THE SOCIAL ROLE OF POPULARIZED SCIENCE

by

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Abstract

In this thesis I will argue that popularized science books should adhere to normative criteria regarding the presentation, interpretation, and understanding of the natural sciences. The increasing popularity of popular science texts (PSTs)—based on sales, critical notice, and scholarly attention—indicates that they can function to interest and partially educate the lay public in scientific principals and practices. I will identify and analyze the narrative, rhetorical features of two popular science texts: Douglas Adams' Last Chance to See and Alan Lightman's Einstein's Dreams. These texts are selected based on a series of normative criteria, criteria constructed for the purpose of enhancing the public understanding of science. Additionally, these criteria are needed to help the lay public develop a proper appreciation of science. A proper appreciation of science, I argue, enables people to make better informed decisions regarding their own personal welfare and also that of the natural world. Finally, a proper appreciation of science, stimulated by PSTs, may help both scientists and the lay public reconceive the possibilities of narrative, public writing, and civic discourse.

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I thought I was a good writer, and always figured that I had a natural gift for producing written works, but I had never in my life attempted anything of this scope and soon found myself humbled. This project would not have been possible, indeed, would never have been started in the first place, if it had not been for Dr. Jim Collier, a good friend, an advisor, on more than one occasion a classroom instructor, and, above all else, a voice of reason, and, blessedly, antagonism. He never once let me forget that I was doing this to learn, to continue on in my chosen field, and that, while I would never get everything into this paper that I wanted, I had to at least get the basics… after all, it *is* a Master's Thesis. Through numerous meetings and e-mails he helped me construct this from what initially was a class paper—a paper that I wrote two years ago and thought was good, but, having re-read it since, realized that Dr. Collier gave me a good grade because of what I *could* do, what I *wanted* to do. Not because of what I did. My utmost appreciation and thanks goes out to one of the best professors I have ever known. Thanks Dr. Collier.

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Rock'n Roll.

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Introduction

This examination of the social role of popularized science borrows heavily from multiple fields of discourse: the rhetoric of science, the rhetoric of popular science, popularization discourse, technical communication, visual rhetoric, film theory, philosophy, and arts and aesthetics. My focus in this thesis tends towards conservation and ecology, which by no means implies that other fields are any less important. I simply prefer to work with this aspect of the natural world in mind.

Chapter One begins by examining the difficulties in transferring knowledge from specialists to non-specialists and defining terms associated with such transference of knowledge.

Chapter Two then takes into account the actual process of disciplining and acculturation in the sciences with a primary focus on disciplining within academia. I then examine what has commonly been termed the "deficit model" of popularization.

Chapter Three examines normative criteria for defining texts as science popularizations, then focuses on the defining characteristics of those texts that I have chosen to focus my analysis on: Douglas Adams' Last Chance to See and Alan Lightman's Einstein's Dreams.

There are three primary and three secondary criteria that I have selected for the popularizations, or popular science texts (PSTs), that I am most interested in examining. The three primary criteria are largely extrinsic to the text, and are as follows:

1) The text must be a single or co-authored book;
2) The text should be commercially published and readily available;
3) The author(s) of the book(s) have previously gained reputations.

The three secondary criteria are largely intrinsic to the text, and are as follows:

1) PSTs affirm the author's knowledge of the subject matter;
2) PSTs should provide verifiable scientific information;

PSTs should affirm established science.

In a brief coda to this work I consider the pedagogical possibilities of science popularizations.

By examining what constitutes effective science popularization and how these science popularizations are received and used by the public, I show how the increased awareness of science, primarily the natural sciences, allow members of the public to make increasingly educated decisions regarding fundamental issues that affect every human on the planet.

1. The Popularization of Science

I. Transferring Specialist Knowledge to a Non-Specialist Public

Popularized science must communicate scientific knowledge to a public largely without the benefit of field-specific disciplining processes. As such, responsible popularization struggles to convert aspects of a field that take years to master into easily readable (and enjoyable) text, *without* mythologizing the field, the participants, or the subject. While difficult, a careful author can effectively do this, and the resulting text has many potential uses far beyond simple entertainment.

It is useful, at this juncture, to clarify some of the key terms that this argument is based upon, first and foremost among them, that of "science," and those key terms associated with it.

J. Bronowski, in Science and Human Values, defines science as "the organization of our knowledge in such a way that it commands more of the hidden potential in nature" (7), and Karl Popper argued that "science is a biological phenomenon […] that has arisen out of prescientific knowledge; it is a quite remarkable continuation of commonsense knowledge, which may be in turn seen as a continuation of animal knowledge" (5-6). Regrettably, I am not quite sure what animal knowledge is, and, unfortunately, many of the foremost practitioners of the rhetoric of science and associated fields fail to clearly define "science" as a term, though it is used frequently.

For the purposes of this Master's Thesis, I designate science to be that knowledge created and justified by practitioners of the same, which is often accepted as falsifiable knowledge based on the same education, ideology, and precepts that they (the scientists) were trained in; i.e., socially constructed and validated knowledge which is accepted or

denied, and, if denied, reconstructed based on testing, reconfiguration, and reorganization of the previously tested, organized, and codified knowledge. In Writing Biology, Greg Myers also utilizes a similar definition, one that:

> point[s] to a distinctive scientific method involving falsification or replicability, to institutions such as peer evaluation and publication, to the position of the scientist in historical processes, or to some quality of the subject mater studied. These distinctive characteristics of science are taken to separate science from the realm of rhetoric and social processes, so that, however much social factors may enter into a particular case *real* science always continues, or works best, apart from those factors. (4)

Hence, while scientific knowledge still leaves room for unique thought and defining moments of interrogation, qualification, and organization, it also acknowledges that which has come before—in short, a true scientist, science aficionado, science historian, etc., is never, unless at the advent of an entirely new area of interrogation, left to re-invent the wheel, as it where.

I agree that the word "science" has been utilized in so many different ways that it can no longer be held within a sparse paragraph of definition, yet I am also aware that by invoking the term "science" I am metaphorically recreating a highly systematized image of both a field and set of values. By clarifying "science" as knowledge based on empirical research, I hope to avoid some of the "negotiability of the meaning of the term *science*" (Russell 41). Karl Popper argued that:

> It seems clear that in science, especially in mathematics, we often first use a term […] intuitively, then priced later to define it. Bu this is a rather rough description

> of the situation. A more precise definition would be this. Some of the undefined terms used intuitively can be sometimes replaced by defined terms of which it can be shown that they fulfill the intentions with which the undefined terms can be used; that is to say, to every sentence in which the undefined terms occurred (e.g. which was interpreted as analytic) there is a corresponding sentence in which the newly defined term occurs (which follows from the definition)" (290).

In other words, terms are contingent upon their environment, leading to a sense of "Make it up as you go along". Be that as it may, I feel that I have consistently held, and continue to hold, science to be that which I have previously described—an intellectual pursuit that requires significant training and acculturation and one in which presented end products are the result of empirical study. This definition puts much more weight on the academic disciplining that goes with the field, extending science and scientists far beyond historically older views which held that "science is rooted in common sense and is nothing other than an elaborate form of public reasoning" (Bensaude-Vincent 108).

Following from this definition of "science," I hold a "scientist" to be a practitioner of science, and a "non-scientist" to be someone that is not a practitioner. Hence, a scientist is someone who aids the production and creation of scientific knowledge through use of scientific method and empirical research.

The "scientific presentation" of knowledge is that presentation of facts, or knowledge accepted as fact, in such a manner that it conforms to accepted language patterns and presentational guidelines as accepted by the scientific community.

These basic definitions of science and its practitioners are encapsulated within the term “scientific ideology,” a term which, in brief, is a “systematic body of concepts” (“ideology”) representative of empirically produced knowledge.

The last term hinging upon the definition of “science” is that of “science popularization.” In short, I hold the “dominant” (Hilgartner) view of “science popularization” to be the presentation of scientific knowledge in a form and format that is “generally understandable or interesting” (“popularize”) to members of the public outside of the specific area of the sciences from which the original information was originally presented, or simply “science writing for the general public” (Calsamiglia 139). These popularizations are often considered as “translations (often dubious ones) of scientific research for a lay audience” (Paul 32) which “are consciously adapted away from academic rhetorical conventions toward constructions that have mass appeal” (Varghese and Abraham 201) and include “only texts about science that are not addressed to other specialist scientists, with the assumption that the texts that are addressed to other specialists are something else, something much better: scientific discourse” (Myers 265).

Scientific discourse exists in unsimplified form as a method of communication between specialist groups. “Specialists,” are members of a group with similar educational backgrounds that have been acculturated through learning and experience into groups that are able to communicate with each other without having to simplify or qualify their information in order to communicate necessary concepts. In essence, members of specialist groups speak the same language and use the same jargon. “Non-specialists” are members of the public outside of the specialist group currently being discussed, though they may, in turn, be members of their own specialist groups.

The idea of a "Knowledge deficit" refers to a lack of shared information between groups. Hence, the specialist groups of scientists engaged in the study of the natural environment are privy to information that specialist groups engaged in the design of aircraft engines may not be aware of. The "knowledge deficit" is simply a way of saying that there are concepts and information that each group holds that may be communicated partially to other groups in simplified form. These other groups can be subsumed under the larger category of "public."

The public ("people as a whole" ("public")) consists of scientists, non-scientists, specialists, and non-specialists. The production of texts for public consumption includes all potential readers, but each text is specifically targeted towards a particular audience, hence, different groups within a public have differing levels of expertise, cultural identifications, reading strategies, etc. Ken Baake suggests that, "Scientists in the midst of a research program must write different accounts of their work for fellow scientists in their area of specialty, for scientists with different specialties, for granting agencies, for academic generalists, and for the lay public" (Baake 169) which proves that there is not one single writing strategy which lends itself to universal accessibility, thereby necessitating the category of writing, popularization of science, which this thesis explores.

The popularization of science carries with it several integral aspects that make it worthy of study as a potential means of conveying scientific fact. Instant audience is one of the most important: through bestseller lists, word of mouth, casual observers that simply happen to pick up flashy magazines or tune to a particular channel on the television, and pre-existing audiences that tend to follow particular author's works,

scientific concepts may be conveyed without any sort of fear factor, the idea that scientific information, either because of preconceived notions regarding the field, or because of its often intensely formal presentation, is daunting to those not schooled in its understanding.

Many scientists *do not* want their research publicized. It is quite easy to pursue a one-sided argument on the issue that suggests that public availability of knowledge is always a good thing, but this is not always the case. It must be realized that upper level sciences, those areas of scientific exploration far beyond the simple high-school chemistry and biology labs of my youth, can be very scary places for outsiders, especially for those that visit vicariously through another's writing. A simple mis-explanation, one unexplainable or poorly explained term, a partial truth, any or all of these, could lead to public fear and outcry, for instance, recent debates and discussion surrounding stem cell research. Science is not always pretty, and it's a true fact that many members of the public sphere are not ready or able to face. Biologists kill animals in order to preserve them for study. Chemists create poisons, physicists create bombs. Medical specialists make mistakes in new procedures, and, oddly enough, ecologists have been known to chop down trees. Besides the idea that misinterpretation or sensationalism will potentially lead to public outcry is the simple truth that making knowledge public also opens the market to competition. There is *always* a potential negative side to public availability of knowledge. E. O. Wilson captures this in his "first rule of the history of science":

> [W]hen a big, new, persuasive idea is proposed, an army of critics soon gathers and tries to tear it down. Such a reaction is unavoidable because, aggressive yet abiding

> by the rules of civil discourse, this is simply how scientists work. It is further true that, faced with adversity, proponents will harden their resolve and struggle to make the case more convincing. (26)

Scientists may indeed act this way, and scientists are real human beings. Extrapolating outward from this, it is fairly safe to day that *all people exposed to controversial scientific knowledge* will take sides. It then becomes the science writer's moral and ethical obligation to take into account potential debates surrounding the public presentation of knowledge and judge whether such material is suitable, ready, or ethically viable for public dissemination. There is no clear guideline, nor should there be. The issue itself is presented only as a portrayal of fact. No issue is nicely delineated into "shoulds" and "should nots." Ethics remain in the hands of the writers, just as, in the end, what the public actually *does* with the information they have been given is entirely up to them.

Because popular science texts can stimulate public response and ethical debate, Alan G. Gross' idea that "We can argue that scientific knowledge is not special, but social; the result not of revelation, but persuasion" ("The Rhetoric of Science" 20) helps to clarify the persuasive affect of these texts. Popularizations *do* persuade. This pursuit, popularization, is not risk. It is important, at least so far as creating a text that is purported to have a scientific background, to make absolutely certain that the science is sound, that is, that the portrayed science is potentially verifiable. The danger here lies in the miscommunication of fact or the blurring of fact and fiction: as John S. Nelson mentions in a reference to David V. J. Bell, "Rhetoric intends to affect people, and it does—though not always as intended" (209).

In "*Omni* meets Feynman: The interaction Between Popular and Scientific Cultures," D. A. Stone examines the usefulness of popularizing scientific concepts by examining works by the popular physicist Richard P. Feynman and an article by Jessica Maxwell entitled "Into the Woods," a look at wildlife and their interactions with habitat and humanity as viewed by a non-scientist. He also examines works by Jonathan Miller, Stephen J. Gould, and Rachel Carson's Silent Spring. His conclusions are simple and effective:

> Our society desperately needs guidance in the task of trying to understand and control the influence of science. To the extent that scientific writers can free themselves of the ideology of rationalized science (and the examples of Feynman, Miller, Gould, and Carson suggest they can), then scientists themselves can assist with this task by more forcefully expressing the populist part of themselves. They will thereby give a more honest account of the scientific enterprise both as it is conducted within the scientific community and as it relates to the general public. (307)

By more effectively relating to the general public, scientists may be able to more effectively communicate the need for support and funding, and funds, as any scientist will tell you, are often difficult to come by. The general public, however, loves to fund a cause, and in recent years has become heavily invested in the creation of knowledge through research institutions both public and private (Resnik 255-256). The need for funds to continue research has been artfully drilled into the collective skulls of millions, and, so, in many cases, money appears as a result of increasing the public's exposure to research agendas.

