys in its very sketchiness its status as mere approximation of the divine internal design, or, alternatively, serves as testamentary evidence of the hurried, spontaneous inspiration of its artist-creator" (9).

Science has its own "sketch-like marks" that reveal the presence of genius, namely, the "back-of-the-envelope" calculation. Not only does it indicate spontaneity, by using whatever material is close at hand, but it also implies a superior ability. Richard Feynman, whom *NOVA* called "The Best Mind Since Einstein," was famous for doing quick calculations in his head. Documentary depictions of Einstein are filled with references to his "sudden insights." Answers to questions come to him "all of a sudden," we are told repeatedly. The most common example is the theory of relativity, which comes to him while he and his friend are out walking, talking about the nature of light. Einstein relates the moment of clarity in *Einstein Revealed*: "But as I spoke, the answer came to me. I stopped in mid-sentence and ran home." In *Einstein's Big Idea*, we are treated to a rare instance of a woman possessing this ability as Lise Meitner is shown on a ski slope quickly doing a calculation to prove that atomic fission had occurred.

The physical presence of the creator is an important mark of genius. This derives from the Romantic belief in a connection between the powers of the genius (both mental and physical) and the powers of nature. Simon Schaffer gives the example of the analogy drawn between the flash of creativity and the flash of lightning, which appeared to be combined in Galvani's experiments on "animal electricity." Mind, body, and nature were believed to be interrelated, leading the natural philosophers to see themselves as ideal test subjects. One immediately thinks of Timothy Leary and the acid tests of the 1960s. It is this "auto-experimentation" that Schaffer declares "the most characteristic aspect of Romantic natural philosophy" (92). By the end of the nineteenth century such *physical* auto-experimentation was judged "unscientific."

The indicator of spontaneity, the "sketch-like mark," is the descendant of the auto-experiment tradition. Scientists may have shunned the physical manifestations of auto-experimentation, but they were embraced by the art community. A painting, Caroline Jones says, leaves behind a "trace of its maker's hand" (9), either through thickly applied paint, visible brushstrokes, or just in the appearance of speedy construction. The emergence of performance art in the twentieth century is another example. The conceptual art of Yoko Ono is an interesting twist where the artist is denied the status of genius; instead, the audience is expected to perform the experiment, which might be physical, mental, or both.

The scientific thought experiment is intimately associated with Einstein. The questions he asked focused on finding the "underlying design" that he was sure lay "hidden" behind the confusing tangle of late nineteenth century physics. Thomas Kuhn, in an essay on thought experiments, asserts that their actual purpose is to resolve contradictions in the mind of the experimenter. He writes, "the new understanding produced by thought experiments is not an understanding of *nature* but rather of the scientist's *conceptual apparatus*" (242, his emphasis). In other words, these are not just experiments performed *in* the mind of the scientist, but are experiments *on* the mind of the scientist. They are the mental equivalent of the auto-experiments performed by (and on) the Romantic geniuses in the early nineteenth century.

Einstein as Thought Experiment

Einstein's link with thought experiments is a further example of the "scientist sitting at his desk, divining the laws of the cosmos" and an indicator of his status as a revolutionary scientist. The originality and creativity of his work, as portrayed in traditional documentaries, connect him in the public mind to the methods of art more than those of science. Because Einstein is also portrayed as an unreachable genius, his characterization reinforces the separation of science and art.

From Thomas Kuhn's interpretation of thought experiments, which function "to assist in the elimination of prior confusion by forcing the scientist to recognize contradictions that had been inherent in his way of thinking from the start" (242), we can see that Einstein himself, or more accurately, the mythical Einstein constructed by his depictions, operates as a thought experiment. The period of normal science that Kuhn has described is marked by a closely integrated body of knowledge, which tells the scientist "what the world is like and simultaneously defines the problems which still demand professional attention" (261-62). In this way, a researcher is able to focus on problems which are solvable, and which will extend the precision and scope of the paradigm. However, Kuhn says, this method of selecting research questions, "though it makes short-term success particularly likely, also guarantees long-run failures" (262). Some of the failures to fit the paradigm are part of current research attempts, but some are pushed to the sides or "suppressed entirely." As the anomalous results build up, a thought experiment may be employed to effect a re-conceptualization of the paradigm. The thought experiment helps

the scientist to perceive a contradiction and then to replace the confusion with clear concepts.