As Dorothy Nelkin, in Selling Science exhibits, this kind of plea to the public carries the potential of great effectiveness:

> Traditionally working in a context where success is measured by the judgment of peers, scientists have long assumed that a record of accomplishment is sufficient to maintain research support. Thus, information, the scientist's 'stock-in-trade,' has been directed primarily towards professional colleagues. Most scientists have not been interested in public visibility; on the contrary, they have feared it could result in external controls on their work. But attitudes in the scientific community have changed. Dependent on corporate support of research or direct congressional appropriations, many scientists now believe that scholarly communication is no longer sufficient to maintain their enterprise. They see gaining national visibility through the mass media as crucial to securing the financial support required to run major research facilities and to assuring public policies toward science and technology. (125)

As with any sort of discussion opened for democratic debate, the possibility exists that increased public exposure to science will backfire. While Nelkin's argument that "national visibility [may be] crucial to securing financial support" (125) it is also just as likely that the general public will *not* view the research agenda as worthy of support and funding. This is where the science-writer comes into play, along with moral and ethical decisions concerning the rhetorical strategy involved in what could be construed as science marketing. In some ways, however, it is also up to the scientists themselves. Thomas Gieryn et al. suggest that:

> Ideologies found in public science are not sufficient to explain the growing authority and resources of the profession of science: one must also consider how scientific knowledge is put to use, say by the State or private industry. Yet decisions by government or industry to invest in scientific education and research are sometimes based on crude images of *what science is* and what it might accomplish in the future. Scientists have a professional interest in diffusing images or ideologies of science that encourage these public or private investments. (406-407)

Since the images of science that are diffused to the public are quite varied in nature, it is now necessary to consider how these views are to be taken. In short, an examination of the public portrayal of science must consider "whether the rhetorical is a legitimate perspective from which to view science, and whether, as a consequence of that perspective, new insights are achieved" (Gross, "The Science Wars" 447). It is also just as viable to suggest that a reconception of information can lead to a dialogue between specialists and non-specialists that works to provide a humanist consideration of knowledge production within the sciences themselves.

Besides increasing the potential for increased public funding, these "new insights" may be provided by well written popularizations that also function to increase interest in a particular field or subject *within* the boundaries of specialized fields. In at least one particular instance this has already occurred. In "Spreading Chaos: The Role of Popularizations in the Diffusion of Scientific Ideas," Danette Paul examines this particular role of popularizations in the creation and dissemination of knowledge within scientific fields of study. In particular, she looks at popularizations of chaos theory in the

associated field of physics. Paul points out that, in many circumstances, popularizations are not accepted as useful information by embedded members of the scientific community; instead, most research examines only:

> [W]hat is considered the primary purpose of popularizations—to educate, persuade, or communicate with the general public. Although [many other researchers] recognize scientists as potential readers of popularizations, they do not consider the possible consequences these readers have for science; in other words, they do not consider what, if any, role popularizations play within the scientific community. (33)

However, Paul argues that, at least in the role of chaos theory, "popularizations played an important role in diffusing concepts of chaos theory within and across disciplinary boundaries in science itself" (33). The basic idea is that a well written popularization becomes accessible to multiple audiences, and while the science contained within the popularization is not as in-depth as the science presented in a peer-reviewed journal, the fact that the book is accessible, well-written, and well-researched makes it an important form of publication for the progression of the scientific field itself.

It is useful to point out that the word "popularization" sometime connotes anti-intellectualism. In a personal communication with author James Gleick, Paul quotes Gleick as saying that, "I never liked the word 'popularizations.' I think it connotes 'here's this body of knowledge, now we're going to explain it in simple terms to a lay audience'" (47). What Gleick seems to be saying is that "popularization" often becomes synonymous with "cheapen." This should not be what occurs in a popularization at all, but because not everyone can be an expert on everything, specialists reviewing

popularizations about their own fields are often likely to notice what is *not* included, as opposed to what actually is. Because there are specialists, there *must* be a non-specialist audience, and it is to this audience that popularizations are aimed.

I would suggest that popularizations can serve as "gateway" texts—an idea that Paul points out through interviews:

> [A] scientist, when asked how he became involved in chaos studies, responded that he had been having a conversation with another scientist in a bar, and the other scientist told him that he ought to read a book called Chaos. Two other scientists, when asked about training graduate students, said they had started training graduate students by having them read Chaos. (48)

Popularizations, then, can become part of the disciplining process. In the case of Chaos, Gleick's work helped to define a discipline, and it is worth noting that while "scientists produce science, […] they also produce, read, and participate in scientific popularizations for a variety of reasons. In turn, their participation in scientific popularization, whether as contributors, producers, or readers, has consequences for the science. (Paul 61)

These consequences relate to the idea that there are moral and ethical considerations when mass producing a text that will potentially function as the public façade for a discipline or field of study. In the case of deliberate miscommunication, the results can be extreme. Specifically, scientific hoaxes, while often amusing, show how the misuse of scientific presentation can draw a public into a conversation with no verifiable "fact" and, in some cases, (such as that of Sokal) weaken a discipline's trust in other members of that discipline.

Secor and Walsh's interrogation of the rhetorical strategies employed by Alan Sokal in his classic hoax publication "Transgressing the Boundaries: Towards a Transformative Hermeneutics of Quantum Gravity" reveals many useful strategies (interestingly enough) that may be utilized in order to achieve publication. The crux of the discussion is captured in the realization that publications containing scientific (or pseudoscientific) information may be taken as correct and valid by an audience who is readily impressed by scientific phrasing, form, and format. Writers owe it to their audiences to provide information that is morally appropriate (strives for accurate presentation) to its parent material. Sokal's hoax, as Secor and Walsh state, simply "offered ammunition to those who believed all along that postmodernism and science studies were jargon ridden and illegitimate" (77).

Unfortunately, these hoaxes have also helped mythologize science and its practitioners, leading to public opinion that is often confused in relation to "science" and "science fiction" (Moore 108).

Similarly, there is a prevalent social view of the scientist which suggests that "rationalist science is dangerous to one's spiritual well-being because it is too clinical, too abstract, and that the scientists who control the mysteries of modern secular knowledge are unaccountable to conventional standards of morality" (Toumey 411). Basing his work on an examination of the scientist as portrayed in classic films and literature, specifically such notable characters as Dr. Jekyll and Mr. Hyde, Dr. Frankenstein, and Dr. Moreau, Christopher Toumey suggests that it is important for the science-writers, scientists that write, and public portrayals of scientific discovery, to stay true to the realities of scientist's work if the implications or intentions of a work are to

cast science in the light of reality. He states that "scientists are accustomed to critiques of science by articulate well-meaning intellectuals like C. P. Snow and Lewis Mumford. But outside the circles of academic etiquette there is another kind of critique, a kind of Gothic subterranean reality, which reveals a visceral fear of science" (433). This fear is also a fascination however, and that fascination makes itself apparent in Hollywood's use of "accurate" scientific portrayal within the movie industry.

The idea that science popularization is most certainly not limited to paper format is supported by Myers argument that, "[…] Focus on written texts, even if it is traceable to purely practical consideration, limits studies on popularization. First, some of the most dramatic and memorable encounters with science are primarily visual, rather than verbal" (272). This suggests that popularizations outside of purely written discourse can also serve as modes of scientific communication, and certainly refers to charts, graphs, photographs, movies, etc.

Within film, the idea is often not that a work of fiction be verifiable, but simply perceptually believable. Consultants are often discussed as attempting to cast a sense of reality on their fictional counterparts. Scott Frank points out that, "It is no stretch to say that more people have seen scientists on TV or in films than know one personally, and that a greater population has seen *Jurassic Park* than have ever taken a paleontology class" (428). Perceptual believability, in these cases, can lead to the commodification of science, and is often viewed by the movie industry not as a teaching tool, but as a way of maintaining an audience. With the idea of believability comes the idea of suspension of disbelief, and Frank essentially points out that:

> Filmmakers are looking for 'real science' to increase the perceptual reality of their projects, for whatever reason—personal preference, box office take, what have you. To do this, they hire real scientists and engineers. These consultants come to Hollywood to tender their opinions, allowing the studios and filmmakers to stake some claim on the power of reality. (462)

Beyond this, there is also some belief that accurate scientific portrayal in mass-marketed movies, or, at the very least, semi-realistic portrayals, "may even positively affect the public opinion of science" (464) but to what extent this positive affect influences or actively supports the sciences is still somewhat cloudy. It is useful to note, however, that "for the vast majority of the audience, the only paleontologist and volcanologist they've ever seen are the hero-scientists portrayed by Sam Neill in *Jurassic Park* and Pierce Brosnan in *Dante's Peak*" (465). On the flip side, they may also be familiar with the mad-scientists and Doctors as outlined in Toumey's article.

Science popularizations can be put to good use by both scientists and science writers to achieve a greater public understanding of scientific concepts, which can then be utilized by the consuming public in everything from political to ecological decisions, to reconceiving the study and practice of science itself. Two examples of these effective popularizations are Douglas Adams' Last Chance to See, and Alan Lightman's Einstein's Dreams.

II. Effective Popularization

Effective popularizations are accepted by the public as "good writing" and convey a sense of science-as-it-is: in effect, they allow the general public to reconceive the world of the sciences. By recasting science in a humanist light (showing scientists' social awareness of their actions), changes can be made by both scientists and the lay-public in the way each group perceives the other, in effect de-mythologizing both specialist and non-specialist groups. This de-mythologizing would allow for specialist/ non-specialist conversation where information is made available to all aspects of a public, thereby increasing the chances (and availability) of/ for increased education which could be used to make educated decisions regarding issues concerning public welfare.

With that in mind, I consider both Douglas Adams' and Mark Carwardine's Last Chance to See and Alan Lightman's Einstein's Dreams as science popularizations that work to both engage the audience in an ongoing conversation and also bring to the surface discussions which may function to stimulate thought and interest in matters pertaining to realistic public concerns.

Effective popularizations function to inform non-specialist publics about specific areas of scientific inquiry by utilizing didactic aestheticism. Essentially, these texts provide a pleasurable experience that at the same time effectively a subject (or aspects of a subject) to the reader.

This idea of didactic aestheticism is effectively shown through a series of papers concerning an ongoing discussion of ecology and aesthetics, and while, again, instances of the presented ideas utilize examples from art forms outside of the printed text, the underlying theme and argument are relevant to the discussion at hand.

Allen Carlson's 1979 paper "Appreciation and the Natural Environment" opens an important discussion concerning the aesthetic portrayal of nature as a method of forwarding knowledge which is still, to some extent, being worked out today. Carlson examines different models regarding the aesthetic appreciation and understanding of nature by making comparisons with paint and sculpture artworks, suggesting that the differing ways in which we appreciate, or view, art mimics the ways in which we appreciate and view nature: "Works of different particular types have different kinds of boundaries, have different foci of aesthetic significance, and perhaps most important demand different acts of aspection" (267). The two methods of aspection Carlson proposes are Object and Landscape models. In Object, we view nature, or aspects of nature, in the same way that one might view a sculpture:

> For example, we may appreciate a rock or a piece of driftwood in the same way as we appreciate a Brancusi sculpture: we actually or contemplatively remove the object from its surroundings and dwell on its sensuous and design qualities and its possible expressive qualities. (Carlson 268)

Potential flaws in this idea are related to the assumption that objects in nature are easily separable from their surroundings: "The limitation marks the distinction between appreciating nature and appreciating the objects of nature" (268). In the landscape model, nature is viewed in the same manner as a landscape painting is viewed; hence, one sees, from a given viewpoint, what an area looks like at a particular moment in time. This too has problems:

> The model requires us to view the environment as if it were a static representation which is essentially 'two dimensional.' It requires the reduction of the environment

> to a scene or a view. But what must be kept in mind is that the environment is not a scene, not a representation, not static, and not two-dimensional. The point is that the model requires the appreciation of the environment not as what it is and with the qualities it has, but rather as something which it is not and with qualities it does not have. The model is in fact inappropriate to the actual nature of the object of appreciation. (270)

Yet even though the models are flawed, they do allow an inroad to appreciation, that is, one can not begin to understand and appreciate something without having some form of knowledge about the subject in the first place. The greater the knowledge, the greater the potential for appreciation. Hence, while one may appreciate art, a true artist will catch nuances of color and brush strokes that others might miss. Similarly, the more exposure that a public has to an idea, a concept, a field of study, etc., the more they can either appreciate it, or at least make educated decisions regarding its output and the utilization of knowledge gained from such a source. Carlson suggests that:

> [T]he question of *what* to aesthetically appreciate in the natural environment is to be answered in a way analogous to the similar question about art. The difference is that in the case of the natural environment the relevant knowledge is the common sense/scientific knowledge which we have discovered about the environment in question. This knowledge gives us the appropriate foci of aesthetic significance and the appropriate boundaries of the setting so that our experience becomes one of aesthetic appreciation. (273)

Given the beginnings of verifiable information in a popular book, readers begin to hook up that short-form knowledge with their own appreciation of their environment; hence,

the more "education" one absorbs the greater ones understanding and appreciation of ones surroundings. While the primary focus here is on nature and the natural world, this analogy may be extended towards any form of scientific inquiry. Information gained with relation to *any* previously unknown or less understood idea leads to a heightened ability on the part of the reader to appreciate that idea, for better or for worse.

Carlson continues his argument in 1981's "Nature, Aesthetic Judgment, and Objectivity" which describes the value of accurate categorization of nature in order to more fully appreciate it in its entirety. The first section deals with Kendall L. Walton's method of categorization, in which Walton suggests that "the aesthetic judgments which *seem* true or false of a work are a function of the perceived status of its perceptual properties given in any category in which the work is perceived" (Carlson 16). Essentially, work (art) is judged by which category an observer/critic presupposes that work to be placed in. Walton's four categories, as detailed by Carlson, are paraphrased as follows:

1. Standard properties with regard to what it is "supposed to be,"
2. It (the object) is "better" when perceived the way it is "supposed" to be perceived,
3. The author/artist intended it to be perceived as such, and
4. The category that the work belongs to is well established (16).

Carlson expands on the potential uses and problems in Walton's model (which was based on cubist art work) by relating them to the natural environment. In regards to nature, pigeon-holing experiences leads to some interesting perceptual problems, among them the rather broad insight that "it appears to be a matter of aesthetically appreciating whatever one can and as much as one can, but *not* a matter of getting it aesthetically right

or wrong, *not* a matter of making true or false aesthetic judgments" (17). His argument contains the fundamental idea that nature is not created by humans. Hence, if humans attempt to re-create nature, that re-creation falls into a different perceptual category than nature itself. Again, categorization plays an important role regarding the perceptual awareness and value of an object: "not only are works of art the products of societies, but in a similar way so are the categories of art themselves. Consequently, not only do the circumstances for a category being correct not readily apply to nature, but the categories themselves do not apply" (18). In other words, the categories apply only to the human creation—not the natural environment that is the model for the creation. Extending Carlson's idea, it appears that good human creation may lead to increased appreciation of nature, but does not designate nature itself as intrinsically good, just as bad creations reflect only on the work itself, not what the creation was attempting to portray. Hence, *good* creations have the potential for positively affecting appreciation more than *bad* creations have the potential to negatively affect appreciation.