The contradiction which is confronted in the Einstein myth is the separation of art and science. The paradigm shift in the nineteenth century, away from the imagination and creativity and towards "mechanical objectivity," guaranteed the short-term success of "normal" science. The anomalies that arise in this analogy are scientific theories, such as evolution, relativity, and quantum mechanics, that are difficult to fit into ordinary understanding. The "thought experiment" that is the Einstein myth should help us to recognize that our confusion arises from the contradiction we have established between science and imagination, or, more generally, art.

However, by moving the paradox to the mythological level, the contradictions are allowed to remain. The mythic Einstein is not a role model for the public to follow; he, or another person of his caliber,[14] unites the contradictory abilities for us. Like most myths, the point of the Einstein myth is not to imitate the master literally, but rather to contemplate his example. Joseph Campbell, in his comparison of hero myths, illustrates this point with the example of Jesus, who united man's soul with the divine. According to the church, the union of opposites for the common person happens after death; in this world, we work in service to God, maintaining the distinction between the categories.

Human myths, around the world, are expressions of a submission to the inevitableness of destiny. Myths, Campbell writes, provide guidance on how to live in the world, or perhaps one should say, to live *with* the world, in the way that it exists. "No tribal rite has yet been recorded which attempts to keep winter from descending; on the contrary: the rites all prepare the community to endure, together with the rest of nature,

the season of the terrible cold" (384). They tell a story about how the world is, so that we can learn to accommodate ourselves to its ways. The lesson of the Einstein myth, of the myths of creativity and originality, is not to bother mixing science and creativity lest you fly, like Icarus, too close to the sun.

THE SCIENCE ESSAY FILM

> *"If my mind could gain a firm footing, I would not make essays, I would make decisions, but it is always in apprenticeship and on trial."*
> Michel de Montaigne, "On Repentance."

The separation of art and science is aggravated by the traditional science documentary. Its form, or what Bill Nichols, in *Representing Reality*, calls its "voice," communicates a message as loudly as does the content. As biographical narratives smooth the "errant trajectory of life," science narratives smooth (or smother) the halting, lurching, and, at times, backward movement of science. The slow process of science research, where hypotheses are tested, modified, and sometimes discarded, is reduced to a summary of key events. The selection of which events to present is made at a later stage, with the full benefit of hindsight. Condensing research into a series of linear steps is analogous to the summation of work encapsulated into the "eureka moment." The small little steps of science, which wind around and double back on themselves, are erased, leaving behind only the footprints of one giant leap.

The biographical form, with its inherent focus on the "significant" individual and the "significant" moment of discovery, is ill-prepared to overcome the presumed separation of science and art. The "traces of production" of creativity — the daily reorganization of thoughts and ideas — are erased, leaving only the "flash" of insight. A line is drawn by the traditional documentary, separating "those" scientists, who are considered extraordinary enough to handle the imagination, from the rest of us. What is needed is a new style of science film, one that can straddle the line between documentary

and personal art film. Following Ann Utterback's description of the voices of the documentarian (adapted from T. S. Eliot's three voices of poetry), we need a style that will combine the traditional Griersonian voice addressing an audience with the "art film" voice talking to itself. This latter case, Utterback writes, "is purely the result of the poet's search for his own meaning" (33), an attempt by the author to explore an idea. This is the motivation that begins and guides the process, and it is only later that, in the words of T. S. Eliot, the creator will "want to know what the poem which has satisfied *him* will have to say to other people" (34).

Science writing has already developed a similar style in the form of the personal essay. The writings of Steven Jay Gould or Roald Hoffmann provide a science lesson but also connect that information to their life and the lives of their readers. This style, as well, allows one to emphasize the trial-and-error process, in contrast to the traditional form which nearly requires the author to cover it over. Any setbacks which do appear in a biographical documentary are transformed by the narrative itself into obstacles which the hero, naturally, overcomes. The essay, on the other hand, tends to complicate a discussion with anecdotal fragments and other digressions. Michael Renov, who has used the essay as a way to analyze the films of Jonas Mekas, argues that the logic of the essay form denies the coherence of rhetorical composition and even the notion of mastery: "Knowledge produced through the essay is provisional rather than systematic" (216). The essay is concerned with process, tying the thought process of the author with the physical process of writing. The science essay makes a further connection to the practical day-to-day activities of science.

It is somewhat surprising that the science essay has never (or very rarely) served as the basis for a film. Although, to be fair, the essay film in general is a difficult genre, with only a few real masters: Chris Marker, Jonas Mekas, and Alain Resnais. The essay film, as developed by Mekas and Marker, is not quite autobiographical and not quite a diary. At least, not in the way that these genres are approached in literature, although Marjorie Keller does provide convincing evidence linking Mekas's work to women's diaries. The self-reflections of an Augustine or a Descartes, for instance, are pre-calculated. As Keller writes, "Their plans are announced and determined ahead of time" (84). In contrast, Mekas's films are made progressively and may even wander a little aimlessly. Notably, they do not cover the "moment of his incarnation as a filmmaker:" Mekas simply bought a camera. The emphasis is placed on the day-to-day activities of life instead of a few "significant" moments.

The "home movie" style of Mekas certainly does not concentrate on a hero character, but neither does Marker's *Sans Soleil* (1983) or Resnais's *Night and Fog* (1955). Resnais's essay film goes to great lengths to indict all who were involved in the Holocaust and even those who were not. It is a masterful piece that pulls in the perpetrators, the by-standers, and even the audience of the film. There is no sense of "us" versus "them," like a viewer might get from a traditional World War II documentary.

The literary ancestors of the essay film, in particular Michel de Montaigne and Roland Barthes, made use of fragments and digressions to avoid the smoothing that traditional narrative brings to a work. Such an approach acts as a counter-ideology of form, Barthes said in *The Grain of the Voice*, because "the fragment breaks up what I would call the smooth finish, the composition, discourse constructed to give a final meaning to

what one says, which is the general rule of all past rhetoric" (209). It avoids the single interpretation that a rigidly linear story requires. Instead, as Phillip Lopate writes, "the essay [often] follows a helically descending path, working through preliminary supposition to reach a more difficult core of honesty" (244).

Chris Marker's *Sans Soleil* is the high water mark of digression, moving from images of Iceland to Africa, Japan, and San Francisco, among others. Meanwhile, the narrator ruminates on the sense of place and the limitations of memory. This essay film could be contrasted meaningfully with Ron Fricke's *Baraka* (1992), which jumps through twenty-four countries in a whirlwind tour of sensationalism. Unlike *Sans Soleil*, which actively puzzles over the questions it raises about history and memory, *Baraka* merely repeats the standard hierarchy depicting nature as a lost paradise. Instead of working through a thought process about the place of human civilization in the world, it settles for what Silverstone calls the "images of its effects."

The science essay film provides a form that is inherently geared to presenting the creativity that all scientists have. It doesn't focus on big events and famous people; instead it highlights the artisanal nature of science, the craftsmanship that is employed everyday by all scientists. The essay allows for an explication of the process through which the author grapples with questions of science. The personal outlook can open up the discipline, describing its culture to a larger audience. At the same time, the personal essay can demystify the subject, showing the processes of scientists as not that different from what we all use to muddle through everyday life. Connecting the viewer to the daily activities of science will lessen the division between scientists and non-scientists, blurring the distinction between "us" and "them" that is so prominent in the traditional documen-

tary form. By accentuating the imagination and creativity that all scientists, and really, all humans, possess, the essay film rejects the alleged separation of science and art.