All of these debates concerning the aesthetic appreciation and categorization of nature are brought home in conclusion with a discussion pertaining to environmental awareness. Once a reader learns to see a thing with more depth, with greater relation to his or her surroundings, and with more of an intellectual attraction to the thing because of knowledge gained about the subject, then that reader is more likely to categorize that thing as important, and worthy of care/attention. Carlson suggests that:

> If our aesthetic appreciation of nature helps to determine our ethical views concerning nature, then our aesthetic appreciation of nature should be of nature as it in fact is rather than as what it may appear to be. By aesthetically appreciating

> nature for what it is, we will shape our ethical views such that there is the best opportunity for making sound ethical judgments in regard to matters of environmental and ecological concern. (24)

Noel Carroll extends Carlson's perceptual model to more clearly explain the aesthetic value of artistic appreciation in perception of the natural world. He focuses primarily on the differing theories of what actually constitutes art, or the artistic experience, and examines the function of artwork to arouse the desire to interpret art in the observer. This holds true for all forms of artwork, from ballet to literature. In many cases interpretive play, as Carroll defines it, has been historically viewed as non-important in the definition of art because it does not constitute an aesthetic experience. Carroll determines that such mental play can and, in many cases, does provide some form of aesthetically moderated pleasure. As important is the idea that art holds the promise of reward for the observer/critic/receiver: "Simply put, our aesthetic interest in an object is predicated on the possibility of our deriving aesthetic experiences from the object" (58). The joy of interpretation, ostensibly held within an object of art, waiting for a subject to come and unlock it, constitutes, in Carroll's view, at least part of the art experience, an art experience that yields "more responses, appropriate to artworks, than aesthetic responses" (67). Hence, art is, or rather could or should be, categorized with relation to a multiplicity of potential engagement tactics.

These potential engagement tactics are extended by M. Eaton in her discussion of the usefulness of the portrayal of the natural world through fictional or creative writing. There are two sides to the debate, as she sees it; that of the "cognitive model of nature

appreciation," and the "imaginative" model (149). The cognitive model's primary proponent is Allen Carlson, who argues that:

> 'Aesthetic appreciation of nature must be directed by knowledge about it,' that is, one must be well versed in true scientific understanding of the natural world in order to fully appreciate it. The imaginative model holds that 'one manifestation of imagination—fiction—plays an enormous role in shaping the way a culture perceives and conceives the environment.' (in Eaton 149-150)

The human imagination colors the way in which surroundings are perceived. Eaton uses the example of *Bambi* to show how attitudes towards deer changed following the publication of the book and the release of the movie, suggesting that if fiction stirs the imagination and allows for increased interest in the natural world, then it can and should be utilized. This use of fiction, used "broadly as referring to objects created by and appealing to the imagination," (150) must be utilized carefully, however. One must be careful not to "impoverish rather than enrich appreciation" (151), and one must be careful in portrayal lest over-zealousness (for example, hunting bans, modification of environment, etc. that occurred as a result of *Bambi*, and ended with overpopulation and environmental degradation) lead to misconstrual of intent and actually destroy what one is seeking to preserve. So, the end result is that use of the imagination, fiction, in environmental portrayal, can be useful, if used carefully.

It must be remembered that only in a perfect world could one choose to only effect those that would use knowledge for good (itself subjective). Thus, in the creation of popularizations, it *must* be remembered that, while the aim of the text may be to promote understanding, the misconstrual of the contained information, or public

overzealousness towards a cause sparked by the text, could actually carry a negative impact.

Effective presentation of scientific information, especially when writing with an agenda, is one of the ideas behind popular science texts, but to reiterate, there can be *no* impact if the text(s) are not popular. In "Pursuing the Popular," Timothy Gould, in an idea borrowed from Northrop Frye, effectively sums up the entire concept of didactic aestheticism. When reading a popular text, "There is something which itself gives pleasure and keeps you turning the pages, and whatever it is that keeps you turning the pages permits you to enjoy something else, something rather less predictable" (121). It is this area of unpredictability that the popularization aims to direct; to enforce a pedagogical aspect while still maintaining both aesthetics and popularity.

2. Specialist and Non-specialist Publics

I. Disciplining

Society struggles to come to terms with the "shifting status of science" (Charney, "Introduction" 5). This struggle continues, in part, because there is no unified system of discourse which has been able to find a probable solution to the problem of scientific illiteracy. While it is possible that a single solution may never be found, it is just as reasonable to suggest that the literary qualities of effective science popularizations could help to bridge the knowledge gap between scientists, non-scientists, specialists, and non-specialists. In order to see how this particular problem functions, I feel that it is important to examine the initial instances regarding the creation and manipulation of authority in scientific and academic matters. This initial groundwork is necessary to provide reference points for the continuation of certain debates surrounding popularized science, specifically those concerned with the deficit model of science versus public interaction.

Power is inherent in all systems, and is more or less utilized by all participants. A power/ knowledge deficit occurs when there is a lack of information overlap between groups, so that one group (usually the specialists) is perceived as wielding more power, or authority qua knowledge, than another. Looking broadly at the creation and maintenance of an academic discipline, one begins to see how the effective use of power on multiple levels creates an entity that is unique both in shape and appearance and is able to interact only nominally with other entities in other forms of disciplinary structure and discourse. Examining Foucault's perceptions of disciplinary power and comparing and contrasting them with those methods of discourse discussed in Pierre Bourdieu's

Academic Discourse, I examine the creation and importance of academic disciplines and their importance in the communication of what we broadly conceive as "knowledge."

To define "discipline" as it will be used in this context, I focus primarily on its academic use as a term referring to:

- A power structure consisting of knowledge managers (those units of academia that decide what the intended focus of a field of study will be and how that will be communicated:
- Teachers and professors (agents of the field of study who exist to develop ideas that fit into an area of study defined by the knowledge managers, and to communicate previously existing knowledge to students who have entered the field:
- Students (those who have placed themselves in a field of study and who wish to contribute to the growing body of knowledge that constitutes a field of study:
- Members of the lay-public (people either outside of academia, or members of academia who are not specialists in whatever field or topic that comes up for discussion or is presented for inspection.

These groups—knowledge managers, teachers and professors, students, and lay-public—constitute the physical backbone of what is commonly referred to as an academic discipline.

Distinguishing between a discipline as a thing, and a discipline as a practice is important. While the two are often deeply enmeshed, superficially they are separate entities. Foucault focuses primarily on the latter use of the word; that is, he primarily

investigates “discipline,” in relation to the manipulation of power/ knowledge. However, I would tend to agree with Goldstein in his analysis of Foucault’s underlying theme:

> The term “discipline” has, in both French and English, the perfect ambiguous resonance for this conflation of a social power-wielding activity and knowledge. The older medieval Latin meanings of the term—the maintenance of a set of rules and the punishment meted out for their infringement, or somewhat differently, a formative instruction or moral direction to which one submits—are the meanings that Foucault adopts most patently and deliberately in *Discipline and Punish*. But the additional meaning which the term acquired in the modern period—a branch of knowledge—lurks beneath the surface of the text and is equally germane to Foucault’s concept. (178)

Once defined, a discipline must organize itself in a manner that presents a strong unified front. In this organization is the presence of what is broadly conceived of as power: a unified front represents a majority with similar goals and purposes, in essence, a whole much greater than the sum of its parts. Traditionally, the physical sciences (Snow 15) have created a more visible unified front than the humanities. When asked “What exactly is it that you do?” a scientist is typically more likely to give a description that carries with it the sense of production of knowledge for the public good. For example, a scientist can respond by saying, “I am developing a cure for the common cold,” or “I am researching a new method for downsizing computer screens so that new laptops will weigh half of what they do now while producing images twice as clear.” The humanist is somewhat limited in the ability to directly connect with the lay public in a way that indicates production of useful knowledge. When faced with a choice between funding a

cure for AIDS, or funding research on the life and times of Ben Johnson, I would argue that the lay public, a government funding agency, for example, will send funding towards that research which produces a tangible public "good." This type of social validation is evident when researching the term "academic funding" within the 2000 U.S. Census. The bulk of returned items focus on science and technology, and even within science and technology, those groups whose research agenda indicates production of a usable "thing", i.e., those projects involved in "Development," receive more funding than those projects categorized as "Basic Research" (U. S. Census, "Statistical Abstract" 602). The idea that a discipline exists on the strength of its physical presence is exemplified in Becher's work:

> This perception is to a certain extent shared by outside observers of the academic scene, who will tend, independently of calculations of utility, to show a greater sense of awe towards research in biochemistry and physics at the one extreme than to studies related to education or social work at the other. The establishment of a strong academic image is therefore by no means irrelevant as a move in the game for external credibility and status. (174)

A discipline's physical presence, the establishment of a "strong academic image," is derived primarily from the language and culture inherent within an academic discipline. "Academics as a group employ a certain form of language which operates as a given" (Bourdieu 36). As a neophyte is acculturated, redefinition of previously accepted terms is accomplished. In short, jargon (a discipline's shorthand for the communication of large quantities of knowledge in the least amount of time) becomes ingrained in a subject, and that subject begins to proceed "upward" hierarchically within the bounds of

the discipline. This same method of acculturation—redefinition of terms and methodology—is more broadly represented by the actual discipline itself. The more specialized a discipline becomes, the more incomprehensible its jargon becomes to outsiders, and the more internalized that jargon becomes to participating members of the discourse community. As explained by Charles Bazerman:

> […] Each reader calls on personally organized knowledge. This schema extends beyond textbook knowledge of accepted facts and theories to include dynamic knowledge about the discipline's current practices and projections of its future development. The schema even includes judgments about the work of colleagues. (239)

In a model of the prior argument, Pierre Bourdieu examines the language of teaching, observing that professors speak in a certain discipline-specific manner in order to organize their thoughts and pass them along to students, most of who have not been trained in the language of academic discourse, and thus receive, or actively understand, only a small portion of that material which is presented for their study. Bourdieu's study, performed in Paris in the 1960's, examines the pedagogical structure at the time and explicates the language structure inherent in the academic system. Bourdieu explains that:

> […] while students and their lecturers have a theoretical and long-term interest in challenging how universities work, they also have a practical and short-term stake in preserving a fiction which performs vital functions for them in a situation in which they have to act and of which they are a product. (14)

This “fiction” seems to be most obvious at the introduction to a field of study. Initially, students find an academic’s jargon to be nearly incomprehensible, yet they persist in the field, reinforcing that particular field’s method of discourse. As students become acculturated, their own perceptions and language become sufficiently colored by all that has come before to the point where they are then able to participate in what was initially a “fiction.” While it initially seems ludicrous to think that all of the facts and figures that a new student is inundated with will be recallable at some later time, the system works subtly by acculturating the student to disciplinary dialect, and by doing so becomes a self-reflexive example of disciplinary power in action.

Not all students are easily acculturated however, which leads to defining moments of teaching. Upper-level academics must constantly strive to communicate knowledge to those who lack the proper vocabulary to adequately understand it. As such, new turns of a phrase and new teaching methods are employed and continue to be employed until these lengthy explanations are no longer needed and the student has a proper grasp of disciplinary jargon and is able to fill in the blanks on his/her own. In short, “bad pupils are at one and the same time the truth and the justification of the system of education which consigns them to hell” (Bourdieu 17). The more that a student struggles, the more a professor attempts to communicate the “correct” way of perceiving a problem (and ostensibly its answer). Thus, struggling to communicate difficult disciplinary concepts to the “bad pupil” constitutes one of the primary activities of academic life.

Despite difficulties in communication, the discipline maintains a sense of internal integrity. No effort is made, especially at upper levels, to maintain knowledge in a form

which is readily accessible to the lay-public. Bourdieu suggests that academics are "imprisoned" by the system of which they are an integral part:

> It is the logic of the system which dominates the ways in which the actors represent the system and its failings, and which also establishes the limits of this representation. Thus, even in their most utopian images, students and academics remain imprisoned by the logic of the institution in its present form. If their fictive images of another possible system are so impoverished, it is because the object deficiencies of a system can not appear in their true guise to the human subjects who are trapped in it and subject to it. (23)

This seems, however, to represent a rather skewed perspective of the power structure. Knowledge, and the power resulting from knowledge, is difficult to access. Thus, academic standards must remain high. The defense (broadly conceived) for the initial difficulty of achieving access to that knowledge is that only by knowing how the discipline works, and by knowing what work has taken place before, can one hope to even begin to attempt to create new and potentially valuable thought.

In the second of two lectures given on January 14, 1979, Foucault discusses the inherent power utilized and created by disciplining. Similar in effect to the sort of power wielded under a monarchy, his ideas can be extended towards the creation of disciplinary systems where the new student is brought in to an existent structure and is molded by direct intervention and subtle nudging to an accepted academic system standard. Foucault's conception of power, when applied to the disciplinary structure of a field of study, is quite apt. Not only does the field call for a formalized language which mediates the need for extensive repetition on behalf of the players in the system, but by functioning

within the system, each player becomes more disciplined in the accepted norms and roles that that field requires. Immersion in a field subjects one to the inherent power found around each person. Each being wishing to become part of a singularly unified system of power— and by singularly unified I mean an ideal structure in which each participant researches and practices towards a common goal— benefits from disciplinary immersion and the power negotiation that such immersion implies. This power delineation, the covert norming of an individual *subconsciously*, if not *consciously*, causes participants to have power *acted upon them* in such a way that they tailor their presentations and research methods to be socially acceptable within that field of study. Each participant in the field wields academic power. Participants wield power consciously by accepting or declining other participant's views/offerings, or subconsciously, by *acting as their field dictates that they must act*, and thereby enforce upon others the impression of unity within a field. This unconscious act is a major cause for covert disciplining within the university environment. In one way or another, students perceive the way that their professors dress, speak, and act, as defining moments in the function of a field of knowledge, then begin adding particular language terms, field-specific metaphors, and speech/language patterns to their personal lexicon.