My thesis movie, *Synthetic Art*, attempts to steer a course between the traditional science documentary and the art film. I tried to provide information on chemistry, at least how and why we draw molecules the way we do, a small but necessary part of the field. The essay form is a way to share information with the audience, rather than lecture to them or mythologize a hero. I wanted to share my excitement, to pass along my interest in chemistry. In fact, I find chemistry fascinating, even captivating — I am drawn in, much the same way a film draws me in. Both fields rely on motion: molecules never stay still, they are always moving around, bumping into each other and sometimes reacting. Movies are also never static, on many levels. The story has a progression, each scene and shot raise the question in the viewer of what will happen next. On the technical level, as well, film is fundamentally a progressive series of still images.

The contrast between the static pictures in the textbook and the chaotic motion in reality is the essential hurdle in describing chemistry. I made this tension the core of my movie, playing off the same contrast of stasis and motion in film. Therefore, I "set" the movie as a science lecture using slides and then I turned the slides into the single cells of animation. The single frame, a still image, is the essence of film, as Peter Kubelka's work exemplifies. His theory is explained briefly in P. Adams Sitney's book *Visionary Film*: "Cinema is a projection of stills—which means images which do not move—in a very quick rhythm" (286). A film projector is no different than a slide projector, except much faster. None of the images are actually moving, but the viewer perceives them as if they were.

In a similar fashion, when we present a chemical reaction, we see the first frame (the starting material) and the last frame (the final product) with maybe a middle frame (the transition state), and we must supply the missing frames in our head, using our "visual" imagination. I wanted to emphasize this link by having the film move between the different frame rates: the very low rate for the still images, the "normal" rate for video, and in-between rates for the animated segments. Some scenes even "skip" frames, like in a synthetic scheme published in a chemistry article. The viewer, then, must supply the missing frames of the movie in an analogous fashion to the "missing" frames of the synthetic scheme.

Synthetic Art also focuses on the act of drawing in an effort to showcase the craftwork that is inherent in chemistry. Several scenes are extreme close-up shots of the tip of a pencil drawing on paper. This serves to draw the audience in, to kindle a concentration in the viewer that is similar to the concentration that we ascribe to the artist. It is not just the mark of the artist, though, it is the mark of a master in any field. The focus of the master craftsman is something we humans find compelling. We watch musicians rather than just listening to them; we watch chefs, carpenters, and athletes, too.

Scientists often have this same intense concentration, but the product of their work is obscured to us — the molecules are beyond microscopic. You cannot watch a chemist build a molecule in the same way you can watch a carpenter build a table. So we are left with the "images of its effects," like the pipette in biology documentaries, or the pills being routed into bottles on the evening news. I used the images of the act of drawing, hoping to bring out the "craft" character of chemistry and to emphasize the process of research rather than the product.

The personal essay form allowed me to combine Ann Utterback's two voices of documentaries: one voice sharing information with the viewer, the other voice working out my own thoughts on how to explain my fascination with chemistry. Most important, the personal essay is an alternative to the hagiographic depiction of scientists that is the usual form of science films.

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APPENDICES

APPENDIX A:

FILMOGRAPHY

YEAR	TITLE	DISTRIBUTOR

1960 **"Einstein Dead!"** ***Greatest Headlines of the Century*** Official Films
A short, three-minute piece about Einstein, emphasizing his connection to atomic energy, as well as his simplicity, intelligence, and humanitarian works.

1970 ***Albert Einstein*** McGraw-Hill
Classroom film, probably intended for children in late elementary school. A mix of cartoon-ish still drawings and live action dramatizations. Focuses on Einstein as a quiet but curious child, and how that pattern carried through to adulthood. Also describes how learning can be fun, especially when you have as unusual a teacher as Einstein.

1974 **"The Majestic Clockwork," episode 7 of** ***The Ascent of Man*** PBS
A one-hour episode on Newton and Einstein and how they re-shaped our view of the universe.

1979 ***A. Einstein*** NOVA
A standard PBS biography made for the centennial of his birth. Emphasizes Einstein as an outsider in science and politics.

1979 ***Images of Einstein*** Drew Associates and IBM
A thirty-minute film about the making of a statue of Einstein for the National Academy of Sciences in Washington, DC. Includes almost equal time on the sculptor as it gives to Einstein and his work. Emphasizes the similarities between the two.

1991 ***A. Einstein: How I See the World*** American Masters (PBS)
An interestingly made biography, depicting Einstein as a mystic. Highlights his pacifism and anti-nuclear efforts.

1996 ***Einstein Revealed*** PBS
A two-hour special with an actor portraying an old Einstein, going through his old letters and papers. The first documentary to emphasize his relationship with his first wife, Mileva Maric.

1996 ***The Life and Mind of Albert Einstein*** Educational Distributors of America
A one-hour classroom video, featuring a standard biographical depiction. Avoids much discussion of his first wife. Emphasizes Einstein as a late bloomer.

2003 ***The Elegant Universe*** PBS
An adaptation of a book about string theory which includes a lot of discussion about relativity. Einstein is portrayed as the prophet that opened the way to a twenty-first century Theory of Everything.

YEAR	TITLE	DISTRIBUTOR

2003 ***Einstein's Wife*** PBS
A biography of Mileva Maric, Einstein's first wife. Investigates the claim that the Special Theory of Relativity (and therefore, $E=mc^2$) was a joint invention. Depicts Einstein as a besotted lover.

2004 ***Exploring Einstein*** **"Life of a Genius"** The Science Channel
Covers Einstein's life as it dramatizes his last few days spent laying in a hospital bed.

2005 ***A. Einstein*** A & E *Biography*
A biography of Einstein that spends a good portion of the time describing his relationships with women, from the passion and dissolution of his first marriage to his many affairs with "groupies." A little bit of explanation of his work and a little bit on his impact on society.

2005 ***Einstein's Beautiful Equation*** The Science Channel
Focus on the meaning of $E=mc^2$ and its impact on the atomic bomb. Dramatizes the Einstein-Szilard meeting and the letter they wrote to President Roosevelt.

2005 ***Einstein's Big Idea*** NOVA
A two-hour adaptation of David Bodanis's book "$E=mc^2$" that mixes docudrama with interviews and a narrator. Spans the years 1896-1905, when he was a college student and a young clerk at the Swiss patent office, culminating in the publication of his Theory of Special Relativity and the aforementioned equation. The program also dramatizes other scientists whose work covered a portion of the equation (Michael Faraday, Antoine Lavoisier, James Clerk Maxwell, Emilie du Chatelet, and Lise Meitner). All of them struggle to convince other scientists, except for Einstein who merely must "explain his difficult, complex ideas to a confused physics community."

APPENDIX B:

NOTES

[1] Many of these pieces are collected in *Cultures in Conflict: Perspectives on the Snow-Leavis Controversy*, edited by David Cornelius and Edwin St. Vincent. A summary of the historical background underlying the debate is in the *Encyclopedia of Literature and Science*, edited by Pamela Gossin, in the sections on "Science in Literature" and "Scientists in/and Society."

[2] While there has been an emphasis on the creative individual in science (especially since the 1960s), the ordinary person continues to be overlooked. The interest in creativity has taken either a "bottom up" approach (trying to encourage it in young children) or a "top down" approach (pointing to select people as exemplary role models). Both methods assume that all but the best lack creativity, and that it is a talent that cannot be learned; one can only encourage a seed that is already planted.

[3] Quotations from the documentaries studied in this essay are from transcripts prepared by the author, with the exception of *Einstein Revealed*, *Einstein's Big Idea*, and *The Elegant Universe*, which were downloaded from the *NOVA* website, accessed at http://www.pbs.org/wgbh/nova/transcripts.