A student wishing to enter a particular field begins a process of overt disciplining. A student is disciplined by the system—forms and formulae that higher authorities have decreed that a student must know in order to be accepted by existing members *of and in* the system. Students also self-discipline. They strive to fit into a mold in the particular discipline. However, a student, upon realizing a desire to become a member of a particular field, does not immediately run out to purchase some a uniform in order to be

accepted into academic society. Still, once immersed in a field, a student is constantly subjected to accepted norms, and that that student will become less and less academically distinguishable from other higher ranking members of that field. This model exemplifies Foucault's theory that "power never ceases its interrogation, its inquisition, its registration of truth: it institutionalizes, professionalizes and rewards its pursuit" (93). However, Goldstein argues that Foucault's work is largely invalid because:

> […] its sweeping claims rest on insufficient research in the available sources; it employs an opaque philosophical vocabulary [in and of itself a sign of disciplining]; the historical process seems devoid of flesh-and-blood actors and is narrated largely by use of the impersonal pronoun "one"—to cite some of the most common complaints. (171)

The views exposed by Goldstein are not limited to only one or two critics. As delineated in "The Disciplinary Society: From Weber to Foucault," by John O'Neill, there is some argument that while Foucault's analysis of power "scores nicely against certain Marxist conceptions of state power, his own views are in danger of leaving us the victims of power that is everywhere and nowhere" (47). This is, I believe, the crux of the matter. If one accepts that power is omnipresent, then learning how to successfully manipulate social systems constitutes effective use of power. Power, then, must be "out there," simply waiting for someone to act. The question to ask, then, is not *where is power*, but rather, *how is power used*.

Foucault suggests that we examine not *individual* choices but instead focus on *unit* choices, that is, if it is accepted that power may be wielded, then look not an one

particular individual's use of power, say, a monarch or scientist, but rather the institution that that individual represents:

> Let us not, therefore, ask why certain people want to dominate, what they seek, what is their overall strategy. Let us ask, instead, how things work at the level of ongoing subjugation, at the level of those continuous and uninterrupted processes which subject our bodies, govern our gestures, dictate our behaviours etc. (97)

I would argue that the affects of power, both in and on a discipline, can be tracked financially. While disciplines are often internally competitive, that is, the right to develop and propose new insights is granted to those members of a discipline who have received "permission" to speak, what actually becomes an accepted method of discourse is granted privilege based on support and funding. Becker, in relation to this argument, suggests that:

> […] It also has to be recognized that the competitiveness here is in a large measure occasioned by the dependence […] of intellectual work on external economic support and on the means by which that support is acquired and distributed. Freedom of research is in general limited by the need to persuade others that the necessary resources should be provided. Unless, as rarely happens, money is available in sufficient abundance to dispense with any competition for it, disciplines are forced into the position of rival interest groups. Their quest for status, which one might see as in some respects analogous with the individual academic's concern with reputation, is stimulated not merely by an intrinsic tribal pride but by an extrinsic need to justify their existence and maintain their collective livelihood. (173)

Academic disciplines are then put into the position of constantly having to prove that they are worthy of continued support and funding. Consider, for example, the previously mentioned census data. Disciplines are also under the continual onus of creating professionals within the system that are beholden to the system which created them—thereby providing a self-serving unified base for continual field propagation.

In English, for example, incoming students are indoctrinated into particular methods of discourse. They are "formed," as it were, by being assigned papers to be written in a particular format, then held to accepted methods of writing and inquiry which become self-serving (by self-serving, I mean that form and format of expression is repetitive and becomes ingrained and unconsciously accepted. As students progress along a disciplinary path, they are more and more constrained in the particular writing styles and expressions that they are "allowed" to use. As terms are defined, perceptions become colored by disciplining. When one reaches the upper echelons of the university power structure and one is heavily steeped in its laws and lore, one becomes essentially unable to function methodologically outside of the chosen discipline. Power, then, is wielded on multiple levels throughout a discipline, spilling down from the top, the knowledge managers, and, in the end, cycling reciprocally back to them again in the end. Hence, the knowledge manager wields power over the teacher, the teacher over the student, the student over the work, which, depending on the level of the student, or the student's immersion in non-academic society, may be either formally or informally presented to members of the lay-public, who, either being tax-payers who dictate state funding to land grant universities, or alumni who being contributing agents to the financial welfare of academia have a say in what work succeeds or fails, and in how

much effort the student (again, at any level) is to put into the work, which causes the work to wield power over the student (by causing time constraints, need to acquire knowledge, etc.), the student to wield power over the teacher (in much the same way that work wields power over the student), the teacher to wield power over the knowledge manager (by agreeing/disagreeing, to some extent, to acknowledge the knowledge manager's authority) and the knowledge manager to then take all of this into consideration (in an ideal world) and restate the power he/she wields over the teacher, ad infinitum.

The above analogy may be applied throughout academia, all the way from classroom interaction to academic conversations. In the end, power seems to be exactly as Foucault proposed—a model quite similar to monarchical/societal engagement. One must always remember that even in the case of a well-established monarchy the peasants could riot, thereby effectively wielding great power, and, in the case of academia, power over job and hiring decisions.

Disciplinary discourse is disciplined by and from the disciplines themselves. Foucault suggests that:

> [T]he disciplines have their own discourse. They engender […] apparatuses of knowledge (*savoir)* and a multiplicity of new domains of understanding. They are extraordinarily inventive participants in the order of these knowledge-producing apparatuses. (106)

Disciplinary knowledge is presented in such a way that it is often beyond the non-discipline-specific understanding of the lay public. The separation of the public into

specialist and non-specialist groups results in what is often accepted as a “deficit model” of discourse, a topic examined at some length in Section II.

II. The Deficit Model of Popularization

I would argue that most non-scientists are daunted by the typical format and presentation of scientific information. Few people outside of scientific specializations are trained to read and comprehend the standard scientific paper. Even fewer are likely to pick up an academic review or textbook for casual reading. In the same manner, professionals are unlikely to actively seek specialist information in multiple areas outside of their own field, rendering them a lay-audience when dealing with information outside of their primary areas of expertise.

Jon D. Miller's compilation of data on scientific illiteracy shows a general deficiency in the public's understanding of scientific concepts. Miller's study, "Scientifically Illiterate: Research on Adult's Understanding of Scientific Terms and Concepts," consisted of data compiled on "2000 adults conducted […] by the Northern Illinois University Public Opinion Laboratory" which "reveals widespread public confusion about scientific facts" (26).

Miller suggests that the level of general scientific knowledge and understanding is somewhat disturbing because:

> The survey […] shows that the majority of Americans don't know enough to understand basic discussions about scientific research. If a newspaper runs a story about how a newly discovered chemical changes the molecular structure of a compound, at least two-thirds of the readers will not understand it (26-27).

The idea that the majority of the public lacks basic concepts which could lead towards educated choice in regards to scientific information, which in many cases influences everything from politics, to medical funding, to conservation debates, seems, very nearly

a cause for panic. A deficit model that suggests that the public does not possess enough information to make informed decisions is problematic, yet Miller's data suggests that these very same people are *themselves* affected by their lack knowledge:

> For the 25 million Americans who do not have a high school diploma, the world is a strange, hostile, and somewhat dangerous place, according to the results of this survey. This group has a strong sense that it lives within an incomprehensible system. […] When asked whether "scientific researchers have a power that makes them dangerous," 70 percent of high school dropouts agree. Education does not completely erase this suspicion, because 38 percent of college graduates also agree. Yet the least-educated feel strongly that they must depend on leaders and experts to explain the world around them. Over 80 percent agree that "the only way we can know what is going on is to rely on leaders and experts who can be trusted." A majority of college graduates reject this statement. (28)

In relation to the idea of popularization of science, Miller's survey results indicate that any sort of forward movement in the public understanding of science (PUS) would be a good thing. The public would be likely to benefit from an increased understanding of scientific knowledge. One potential benefit would be an increased awareness of the actual world in which we live. This knowledge would allow people to make educated judgments based on scientific fact, rather than judgments solely based on advertising or propaganda. As Fahnestock, among others, has suggested, any movement of knowledge from its highly specialized point of origin/observation to a less-specialized public implies a mediation of some sort ("Accommodating Science" 334). Miller indicates, however, that:

> American elementary and secondary schools do not provide an adequate conceptual framework for later learning. By failing to confront superstition and pseudoscience, schools leave gaps in knowledge that are filled by the marketplace. And in the marketplace, there are few distinctions between science fiction and science facts. (28)

This suggests that there is a distinction between popularization and pseudoscience. Advertising, the marketplace's way to fill in the "gaps," does not necessarily attempt to adhere to truth. Information gained from knowledge derived from, based on, or the description of scientific facts (in this case, popularizations), help to combat what Miller describes as "superstition and pseudoscience." It is difficult to say outright that Americans must be fully cognizant of scientific knowledge and information. It is as equally difficult to claim that all Americans must have some basic ability to understand the implications of the information presented in any sort of media that potentially has the ability to mediate understanding, use, and impact on the real, physical, ultimately finite world outside the front door or outside of the bedroom window. My belief, however, is that a basic grasp of scientific knowledge would be beneficial in allowing Americans the ability to, at least, to make informed and educated decisions regarding their natural environment based on realistic presentations of science. For instance, greater awareness of debates surrounding global warming, drilling for oil in the Alaskan wilderness, or a more in depth knowledge of the limitations of medical science, would allow for considered decisions regarding debates surrounding the issues.

The grasp of rudimentary scientific knowledge is not contingent upon an advanced degree, yet statistics regarding such degree holders may help to illuminate

perceptions help by some members of specialist publics regarding non-specialist publics. In Delaware alone, per the 2000 U.S. Census, only 9.4 percent of the population held a graduate or higher degree, which leads into David A. Stone's idea that:

> When scientists think of the public, especially when they express their frustration at the difficulties of communicating with a general audience, they tend to characterize their readers in terms of absences: the low level of public education of science; the public's intolerance for the technicalities of scientific discourse; the public's inability to accept that, regarding many of the burning questions of the day, scientific knowledge is incomplete and gives ambiguous answers. What is easily overlooked is that the science-reading portion of the public has its own culture, with a fairly coherent system of positive beliefs and values concerning science as well as the negative ones just mentioned. (291)

Popular science texts may fit into the culture that Stone mentions, providing an effective medium for the transfer of information from the specialized sciences to the lay public, in effect, bridging the cultural gap created by belief systems. As Paul Hernadi states, "There is no reason why human scientists should not attempt to explicate, explain, and explore all instances of human speech and writing as message, seepage, and image" (269). By providing a form which is both easily accessible and entertaining, popular science texts and presentations may work to increase public levels of awareness and help to communicate the importance of continued research.

The genre of popularization is organized around a constant and ongoing battle that hearkens back both to the previous discourse on power and knowledge, and to C. P. Snow's 1959 "Two Cultures" speech. Snow identified "two polar groups," (15) one of

which consisted of humanists, and the other of scientists; more importantly, it portrayed the general public as being "poorly trained in the facts and minimally interested in the effects of science and technology" (van Dijck 178). In a more recent article (2003), José van Dijck examines some of the past discussions surrounding C. P. Snow's "Two Cultures" and suggests that because of modern approaches to the communication of scientific knowledge, the two cultures gap is no longer as large as Snow made it out to be:

> Snow's bipolar modernist concept, obviously, no longer applies to a contemporary situation; social, intellectual, and institutional transformations have radically changed the academic landscape since Snow's pretentious framework triggered both public acclaim and outrage in 1959. (178)

His primary argument is that modern ways of knowing have breached the knowledge gap that once was in existence, a knowledge gap that, as portrayed by Snow, led to several semantic problems in the discussion, among them the idea that translators need to exist between the two cultures (181). Van Dijck feels that the omnipresence of science and technology in today's society has removed this language barrier and cultural gap:

> Forty years after [Snow's] famous lecture, science and technology, it is safe to say, have become part of fabric of everyday life. Children start using computers at age six, play with Game Boys, and handle complex audio systems. Hardly any people live their lives without being confronted with medical doctors. Computers, scanners, cameras, medical technology, airplanes, and other means of high-tech transportation are not only ubiquitously present, but our bodies have also to a large extent incorporated these technologies into our basic systems. (183)

In van Dijck's case, the technology discussed is not necessarily scientific technology, but the example functions to illustrate a point. Despite technology's omnipresence, how many people actually know the theories behind any of the toys? How many people realize what goes into making a computer, how to actually rewire complex audio equipment, what went into making it, how the materials were mined and smelted, what the environmental implications were, and how continued use of the technology will affect them and their family? Technology, and the public's ability to use it, may have moved on, but the basis of the argument is still in place. Essentially, while even children are playing with complex technology, they still do not understand the implications behind it. It is ludicrous to suggest that every person on the planet, or even every person in the United States of America, should be well versed in some form of scientific/technological literacy, but, at the same time, it is vitally important that those resources be made available and prevalent so that increased understanding of the world and its phenomena (both man made and natural) can occur. There *is* still a gulf: while technology and understanding between the two cultures has moved forward, *both* sides have moved forward, thereby maintaining a constant distance between the two.

While published two years earlier than van Dijck's article, B. Bensaude-Vincent's "A Genealogy of the Increasing Gap between Science and the Public" offers a different view. In her discussion of the history of the science-public split, she states that it is now "taken for granted that the rapid advances of scientific research, coupled with its increasing specialization and more technical language, deepen the gulf between scientists and the lay public. Therefore, the need for public communication of science is a side effect of scientific creativity" (99). Bensaude-Vincent suggests that there is a type of

symmetry in the discussion surrounding the issue. It is not that there is a knowledge deficit, but that there are differing views on the importance and types of knowledge. In her discussion of twentieth century studies, she points out that:

> While we still use the phrases popular culture or popular music in the twentieth century, the term popular science no longer refers to any specific practice or discourse of science. It is only used to refer to the image of science as reflected by vehicles of pop culture such as advertisements, best-selling novels or television, serials. [Sic] […] What is certain is that the notion of a popular science as a science distinct from that of the professional scientists is no longer acceptable. (106)

This essentially establishes the differences in our cultural time period from those in others. Popular science historically referred to aspects of science that were being performed by an educated public in public demonstrations, for example. What popular science has now come to mean is that there is a "real" science for professionals and a "pseudoscience," or fictionalized science for what have come to be viewed as a largely ignorant mob. This places the process of discovery entirely on professionalized scientists, or, as Bensaude-Vincent states: "Public knowledge is denied all relevance while a minority of scientists holds the monopoly of legitimate knowledge" (107). This suggestion significantly removes valorization from well-educated amateur scientists and works to increase the perceived knowledge gap.

As a method of reconceiving the problem, Bensaude-Vincent suggests that:

> [I]nstead of trying to reduce the notion of the public to one of its dimensions, we ought to recover all of its dimensions. The notion of a gulf is so archaic, so full of

> meaning and over-determined that we need to reconsider all its facets before introducing a policy to heal the "social fracture." (109)

This idea holds especially true when considering that in many discussions surrounding the public dissemination of scientific information it is often forgotten that the public is a collection of highly intelligent individuals, each with their own aims, desires, and forms of education. In addition, the public does not consist of groups of poorly organized, semi-intelligent, nincompoops without any ability to differentiate between right and wrong. The public is not a collection of morons to be led by the hand through a dangerous world. Instead, the public is comprised of each member of society, a society that includes scientists themselves. Lost in the conversation is the idea that a lay-person is any member of an audience without specialist knowledge of a given subject. By this reasoning, then, a member of the "lay-audience" might be a high-level particle physicist reading a journal article on archaeology, or a Nobel-prize winning medical doctor reading a book on botany. The public is infinitely more complex than many discussions take into account. I would hazard that the primary reason for this oversight is that it is much easier to apply a deficit model to a group of faceless people seemingly lacking in complexity. The deficit model is then based solely upon the lowest common denominator of a group as a trope for the entirety. It serves only to increase the gulf between the created reality of society and created reality of scientists. Acknowledging the deficit as a gap based solely on legitimizing and disseminating information helps portray the science writer as a figure "designed" to make knowledge available to a *complex* public by removing information from its formalized field of specialization and re-presenting it only without specialized field-specific jargon, *not* without wit, intelligence, and style.

This "re-presentation" is considered by J. Fahnestock in "Preserving the Figure: Consistency in the Presentation of Scientific Arguments," which examines methods in which scientific information is re-presented for a non-specialist public. Fahnestock considers science popularization as "a special case of a general process by which versions of a core message travel to or are adapted for different contexts" (7-8). She suggests that it is necessary to consider:

> [H]ow a scientific argument can be adapted for different audiences with different needs, interests, and background knowledge and yet remain recognizably the same argument. After all, an argument crafted for one audience may have little in common with a version drafted for another; the wording, in particular, may be radically changed from one register to another. (8)

This idea, that an artifact must be articulated, or qualified, in different ways depending on its intended audience, follows from her 1998 publication "Accommodating Science: The Rhetorical Life of Scientific Facts." Fahnestock argues that as scientific facts move from the sphere of science writing for scientists to science writing for non-scientists, the presentation of scientific fact moves from a level of qualified material to a level of non-qualification. Essentially, as material is re-written for a less specialized audience, qualifiers are removed so that the material often takes on a more confrontational tone. As Fahnestock puts it, "the work of epideictic rhetoric in science journalism requires the adjustment of new information to an audience's already held values and assumptions" (334). Levels of certainty are often placed upon the information that the original researchers may not have intended, so that a report detailing new findings, while originally qualified to show that the research is new and under production/ still being

researched, becomes a statement of fact by the time it reaches the level of public consumption. She says that:

> Scientists-as-authors will retain wording as close as possible to their observed results, even though such a practice leads to complicated and verbose phrasing, whereas a popular account will naturally replace these substantive-as-signs with substantive-as effects. In other words, accommodators will leap to results, whereas the original authors stay on the safe side of the chasm. (338)

The accommodators may tend to sensationalize the information by "leaping to results." There is a fine line in these cases between popularization and sensationalism. The practice of sensationalizing information is inherently problematic. While sensationalism sells, it also functions in a manner that typically misrepresents the original data presentation in a scientist's publication or presentation, hence, where the original idea may have been to suggest that relationships between objects *may or might* exist, the sensationalized version implicitly states that they *do* exist. This rhetorical register shift distorts facts, or at least the perception of fact, and typically occurs when information is removed from its original field of knowledge management. This does not mean to imply, however, that scientists are unwilling to utilize rhetoric in communication with their peers. Scientists choose to operate within a culturally legitimized framework in order to more accurately convey information within a professional environment.

In relation to this idea, Fahnestock's 2004 paper, "Preserving the Figure: Consistency in the Presentation of Scientific Arguments," suggests that:

> [While] scientists and science writers today have no conception of the connections between argument and style presented so richly in the rhetorical tradition, it still

> makes sense to ask whether figures, as epitomes of lines of reasoning, are present in research reports and whether they do appear when that reasoning is re-presented. (10)

She argues that scientists and science writers are unaware of the rhetorical tradition from which they operate, which suggests that their work is somehow non-rhetorical, or should be viewed in a different manner from those professions which typically engage in a study of rhetorical history. The problem with this is that many scientists are only lacking rhetorical terminology and rhetorical awareness, not rhetorical ability. As scientists become increasingly acculturated to their field, they study, and ostensibly become familiar with, research that has gone before. While scientists are not necessarily historians, they are quite cognizant of research that has been performed in their chosen area of expertise. Similarly, they are aware of the rigorous methods of presentation required for scientific journals. Scientific journals are not written for a general audience. They are written for a group of practicing specialists. While scientists may indeed be lacking rhetorical awareness, or rather, the awareness that what they are doing is rhetorical, their attention is turned towards proper form and format which is typically represented by the IMRD structure of scientific publications. This format (Introduction, Methods, Results, Discussion) of scientific presentation allows for a trained way of seeing that lets the information presentation within the sciences progress with a relative minimum of cultural repetition. Similarly, within the sciences:

> Genuinely probing referee's reports often go unheeded (let alone appreciated) because scholarly authors are encouraged to work out their arguments with such thoroughness prior to submission that they are psychologically ill-disposed to any

> response that would have them rethink major portions of their position. In this way, the whole point of criticism is routinely defeated. (Fuller 285).

One of the ways that this thoroughness is accomplished is by adhering to a strict presentational format, or, to borrow from Latour and Woolgar, the idea that "writing [is] not so much a method of transferring information as a material operation of creating order" (245). When tracking this form and format of scientific presentation back through history one begins to see their evolutionary pattern. This pattern is intimately attached to reading practices, which is exemplified in David Hutto's "When Professional Biologists Write: An Ethnographic Study with Pedagogical Implications" (2003). Hutto's study deals primarily with the reading practices of scientists in relation to scientific journals and texts. While his study is based largely on examination of professional scientists and their attitudes towards, and use of, professional journal articles, the paper also takes into account language acquisition skills and textual-engagement among students that are becoming newly acculturated to scientific practice.

This method of acculturation is a form of social constructivism in which expectations must be met. Scientists are used to seeing information presented in a standard format—a format in which:

> […] the chaos of intellectual differences is eliminated. Individuals assumulate bits, follow rules, check each other out, and add their bits to an encyclopedia of behavior of subjects without subjectivity. There is not much room for thinking or venturing here, but much for behaving and adhering to prescriptions. Thus we get to the ever-expanding *Publication Manual*. (Bazerman 275)

Varying from this standard format can create problems in understanding, especially among those that have developed rapid reading methods in order to cope with time deficits. These practices are developed in order to get the most information as possible out of an article while acknowledging the importance of knowledge acquisition through the engagement of professionally written and moderated journals. This type of form-norming is a social collaboration. Scientists present their findings in an accepted format so that other scientists may readily access their work. In the same way, texts produced for use by students also need to be produced in a form and format that allows for maximum usability. Hutto suggests that:

> While reading journals is a private, individual activity, such reading has a social aspect as it places the reader in the context of communal knowledge. Even when the ideas are written down rather than spoken in person, the effect is still to expose the reader to someone else's knowledge and point of view, with its subsequent effect on the reader's own thinking. (213)

This awareness of social constructivism is important to keep in mind, especially when producing documents for a lay audience. The document must be usable, entertaining to some extent, and also allow the reader/audience to create their own impressions (also viewable as "create their own knowledge") based on viewing and use of the end-product.

If this discussion on document norming is brought back into an examination of the idea that "scientists and science writers today have no conception of the connections between argument and style presented so richly in the rhetorical tradition" (Fahnestock 10), we see that scientists are not in any way *constrained* to write the way that they do, they are instead *trained* to read and write in a particular form and format that increases

scientific legibility and significantly increases ease of access. Scientific persuasion then begins to rest on, not surprisingly, rhetoric. The order in which "facts" are presented, the background upon which they are placed, and, as is becoming increasingly clear, the audience to which they are directed and the ethos from which they are given, play immense roles. Recognition of the factors present in each scientific artifact works against more archaic forms of the rhetoric of inquiry, which, as Nelson states in “Stories of Science and Politics,” “conceived science as a rigorously impersonal system of observation and inference not only governed but also legitimated by formal rules of procedure” (201). Formal rules of procedure aside, Charles Bazerman points out that politics, legitimization, challenges, background, and humanity have most definitely led science to its current point of formal discourse, leading to a “well-established frame of reference in which to fit [a] new claim” (28). In the sciences, prevalent ideology is that data speaks for itself. Hence, while there are prevalent rhetorical strategies in place within the sciences to “prove” to other scientists the worth of an experiment or new theorem, the problematic aspect then becomes porting the facts over to an outside source, in the case of Fahnestock’s paper, the magazines Science or Nature. The re-presenting of forms and figures, then, is often problematic with regards to interpretation or articulation, as specialist scientists have both verbal and written shorthand that many non-specialist readers will lack. It should not be surprising then that significant data-presentation modifications are necessary prior to presentation to a non-specialist audience.

These methods, according to Fahnestock, include “preserving the figure,” (14) where scientific figurative language ports over, though often in slightly modified ways (often stronger/weaker); the “dominance of antithesis,” (16) where simple either/or

contrasts are set up; “improving the figure,” a process of modifying argument wording so that clarity is improved (in some cases “subtly alter[ing] the argument) (17); “adding a figure,” (19) where clarification is added to an argument in order to make it more readily intelligible; “antimetabole,” (20) reversing key terms for greater affect—Fahnestock uses the example of “we should eat to live, not live to eat” (20); “common factors” (21), which essentially draw general conclusions based on perceived similarities; “concomitant variations” (22), simply put, variation for affect; and, lastly, “metaphor” (23).

These methods of modifying presentations constructed within formalized discourse and the rhetorical implications surrounding such movement (from specialist audience to non-specialist audience) are taken into account by Greg Myers in his 2003 paper “Discourse Studies of Scientific Popularization: Questioning the Boundaries.” His argument suggests that the dominant ideology seems to follow that of the “golden rule”: He who has the gold makes the rules; or, in this case, the idea that science belongs to scientists and the general public must accept what scientists say. Myers points out that this deficit model of interaction and the accompanied “dominant view” of popularization discourse makes a variety of potentially problematic assumptions, among them, the view that:

> […] there are two separate discourses, one within scientific institutions and one outside of them, and that information is *translated* [italics added] from one of these discourses to another. There are several assumptions that go with this view:

- That scientists and scientific institutions are the authorities on what constitutes science;

- That the public sphere is, on scientific topics, a blank slate of ignorance on which scientists write knowledge;
- That this knowledge travels only one way, from science to society;
- That the content of science is information contained in a series of written statements;
- That in the course of translation from one discourse to the other, this information not only changes textual form, but is simplified, distorted, hyped up, and dumbed down. (The French term *vulgarization* carries even more of this pejorative sense.) (266)

It is this idea of translation that seems to lead to many of the problems inherent in scientific popularization. Translation implies that the public needs some sort of mediator in order to make any sense of what is being said, but in many cases this does not seem to be the case. What really happens is that many of the metaphors, the academic shorthand and jargon used to rapidly communicate ideals and ideologies within a group of people with similar educational backgrounds, do not pass over into the public sphere. Instead of a translator, the non-specialist public needs someone to bridge the gap, or, in a more organized sense, simply someone to fill in the blanks. Translation suggests that the communicated artifact is in and of itself a form of impregnable truth, created or discovered by entities without flaws. Articulation gives a leniency that allows for the author of the popularization to account for flaws and still convey the appropriate meaning to his/her audience. The differences often seem to me to be more like the differences between British and American English. Many of the words are the same; it is simply the way in which they are used which causes confusion. So rather than a translator, a person

that converts one language to another, the non-specialist public needs someone to re-present or effectively articulate the data: someone to apply appropriate metaphors to the information so that communicated information takes meaning to someone outside of disciplined scientific tradition.

Myers points out that the general public consists of semi-experts in areas of knowledge that specifically relate to their own interests, job-specific needs, or personal lives. He uses the example of parents with sick children being exceedingly well-versed in the medical issues surrounding their child's illness, of a sheep farmer being quite well-studied in the scientific ideas of husbandry, and of protestors (and proponents) of nuclear power being well-studied in environmental impact and production concerns (268). The non-specialist public, however, does not have the same scientific support network that specialists do. Much of scientific discourse and mediated knowledge relies on the ability of scientists to call upon members of their own network for support. In other words, a scientist needs only to be able to back himself/herself up with other members of his/her same cultural cohort, and by doing so strengthens knowledge claims. Members of the lay-public, in arguments surrounding science issues, do not have this type of background resource, and, as a result, are often not taken as seriously in arguments that utilize specialist scientific information. As Myers points out in reference to Latour's work, "Members of the public who challenge scientific claims will never have the same sort of authority as scientific experts, because they cannot marshal the same networks of support for their claims" (269).

One particular area that strikes me as problematic is the information interaction idea, based on Wynne's 1996/2001 work, where:

> Some scientific institutions […] assume that if people knew more about science, their attitudes towards the authority of science in matters of public policy would change: they would be more likely to believe estimates of the risk or safety of nuclear power plants, vaccinations, or skin cancer. But this is clearly not the case; people assess messages about risk in terms of such factors as their trust in the person or institution telling them, its past record, their memory of other, similar issues, and their feelings about how this issue fits with their own experience. (273)

I believe that this portrayal of the deficit model becomes somewhat irrational in its suggestion that the majority of the public are incapable or unwilling to utilize scientific information, or any information coming from respected sources (in and of itself a problematic statement, as a scientist, group(s) of scientists, or institutions must then be respected in order to gain attention) in their everyday lives as a means of making educated decisions on a subject. The presentation of the public as unwilling to accept verifiable information as a standard for decision making suggests that the public is incapable of informed decision, and while emotional and historical aspects of circumstance certainly play a large role in decision making, informed decision based on fact must also be taken into account. For instance, the purchase of a house based solely on a feeling seems potentially problematic, while the purchase of a house based on market knowledge, home inspections, and verifiable, substantive proof that the house is not near collapse makes perfect sense. This analogy is similarly applicable to decisions regarding the natural environment.