[4] A NASA webpage (by Dr. Tony Phillips) on Einstein's miracle year of 1905 gives the impression he reached his groundbreaking results in an original way; not, however, because that was how he worked, nor because a fresh, creative approach allowed new insight, but because of his "irreverent" "disregard for authority."

[5] Immanuel Kant, *Critique of Pure Reason* [1781, 1787], trans. Norman Kemp Smith (New York: St. Martin's Press, 1965) p.645, quoted in Lorraine Daston, "Fear and Loathing of the Imagination in Science," *Daedalus*, vol. 127, no. 1. (Winter, 1998), p. 82.

[6] While written accounts do not have the same length requirements that films have, and hence may address some of life's complexity, they are not immune from simplification. In Rosenstone's words, "we all know many excellent [written] histories and biographies that mute (or even moot) debates by ignoring them, or relegating them to appendices, or burying them deep within the storyline" — or in footnotes like this.

[7] This phrase was used to advertise the 2006 SILVERDOCS documentary film festival and is a standard description of documentaries. A quick Internet search for the combination of "real-life story" and "documentary" resulted in almost 70,000 hits.

[8] Nichols points out how all the senses of the word "representation" are contained within documentary film. It may refer to a likeness or depiction of something, or it may refer to standing in for something, as in political representation. It is also used in the sense of legal representation, where one places facts before other people, by means of a discourse, in an attempt to persuade or convince them.

[9] As the practical activity of science vanishes from a documentary, Silverstone observes that the program will focus instead on the "images of its effects." These images will be contextualized in a standard way: through "establishing exteriors, illustrative cut-aways, images of non-specific activity and so on." (389) The reliance on such "b-roll" is another example of Rosenstone's double tyranny of the necessary image and perpetual movement.

[10] In the measure of a person's life, you cannot score much higher than sainthood. In his biography of Einstein, Abraham Pais explicitly used the form of canonization to recount the 1919 measurement of the bending of light during an eclipse. After a decade of attempts to make the measurement, and only four years since Einstein had published the value expected by the General Relativity Theory, a British expedition in May 1919 succeeded in making observations. Their results, bracketing Einstein's prediction, were formally announced at a joint meeting of the Royal Society and the Royal Astronomical Society. Pais relates the meeting as if it were a Congregation of Rites, with members of the Royal Societies filling the roles of postulator, advocate, and procurator. (p. 305)

[11] Levi-Strauss uses the French Revolution as an example. The historian will see the revolution as a series of past events with consequences that may still occur in the present. "But to the French politician, as well as to his followers, the French Revolution is both a sequence belonging to the past – as to the historian – and an everlasting pattern which can be detected in the present French social structure and which provides a clue for its interpretation, a lead from which to infer the future developments" (85). In the United States, one might see the American Revolution as a similar guiding myth.

[12] In a similar way, Picasso is seen as the founding father of twentieth century art. Einstein scholar Arthur Miller has written a book (*Einstein, Picasso: Space, Time, and the Beauty That Causes Havoc*) on this premise, paralleling the biographies of both figures. There are also, of course, continual references throughout the twentieth century attributing Einstein's theory of relativity as inspiration for Picasso and the cubists, which usually hinge on a misuse of the term 'relativity.' Holton covers this in his book, *Einstein, History, and Other Passions*, pp. 7-10.

[13] Sinclair Lewis, in *Arrowsmith*, made the connection between scientists, artists, and genius: "To be a scientist is like being a Goethe: it is born in you." Quoted in R. Haynes, *From Faust to Strangelove*, p. 298.

[14] Like Einstein was called a "Newton for the twentieth century," so has Einstein become a point of comparison. Richard Feynman, unarguably a great scientist, is also considered a genius. *NOVA* broadcast a biography of Feynman in 1993 called, *The Best Mind Since Einstein*.