While scientific literacy may be a hot-button topic, it is most certainly not the only sort of literacy of which many academics feel that the general public needs to be

cognizant. In "Scientific Literacy and the Competition for Public Attention and Understanding," W. J. Paisley points out that other forms of literacy include everything from business literacy to visual literacy (73) and it is important to realize, especially in relation to the discussion at hand, that "any specialized knowledge with a claim on the public's attention and understanding can be construed as a literacy" (72). He continues, in relation to the idea of scientific literacy, that "thoughtful experts in […] many fields believe that their specialized knowledge should claim a share of the public's limited attention and understanding" (74). Paisley has a point. While conservation ecologists, for example, believe that the public should have a functional knowledge of their world, we would be remiss to suggest that this should take precedence over, say, economic literacy, which would enable citizens to reach some sort of financial stability, computer literacy, which would enable them to better interact with many modern technologies, or even visual literacy, which would help them to become more cognizant of designs and desires constantly being acted out by media groups, among millions of other potential uses and organizations.

Paisley also shows that past efforts to define key points of understanding have met with either disinterest or righteous ire on the part of specialists throughout academia. For instance:

> When Hazen and Trefil published a digest of their book [which attempted to compile a list of items necessary for true scientific literacy] in the journal Science, scores of Science readers challenged all or part of their list. […] Thus, the most obvious shortcoming of the quasi-encyclopedic approach is that even scientists who agree with the approach do not agree with specific items. (75)

Paisley also asks the question, “Can scientific literacy be situational as well as normative?” (77). This idea speaks to examples of non-scientists developing highly specialized scientific knowledge as a result of some sort of upheaval or interest in their personal lives (Myers 268). The best known example of this situation is probably that of “The Reeve Effect,” pertaining to actor Christopher Reeve’s (of Superman fame) work towards increased knowledge and research regarding spinal cord injuries (Groopman). In the end, Paisley concludes that:

> [S]cientific literacy proves to be as dynamic as the field it represents. In the context of informed public action, it competes with other illiteracies for a share of public attention and understanding. With respect to its role in the agora where scientists and the public meet, three factions of experts disagree about whether it should focus on the vocabulary, the grammar, or the pragmatics of science. (79)

Regardless of which literacies are most valuable to a general public, the general public still lacks basic scientific knowledge.

Accepting the obvious seems an odd way to go about argument construction, but it is only by accepting this basic idea of a knowledge deficit that popularized science takes on any relevant meaning to everyday life, including, but not limited to, an increased knowledge base for the general public to utilize when considering questions and ideas that range from the medical to the political.

3. Rhetorical Strategies within Two Popularizations: Douglas Adams' Last Chance to See and Alan Lightman's Einstein's Dreams

I. Defining Characteristics of Popularizations Considered for this Project

Science popularizations appear as non-specialist texts. Consequently, I will not analyze peer-reviewed journal articles. The scientific information does not to be entirely factual. It does, however, need to be based on scientific fact lest the text be relegated to the science fiction section of the bookstore. The science presented in a popularization may be presented within a fictional framework—the characters may be fictionalized, the setting may be fictional, or the circumstances may be fictional, yet the underlying theme of the argument or presented knowledge must be researchable and verifiable.

The types of work that I am primarily interested often fall into the category of creative non-fiction. While the presentational tone and format are entertaining, the facts presented within the book are based on contemporary scientific knowledge. These works are *not* works of the type typically classified as science fiction. The information presented must be based on existing, ongoing, research, or historical studies and events—not fictional speculation based on the potential future of science.

There are three primary and three secondary criteria that I have selected for the popular science texts (PSTs), that I am most interested in examining. The three primary criteria are largely extrinsic to the text and are as follows:

1) The text must be a single or co-authored book;
2) The text should be commercially published and readily available;
3) The author(s) of the book(s) have previously gained reputations.

The three secondary criteria are largely intrinsic to the text, and are as follows:

1) PSTs affirm the author's knowledge of the subject matter;

2) PSTs should provide verifiable scientific information;

3) PSTs should affirm established science.

These six criteria will now be explored in greater detail.

1. The text must be a single or co-authored book.

For the purposes of this study only book-length texts will be considered, though by necessity some ideas relating to popularization, mass production, and popularity must draw on research concerning film and filmography.

My choice of books as an area of study stems from both availability, relative ease of access by consumers (even though illiteracy then constitutes a limiting factor of the public considered within my work), and a rich tradition of literary analysis. As Greg Myers suggests in Writing Biology:

> [W]ritten texts have great advantages as research material, advantages that have long been taken for granted by literary critics, but are perhaps not sufficiently appreciated either by them or by social scientists:
>
> 1. Texts hold still.
>
> 2. Texts are portable. (4-5)

The use of the book as a method of conveying scientific knowledge allows for re-reading, and re-immersion in the text when time and desire permit. Once published, the information contained within a book "holds still," so that one may return time and time again to revisit areas of interest. This is both beneficial to analytical and non-analytical reading.

Popular science books are also now becoming widely accepted as popular. Fellicity Mellnor suggests that, "Both publishers and bookshops now heavily promote popular science books, with many publishers having popular science lists and with booksellers setting aside areas of their shops for popular science" (512), and this popularity guarantees that these books will be reviewed by both scientists and non-scientists, allowing for added information when engaging the texts in close textual-intertextual analysis. This idea of availability leads directly into the second of the primary criteria that I have established.

2. The text should be commercially published and readily available.

To be popularly available, the books must be published by large, commercial presses. Not only does this ensure that these texts have passed review by editors concerned with producing material that will sell well, it also ensures that those texts discussed are commercially available to the general reading public. These books should be readily available at widely located bookstores, for instance Books-a-Million, B. Dalton booksellers, Waldenbooks, and Barnes and Noble. While such ready availability does not guarantee popularity, it certainly increases the chance that the product will achieve such status. It is important at this juncture to delineate the primary differences between "mass" and "popular" media.

In "The Ontology of Mass Art," Noel Carroll suggests that mass art is that art which is easily produced in large quantities and easily disseminated to the masses, such as "television, movies, popular music (both recorded and broadcast), best-selling 'blockbuster' novels, photography, and the like" (187). This type of art has been, and often is, ignored by "recent philosophies of art, which philosophies appear more

preoccupied with contemporary high art, or, to label it more accurately, contemporary avant-garde art" (187). The purpose of mass art is to be readily available and accessible to multiple audiences in different times and locations, without the added stress imposed by a psychological need for in-depth analysis or understanding. It should be understandable without any sort of "special background" (189). These works aim at engaging common themes among the multitudes of consumers; while many critics are opposed to this sort of "homogenization," (190) it is this homogeneity which the creator strives for in order to produce a work that is both understandable and accessible.

Of importance in the creation of mass art is the understanding that "mass artworks [must be able to be] produced and distributed by mass technologies" (191). That is, in order for artwork to be mass artwork, it must be widely and easily distributed.

This type of readily accessible artwork should not be instantly discounted as meaningless or worthless:

> […] the sociability that mass art affords in several ways—as a common source of discussion and criticism, and as a reservoir of common cultural symbols—supplies a powerful motivation for the persistence of mass art. And, in addition, it is far from clear that vast majorities crave the vaunted capacities for interactivity and selectivity that are putatively in the offing. Thus, there are economic and psychological counterpressures that militate against the personalized communication-utopias heralded by pundits of the information revolution. Mass art is here to stay for the foreseeable future. And, therefore, it is incumbent upon philosophers of art to begin to take account of it theoretically. (198)

Essentially, mass art is enjoyable without preparation and planning, a distinction of the utmost importance when considering the significant acculturation needed to understand and appreciate the specialist literature produced by the sciences. Just because art is mass produced and readily available does not make it popular however. As discussed earlier, a science popularization is generally understandable or interesting, thus "popular" is a creation of discussion and interaction with an art, be it text, film, photography, etc. Word of mouth and acceptance of reviews, the concept that people will take at face value the criticism or interpretation as put forth by a critic or reviewer, work to make a piece of art popular. Art does not *become* popular, at least not on a wide, readily observable, shareable level, however, until it is available en masse.

This focus on mass availability is traceable back to Walter Benjamin's "The Work of Art in the Age of Mechanical Reproduction." Benjamin's examination of the perception of and interaction with art in an age of mass reproducibility establishes the variant ways in which consumers/ critics have begun to examine artwork, especially focusing on the differences of perception in the appreciation of still art vs. film. Reproducibility is of prime importance when considering the impact that modern art has had on observer's perceptual awareness. By modern I refer to a time period in which machines aid the reproduction (facsimile, photography, film, the internet) of art, not the style of art by the same name. In previous centuries, critics/observers had fewer outside interruptions manipulating their classification and interpretation of art work. While still influenced by public media, they were able to set up a more personal, internal, uninterrupted monologue wherein they could categorize what they were seeing, and build grounds for an emotional response. In the modern era, especially considering the advent

of sound in film, modern television advertising, radio commercials, and the omnipresent specter of corporate advertising and marketing, including the speed at which textual publication is possible, that uninterrupted personal monologue has been corrupted. While at first it may seem odd to apply this modification of internal monologue to textual media, in reality it is not. Observation of textual form and format suggests that popular texts are often designed for a "quick read," as is Alan Lightman's Einstein's Dreams, and, though physically lengthier, Douglas Adams' Last Chance to See, and the way in which the texts are marketed and physically presented lends itself to preconceived notions regarding the subject matter.

Applying Benjamin's analysis to literature, one can see that mass reproducibility leads to a personal environment in which each particular piece (text) is read. Modifying an idea from straight science, for example, and incorporating that idea into a book with dramatic overtones, leads to potential misinterpretation of the work because the original work in question has been substantially removed from its own particular area of historical content:

> The authenticity of a thing is the essence of all that is transmissible from its beginning, ranging from its substantive duration to its testimony to the history which it has experienced. Since the historical testimony rests on the authenticity, the former, too, is jeopardized by reproduction when substantive duration ceases to matter. *And what is really jeopardized when the historical testimony is affected is the authority of the object* [italics added]. (221)

The other issue at hand involves personal interpretation. By removing ideas from their specialized environment, Benjamin focuses on the differences inherent in the production

of a play and the production of a film; the consumer, while being told to think one way, may end up responding in a manner other than that which is intended by the author. Part of this idea has to do with artistic placement. A less commercially available work of art requires that the observer make a conscious decision to go see it—to hike to the monastery, to purchase tickets for a human production of an event where the actors may tailor their performances to the audience's physical cues—to deliberately place oneself in a mindset that allows for maximum appreciation of the subject. Once art is mass produced, it is readily available at every turn. The observer/critic has no need to gear up to watch/read it, they must simply turn on their television, walk into the Movie theatre (a different experience than actually going to a play, since every time one walks into a movie theatre to see a movie on film one is experiencing the same film over and over with no variations, while every stage play is different based on actor, producer, author's perceived intent, etc.), or approach the best-seller section of the local bookstore, and, as a result, interpretation may be based on events that are only halfway mentally processed because of preoccupation with other subject matter, or a predisposition towards appreciation based on marketing presence:

> One might generalize by saying: the technique of reproduction detaches the reproduced object from the domain of tradition. By making many reproductions it substitutes a plurality of copies for a unique existence. And in permitting the reproduction to meet the beholder or listener in his own particular situation, it reactivates the object to be reproduced. These two processes lead to a tremendous shattering of tradition which is the obverse of the contemporary crisis and renewal of mankind. (Benjamin 221)

Essentially, the masses react to mass reproduction in different ways than they do to less re-created works. As science, in this case, is popularized, it is taken from its "domain of the tradition." At the same time, the information contained within the popularization is made widely and publicly available, essentially becoming a part of the public sphere of knowledge.

3. The author(s) of the book(s) have previously gained reputations.

The fact that an author is well-known in certain circles, for instance, in Adams' or Lightman's case as well established authors, suggests that particular authors will have a pre-established fan base. This fan base allows for immediate reception of new material, as well as perpetuating the word-of-mouth factor.

I will not argue that only previously established authors are capable of writing good popularizations. I will argue, however, that if the text has a distinguishable message, if the author has a real intent to educate the public (which is often difficult to distinguish, though in the case of Last Chance to See Adams makes it clear that he *does* have an agenda), then previously gained notoriety is invaluable in achieving that goal.

A text with these factors—format, availability, and author's reputation—will become readily publicly accessible, often (based on the author's prior fan-base) appearing in print immediately on a best-seller list, a case which serves to become self-perpetuating: when a text is marketed effectively, think, for instance, of the bombardment of new best-sellers that the typical shopper encounters when entering a commercial bookstore, it has an inherent pick-up value. In some cases the text will be purchased for the sole reason of its appearance and accessibility.

The three secondary criteria are principally intrinsic to the text, and are as follows:

1. PSTs affirm the author's knowledge of the subject matter.

Even though the writers that create PSTs may not necessarily be scientists themselves, although Lightman does physics and writing at MIT, they need to have enough knowledge of the field, process, or artifact that they are describing to appropriately convey the work being described. PSTs are primarily exposés, such as the H. Petroski's The Pencil: A History of Design and Circumstance, Richard Preston's The Hot Zone, travelogues such as Darwin's Origin of Species and Douglas Adams' Last Chance to See, examinations like James Gleick's Chaos and Lawrence Weschler's Mr. Wilson's Cabinet of Wonder, or Edward Abbey's The Monkey Wrench Gang, among others. PSTs can be tracked back to Old English with Chaucer's Treatis on the Astrolabe, arguably the first scientific text written in English (Astrolabes). These texts constitute time honored methods of translating empirical knowledge into readable fare, and, in recent years, more and more scientific-based writing is taking its place on the shelves. It is vitally important that the authors write about their topic in a manner that accurately presents the internal data. If the text is to be presented as a popularization then it must *be* a popularization, not an entirely fictionalized account of the subject with no grounding in fact or research.

2. PSTs should provide verifiable scientific information.

If ideas are portrayed as "real" science, then those ideas must be researchable, at least to some extent. Again, leeway must be granted because of the environment that this

kind of knowledge finds itself in, but the best of the bunch lead to sparked interest in, if nothing else, a topic.

There are classic examples of the reality inherent in what I have designated as a true PST. For example, should one feel the need, one can build an astrolabe from Chaucer's description (Sonic.net). While the typical non-specialist reader of James Gleick's Chaos can not immediately begin to take part in the highly specialized discourse surrounding chaos theory, by the simple fact that the reader is now *aware* of the discussion, he/she can begin to research it more thoughtfully, even going so far as to begin to proceed through the disciplinary process (as described in Section II) to become a member of specialist academia if he/she chooses. Besides the research factor in clear presentation of presented scientific knowledge is the fact that a writer's credibility suffers in the field if what is presented as fact turns out to be fiction. While there is a time a place for such texts, misrepresentation of field standards or field knowledge severely impacts the usefulness or effect of the popular science text.

3. PSTs should affirm established science.

Writers of PSTs owe it to scientists to get the facts right. Sensationalism, a result of ignoring qualifications and presenting only end results, functions in a manner that typically misrepresents the original data presentation in a scientist's publication or presentation. The sensationalized portrayal of information can function to increase tension between the sciences and the humanities, which as suggested by C. P. Snow in 1959, are already on shaky footing:

> I believe the intellectual life of the whole of Western society is increasingly being split into two polar groups. When I say the intellectual life, I mean to include also a

> large part of our practical life, because I should be the last person to suggest the two can at the deepest level be distinguished. […] Two polar groups: at one pole we have the literary intellectuals, who incidentally while no one was looking took to referring to themselves as 'intellectuals' as though there were no others. […] At the other scientists, and as the most representative, the physical scientists. Between the two a gulf of mutual incomprehension—sometimes (particularly among the young) hostility and dislike, but most of all lack of understanding. They have a curious distorted image of each other. (15)

A "curious distorted image" of science is what the author of a PST must strive to avoid, and by avoiding a skewed image of science-as-it-is strive to eliminate unrealistic public expectations of the abilities, methods, and products of sciences.

Mathew Arnold, in "Literature and Science," argues that while much can be captured in literary format, that which is captured must be presented in a realistic light. This idea is explained via a description of the typical education in *Belle Lettres* and the idea that one can come to know a culture simply by immersing oneself in the writings dominant in particular times in and about an area of knowledge. As Arnold points out, one must use care: "To know Italian *Belle Lettres* is not to know Italy, and to know English *Belle Lettres* is not to know England. Into knowing Italy and England there comes a great deal more, Galileo and Newton amongst it" (32).

This passage implies that to know a subject well, one must become familiar with all that goes into its formation and understanding. That is, in the shift from literature to science as the primary form of education and interrogation, one must acknowledge that

there are multiple ways of looking at a problem, and to ignore part of the story is to lose part of ones understanding of the world:

> Following our instinct for intellect and knowledge, we acquire pieces of knowledge; and presently, in the generality of men, there arises the desire to relate these pieces of knowledge to our sense of conduct, to our sense for beauty,—and there is weariness and dissatisfaction if the desire is baulked. Now in this desire lies, I think, the strength of that hold which letters have upon us. (34)

Arnold provides an important point. Specialized knowledge or disciplining is important. However, without the knowledge necessary to link specialized knowledge together with its historical context, and more specifically, with its relation to the present, in the daily circumstances from we cannot separate ourselves, specialized knowledge lacks usefulness. Hence, creative and metaphorical relations to scientific knowledge provide for a more useful and encompassing worldview. Arnold goes on to say: "Interesting, indeed, these results of knowledge are, and we should all of us be acquainted with them. But what I now wish you to mark is, that we are still, when they are propounded to us and we receive them, we are still in the sphere of intellect and knowledge" (35-36). Arnold then proposes that creatively centered discourse places the reader within the same sphere of knowledge, albeit on the boundaries, that more serious texts attempt.

Historically, non-fictional literature has been absent from the canon of professional interrogation by those in the humanities. Proposing that "nonfiction literature is as rich and valuable as fiction" (Winterowd 58), W. Ross Winterowd describes this devaluing of non-fictional literature by pointing out its decanonization at

the hands of Wellek and Warren in Theory of Literature in 1956. Devaluing non-fiction was largely a disciplinary response to cultural ideas prevalent in the 1950s:

> Positivism was skeptical of value questions; behaviourism had reduced human action to mere motion; science was becoming evermore triumphant in both its theoretical and applied aspects. In the meantime, the literary scholar was going on with his tatting and crewelwork, a quaint soul for whom the university must provide a niche and a subsistence wage since it is the function of the institution of higher learning not only to advance knowledge but also to preserve the tradition. (45)

Wellek and Warren broke the situation down, essentially saying that the only thing worth studying in language was literature, and literature was "presentational (i.e., intuitive, emotional), not discursive (amenable to propositional explanation, as in philosophy)" (Winterowd 46). Thus, anything that was non-fiction was decanonized.

Yet just because a text is not created wholly from the imagination does not mean that is of no literary worth. The way in which words are put together to paint a picture is as worthy of study as any other type of writing, and numerous texts of immense value would be lost from study forever if they were excluded and forgotten. It must be remembered, of course, that one can engage texts in many different ways, two of which are defined by Louis Rosenblatt:

> [The two primary ways to engage text are] *efferent*, in which 'the reader's attention is focused primarily on what will remain as the residue *after* the reading—the information to be acquired, the logical solution to a problem, the actions to be carried out'—and *aesthetic*, wherein 'the reader's primary concern is what happens *during* the actual reading event.' (Winterowd 47)

These two forms of textual engagement, efferent and aesthetic, reflect the combination of values that PSTs carry.

It is important to note that Winterowd primarily focuses on non-fiction texts that have a rather distinct image about them: Edward Abbey's Desert Solitaire and Peter Mathiessen's The Snow Leopard being first and foremost on the list, both of which could be categorized as popularizations of natural science. Both of these texts meet all of the previously detailed criteria for inclusion as popular science texts, as do the two texts, Last Chance to See and Einstein's Dreams, which I have selected as examples of effective popularizations of science.

Last Chance to See and Einstein's Dreams both have significant similarities in their rhetorical strategies. These similarities function to convey scientific knowledge and the production of scientific knowledge in a manner that is both accessible and entertaining.

The primary rhetorical strategies that will be considered in relation to both texts are use of metaphor; tone; repetition of themes, words, and metaphors; the visual layout and organization of the text; and each text's consideration of audience. By necessity, the majority of the analysis focuses on writer-centered discourse. I am well aware that the contemporary production of books involves many more people than just the author and the printer, yet I believe that responsibility for many of the aspects of these texts rest solely with the author.

In order to judge the effectiveness of each book, I am extending the practice of close textual-intertextual analysis, which functions to provide "a […] reliable connection between internal form and external function," (Ceccarelli 8) to include not only

professionally moderated reviews of each text, but also to non-solicited public responses. In this case, I will examine responses gathered from Amazon.com.

The Amazon.com reviews are of particular interest to me since they are not solicited, represent any reader that felt strongly enough about the book to write a review (a limiting factor), and are comprised of good and bad reviews. The reviews are not refereed or moderated, thus, these represent Amazon.com's public's reactions to the text. This is not the first time that Amazon.com has been tapped for the purpose of gauging public response. Davida Charney, in "Lone Geniuses in Popular Science" also used this particular method of measuring public response. She suggests that:

> [the readers] are not representative of all nonfiction readers or even of all readers of [these] book[s] […] they represent, first, people who felt strongly enough about the book to take the time to write, and second, people who have the resources and the savvy to use technology for this purpose. (234-235)

These readers *do* constitute a reading public, and, as such, can function as a snapshot of public response to these texts.

II. Douglas Adams' Last Chance to See

Douglas Adams' Hitchhiker's Guide to the Galaxy Series and Dirk Gently's Holistic Detective Agency are extremely popular and well-known works. Adams' works are worldwide bestsellers in the genre of science fiction/ fantasy and over the years have amassed a huge public following, which, judging by the numerous fan-sites dedicated to his work (for instance, Douglasadams.com and Floor42.com, among many others), has not dramatically decreased since his death in 2001. Last Chance to See is slightly out of Adams' usual scope in that it is a non-fiction account of his travels with Mark Carwardine, a biologist who was employed by the World Wildlife Fund. Carwardine is the author of over twenty-eight books primarily within the field of conservation biology/ zoology. Essentially written as a travelogue (a genre with a rich rhetorical tradition that includes Darwin's On the Origin of Species) the book details Adams' and Carwardine's travels around the world looking for endangered species, species ranging from the Komodo Dragons of Indonesia to the White Rhinos of Zaire, and recounts their experiences along the way.

As a popularization, this book is fairly unique in that it is a deliberate pairing of a non-specialist writer with a specialist biologist. As such, many of the problems encountered by non-specialist authors in recounting specialist phenomena are alleviated by Carwardine's expertise. As Adams' put it:

> Mark did the tough bits. He did all the preparation and organization and research involved in mounting the trips, and also taught me most of the small amount I now know about zoology, ecology, and conservation work. All I had to do was turn up

> with a suitcase and try to remember what happened for long enough afterward to write it down. (xii)

The portrayals of the endangered species carry a sense of immediacy. The rhetorical implication, even from the outset, is that Adams' is not attempting to deliberately put a gloss or spin on the information that is conveyed in the text. Instead, he is simply factually reporting their experiences and, if learning and knowledge gain happen along the way, so be it. Adams, of course, was not completely ignorant of issues surrounding science and technology. Richard Dawkins, author of the best-selling book The Selfish Gene, provides a brief glimpse into Adams' knowledge, in a lament written after Adams' death, when he says that "what I didn't know was how deeply read he was in science. I should have guessed, for you can't understand many of the jokes in Hitchhiker if you don't know a lot of advanced science […]" (59). Regardless, Adams' voice in the book is not that of the specialist, it is that of the observer. Knowing that he understands some of what he writes about is heartening, because the sense is conveyed that, despite the book's often comic overtones, the information portrayed has not been significantly changed, or artificially created, in order to make a point.

The book functions primarily as a treatise on conservation issues. Since books are deliberately purchased, because they are not forced upon a public unwilling to read yet another glossy pamphlet rife with logical fallacies in search of donated money, they bypass the phenomena of "Eco-Burnout," a phrase initially coined by Nancy Bray Cardozo of Audubon Magazine:

> Extinction is a grim and fascinating topic. It is also extremely well documented. The number of species in danger of disappearing is exceeded only by the number of

> depressing articles written about them. It's getting so that you can't open a magazine for fear of seeing yet another flayed whale or orphaned baby elephant. Eco-burnout is spreading. (126)

In direct relation to this idea of eco-burnout is what I have come to call the "throw-away" factor, what I perceive to be a common phenomena primarily related to ecology/ conservation propaganda. How often do we receive flyers, pamphlets, calls for donations (even to such reputable organizations as the Sierra Club), which we simply discard as more junk mail? Many of these pamphlets have useful and interesting information, indeed, many are even written or valorized by scientists themselves, yet because we are consistently swamped, they tend to be ignored. A careful author can, then, convey scientific facts to an audience in a potentially non-offensive, and non-threatening, form and format: the novel—a format that is purchased *by choice* by a public, often simply because large portions of the public are members of a particular author's fan-base.

Last Chance to See has been extensively reviewed by numerous authors and critics, among them representatives of such high-profile publications as The Boston Globe, The Utne Reader, Audubon Magazine, The Washington Times, and Booklist. All of the professionally moderated responses that I encountered were favorable, indicating that members of the public subscribing to these publications and utilizing the critic's responses in their choice of reading material would be inclined to purchase this book. Regardless, the primary goal of this book was not to become marketing phenomena, but instead to promote a deeper understanding of issues surrounding conservation and ecology. While the book was supposed to entertain—and based on numerous reviews, it

did so—the underlying message of conservation and preservation is never pushed into the background. Indeed, instead of making subtle references to the problem, the authors often simply appeal to the audience's emotion, for instance, in "Mark's Epilogue," Carwardine simply closes with:

> There is one last reason for caring, and I believe that no other is necessary. It is certainly the reason why so many people have devoted their lives to protecting the likes of rhinos, parakeets, kakapos, and dolphins. And it is simply this: the world would be a poorer, darker, lonelier place without them. (211)

This statement ties everything that a reader has ostensibly learned, or learned to appreciate, into a closing note that brings everything back into consideration. This closure is vitally important, because a scant eight pages later (following a brief parable of the Sybilline books and an extensive list of acknowledgments) the reader is presented with a list of organizations and addresses to which they can send contributions (Appendix II). This tactic is wise, since all of the organizations listed in the section titled "One More Chance…" were written about in the body of the text, and, in many cases, primary members of each organization were introduced to the audience by Adams' descriptions. The audience, I would argue, actually feels like they *know* something about these people. To get the point that the reader is ready and willing to contribute money to the wildlife organizations described it Last Chance to See, however, the text must be purchased and the audience must actually read it. Eric P. Kumpf's "Visual Metadiscourse: Designing the Considerate Text," offers insight into how this occurs.

Kumpf outlines seven different categories of metadiscourse for an effective text as follows: first impression, heft, convention, chunking, external skeleton, consistency,

expense, attraction, interpretation, and style. Each cue, when taken separately, refers to a particular aspect of a finished document, and what kind of impression that that particular aspect sets up in the reader's/audiences' mind.

"First impression" refers to a readers overall response to a document immediately after encountering it for the first time. Kumpf compares this to the realtor term "curb appeal" (405). He suggests that this initial impression will set the tone for the entire document. Hence, a document should be designed with audience in mind at all times. Creation of a document that is viscerally geared towards audience expectations, or the expectations that a creator *wishes* the audience to have, is imperative when considering overall effectiveness.

Last Chance to See's external appearance and internal layout are effective representations of the subject matter. Depending on which version of the book is examined (for the book has been released in numerous editions) the cover is either a green/grey similar to that of American Fish and Wildlife colors, or illustrated with pictures of the species that are described within. The paperback version's cover also has photos on it. Both covers differ highly from Adams' usual formats, a key indicator to his audience that this is a different type of book. Most notably lacking is the logo that has come to be widely associated with his Hitchhiker's Guide to the Galaxy texts: a green planet with a large grin and spindly arms that is waggling is fingers with its thumbs stuck in its "ears."

Kumpf's description of "Attraction," which integrates aspects from his other categories, "describes the ability to maintain readers once engaged, guiding them through the document, and if needed, to its end" (414). This is what keeps readers personally

engaged in a book once they have decided to read it. In this case, one of the most effective aspects of Last Chance to See is its utilization of two separate photo sections. These function in at least two different ways: the first relates both to the idea of overall attraction and curb-appeal. When a potential reader examines the book in the store, he/she is able to become rapidly engaged in the photographs, photos that are indicative of common elements in travelogue style publications. The photograph's captions are also witty, and, in many cases, subtly relate to aspects of Adams' other works, most notably the Hitchhiker's Guide to the Galaxy series. For instance, the caption in relation to Fiordland (non paginated photograph section one, page 7) evokes, for Hitchhiker fans, the character of Slartibartfast, who custom designs fjords on his home planet of Magrathea with the caption "Fiordland, New Zealand: The sort of landscape that makes you want to burst into spontaneous applause." Regardless of details from The Hitchhiker's Guide to the Galaxy, the immediate tone in relation to the photos is both humorous and educational—each picture specifically refers to aspects of the text and help to pull the reader into the overall "story" by clarifying appearance (especially useful when discussing endangered species that few readers will have encountered). The photographs are also vitally important to the rhetorical effectiveness of the text. As A. E. Richards argues, the "art of visual design invests scientific research with a persuasive power that remains largely naturalized outside the field of rhetoric and to a great extent within it" (183). Visual representations in the sciences carry with them appeals to authority—the move from an "organic" three dimensional object to a more clearly demarcated two-dimensional work suggests that time and effort has gone into the making. Such effort carries with it substantial impact, especially when considering that

texts based on scientific authority are often largely read by members of the scientific community that wish to further their own levels of knowledge. Following this line of argument, one who reads a scientific journal, text-book, or paper is not as culturally or educationally aware of the subject matter as is/was the original creator of the text; hence, visual representation is a way of simplifying the data/argument into a readily synthesizable or usable form and format. This argument is applicable to illustrations, charts, graphs, and, of course, photographs, because "visual representations of nature always have been inseparable from science because they make it possible for scientists to interact with complex phenomena in an essential way" (Richards 184). In the case of Last Chance to See, these representations of discussed species allow readers the ability to place a "real" image in their minds while reading—a strategy that helps to bring the reality of extinction home.

The last of the generalized textual considerations I feel that is most important in Last Chance to See is what Kumpf refers to as "consistency" (411-412)—the relation of style and tone within the text to the subject matter being presented and to the reader's expectations. A humorous approach to forensic pathology may not be appreciated, just as an overwhelmingly dark attitude towards the art of balloon sculpting might not be appropriate. Again, this speaks to audience perception and awareness as much as it does to the subject matter. An overall presentation and subject consistency lends itself to rapid transfer of information from the presentational medium to the reader, and, in this case, Adams' typical writing style shines through. While Last Chance to See is non-fiction, by habit, training, and necessity, Adams' typically humorous portrayal of information is analogous to his prior works. This is important in maintaining a readership population.

Had Adams chosen to completely change his tone and style, the book would have been a significantly different piece of writing, thereby disappointing a large number of DNA (Douglas Noël Adams) fans who have very specific expectations that must be met in order to keep them as a fan-base.

I examined in detail the chapter entitled "Blind Panic." Commonly cited in reviews, this chapter is indicative of the overall form, format, tone, and presentation style of the entire text. In it, Adams details his and Carwardine's quest for the Baiji River Dolphin, *Lipotes vexillifer*. In an extended metaphor (151-155) he parallels the noise and confusion of a crowded city with the noise and confusion on the river, drawing connective lines between humans and dolphins. In a sense, the foreigner in a city (Adams and crew in Beijing and Tongling) is a metaphor for the dolphins in the Yangtze River. Adams' use of scientific fact, as shown in the following comparison between information provided by the Whale and Dolphin Conservation Society and his own introduction to the Baiji river dolphin, speaks in favor of Gerard Fourez' statement that "emphasizing the fundamentally metaphoric character of scientific notions does not imply that one depreciates the so-called 'scientific' character of science" (917). Fourez' statement speaks to arguments that suggest that attaching non-field-specific metaphors to scientific information will result in a loss in the communication of the intended material. I would argue that (as Fourez suggests) this is not always the case. Indeed, in the communication of specialist knowledge to a non-specialist public it is often necessary to employ metaphors which specialists may find problematic. In some cases, using multiple metaphors may be the most effective way to convey the intended information, an idea that Ceccarelli suggests is significant because:

> […] vehicles that contradict each other in significant ways are more likely to result in a comprehensive understanding of difficult subject matter, whereas vehicles that can be resolved into a single image tend to reduce the elegance of a more complex vision by deflecting our attention away from some useful associated commonplaces. ("Neither Confusing Cacophony" 96)

Providing multiple points of reference to a non-specialist public allows that public more potential ways to intellectually engage in the presented subject matter. By providing multiple points of metaphorical reference, the combined inclusions and exclusions will more effectively present an interactive picture that allows for increased understanding. While the audience's understanding can not take place on the same intellectual level as those who originally provided the scientific research (for the not so simple reason that a general public is lacking in the immense amount of acculturation necessary to assimilate scientific knowledge in its creationary form), it does allow the public a way to see the information in a manner that hooks up with past experiences and reference points, thereby providing an increased form of lay-understanding.

Ceccarelli suggests that this use of multiple mixed metaphors allows for "[an] interaction of complementary vehicles [that] has the potential to convey the richness of a complex subject matter better than does a single simplified image" ("Neither Confusing Cacophony" 103). This interaction of complementary vehicles is especially useful when presenting scientific information in an engaging manner. For instance, the matter-of-fact conservation information regarding the Baiji River Dolphin, while important, lacks metaphorical resonance:

> The Baiji River Dolphin, also known as the Yangtze river dolphin, Pei C'hi, Whitefin dolphin, Whiteflag dolphin, and Chinese river dolphin […] lives in the 1,700m Yangtze River in China and is found mainly where tributaries enter the river, especially immediately upstream or downstream of sandbanks and islets. When feeding, Baijis come closer inshore. They used to occur in lakes Dongting and Poyang during spring floods but water levels are no longer high enough to support their presence. […] The Baiji is currently the most endangered cetacean species. There are probably only a few dozen individuals left. (WDCS.com)

Compare the prior text to Adam's more inspired presentation:

> In the middle of one of the biggest, longest, noisiest, dirtiest thoroughfares in the world lives the reincarnation of a drowned princess, or rather, two hundred reincarnations of a drowned princess.
>
> Whether these are two hundred different reincarnations of the same drowned princess, or the individual reincarnations of the same drowned princess, or the individual reincarnations of two hundred different drowned princesses, is something that the legends are a little vague about, and there are no reliable statistics on the incidence of princess-drownings in the area available to help clear the matter up.
>
> If they are all the same drowned princess, then she must have led a life of exquisite sinfulness to have had the conditions of her current lives repeatedly inflicted on her. Her reincarnations are constantly being mangled in ships' propellers, snared in fishermen's nets full of hooks, blinded, poisoned, and deafened.

> The thoroughfare in question in the Yangtze River and the reincarnated princess is the baiji, the Yangtze river dolphin. (143)

While both examples provide similar information, (that the Yangtze River is polluted and the Yangtze river dolphin is threatened by multiple forms of pollution) Adams' account provides multiple metaphors that have the potential to evoke vivid memories and feelings in relation to similar situations in his readers. This metaphorical potential, coupled with the presentation of factual material, is one reason why popular science texts have the potential to be effective agents of social change.

At the time when the book was written, there were approximately 200 of the dolphins left. The dolphin is almost entirely blind as well, relying primarily on echolocation to navigate. Speaking on an evolutionary timeline, the dolphins have been unable to adapt to the rapid spread of motorized traffic on the river—just as the foreigners are unable to rapidly adapt to unaccustomed sights and sounds. Adams' use of myth characterizes the dolphin both as feminine and as royalty--both tropes designed to anthropomorphize the animal in the mind of the reader.

The dolphin, in Adams' varied descriptions, remains throughout the chapter as the principal subject of his discussion. Essentially, the chapter is a series of metaphors built into a narrative, and each metaphor is designed to describe the plight of the Baiji dolphin. The foreigners—Adams, Carwardine, and their crew—are the secondary subjects, the frame for the dolphin's plight. As Adams and crew encounter difficulties in coping with their new surroundings, the plight of the dolphin is brought more clearly into focus. The anthropomorphized dolphin becomes a clear example of yet another "foreigner" having difficulties with the surroundings.

In all of his metaphors Adams conveys both the absurdity of groups out of their element and the confusion inherent in the situation. Adams evokes a setting that is both humorous and heartbreaking. By painting a humorous picture in which readers laugh at the absurdity of, say, an oriental jazz band playing "New York, New York," or a chase around the city for condoms needed to waterproof a microphone in order to tape the sounds of traffic in the Yangtze River, Adams' metaphor of foreigners in a city matched with "foreigners" underwater remains in play. For instance, humor aside, his detail of the condom purchase has important undertones:

> At last a young and pasty-faced man with glasses pushed through the crowd and said he spoke a little English and could he help?
>
> We thanked him and said yes, we wanted to buy some condoms, some 'rubberovers,' and we would be very greatful if he could explain that for us.
>
> He looked puzzled, picked up the rejected packet lying on the counter in front of the affronted shop assistant, and said, 'Not want rubberover. This better.'
>
> 'No,' Mark said. 'We definitely want rubberover, not pills.'
>
> 'Why want rubberover? Pill better.'
>
> 'You tell him,' said Mark.
>
> 'It's to record dolphins,' I said. 'Or not the actual dolphins in fact. What we want to record is the noise in the Yangtze that… It's to go over the microphone, you see, and…'
>
> 'Oh, just tell him you want to fuck someone,' muttered Chris Scottishly. 'And you can't wait.' (160)

Adams makes his point by proving that if a group of humans, able to communicate on some level with the other inhabitants of their surrounds, are having this much difficulty in achieving even the most basic of goals, then a creature largely ignored by the general populace, thrust into a similar setting, but without any way of contacting anyone for outside help, must be in dire straights indeed. At the same time, his limited use of blue language (profanity appears very infrequently throughout the text) reinforces the impression that specialists are real people. The use of profanity helps portray the scientists and their entourage as fallible human beings, and they become easier to understand. Interestingly enough, Adams' description of waterproofing underwater microphones has been cited by Walter Beare in New Scientist: "for a published account of the use of condoms as underwater microphone covers, as mentioned by Jon Moore (Letters, 7 March, p 56), read Last Chance to See by Douglas Adams and Mark Carwardine" (5656). This is an interesting example of a popularization becoming validated by a scientist in a specialist publication.

To further engage the audience, Adams' consistently utilizes examples from history, sight, and sound. He creates a text that gives the reader a sense of now-ness, as well as a historical backdrop in which to place everything. As Don Handelman puts it, albeit while in regards to a different situation, "With each reading, each interpretation, the literal text is involuted, groping within to reach beyond" (346). Throughout the piece, Adams never fails to give the historical background and relevancy of the places he visits; this works to add a sense of immediacy to his cause—each reading of the text heightens the awareness that there is an important message being passed along between the

descriptive lines of humor and metaphor—extinction is happening more rapidly than ever, and somebody needs to do something about it.

Adams' extensive setting descriptions are evocative. I have identified evocation as a rhetorical tool in the following manner: through evoking memory patterns; bringing out past (historical) connections in the mind of the reader, one may be able to more effectively communicate difficult/ complicated ideas to a person whose mind may, when presented the information without first awakening the necessary linkage pathways, initially disregard the subject out of hand. For instance, if a writer wishes to communicate the necessity for the study and practice of stream ecology to a landowner on the White River, it would first be most effective to evoke in the landowners the feelings that they had growing up, on those beautiful afternoons when they used to go fishing with their fathers—the way the sun shown on the water, the way the leaves rustled in the trees, perhaps the smell of fragrant pipe smoke and the calming sound of a lure hitting the rippling water. Then, after sufficient imagery has been awakened in the reader's mind, one could more effectively bring ideas to bear about the necessity of preserving the habitat. The reader is more likely to find a personal wealth in their surroundings—more so than if the subject matter is presented dryly with little or no "personal effect." In this case, Adams awakens memories that the reader has had of being lost and confused in a strange place. At the same time, the liberal use of humor causes the reader to gain pleasure from the trials Adams and crew face in order to finally catch a glimpse of the creature. Despite all of their heroic attempts, they are unable to find the Baiji. This poignant moment, the realization that despite all of their best efforts

the creature will not be found, gives true meaning to the fact that the creature is nearly extinct:

> An hour drifted by. A couple of hundred yards from us, big cargo boats and barges growled up the river. A slick of oil drifted past. Behind us the fishnets fluttered in the wind. I thought to myself that the words "endangered species" had become a phrase that had lost any vivid meaning. We hear it to often to be able to react to it afresh.
>
> As I watched the wind ruffling over the bilious surface of the Yangtze, I realized with the vividness of shock that somewhere beneath or around me there were intelligent animals whose perceptive universe we could scarcely begin to imagine, living in a seething, poisoned, deafening world, and that their lives were probably passed in continual bewilderment, hunger, pain, and fear. (171-172)

There are arguments that metaphor pulls away from the basic tenets of scientific fact, specifically Derrida's statement that "There is nothing outside of the text" (cited in Garver 32). Garver says that metaphors create a metaphysical reality that is essentially undecipherable:

> […] One cannot come to grip with the challenge of metaphor by speaking of 'metaphorical meanings' of words. Meanings of words are given in dictionaries, and it is just as characteristic of metaphors that one cannot look them up in a dictionary." (41)

Gerard Fourez most effectively refutes this analysis and states the basis for continued use of metaphor in effective scientific communication by illustrating that:

> [P]eople forget that metaphors usually lie at the very origin of scientific concept and practice. For example, in biology, the term 'cell' relates to the small rooms of monks, or of bees. In physics, the word 'force' refers to the force of an arm. The notion of an economic system correlates to physical systems which, in turn, are based on the 'systems' of carpenters' beams. Our scientific concepts are 'hardened', 'entrenched' and enhanced metaphors, whose use has been standardized. People have forgotten the origin of these metaphors to the point that they are believed to be fundamental—and often eternal or quasi-eternal—scientific notions. Moreover, these metaphors are like nomads, circulating from one discipline to another. (917)

As Adams' metaphors work to evoke particular scientific theories and concepts—most notably that of evolution and extinction—metaphor becomes an effective form for creating a believable setting in which the armchair observer begins to care about places and creatures which, prior to the reading, may have been entirely unknown.

At this juncture it is useful to examine published book reviews as a means of determining the overall success of the text. Every review is favorable. That the reviews are favorable does not suggest that the book necessarily attained all of the goals that the authors, agent(s), and publishing house had in mind for it. It does, however, indicate that the book was not unsuccessful, and Adams' himself felt that this book gave him the most personal satisfaction ("Douglas Adams"). Several reviewers indicated that they felt that the book was a success.

In an eloquent response to Adams' work, Christina Robb, of The Boston Globe replies:

> Though rarely at a loss for words, Adams is frequently at a loss on this trek. A major sub theme of Adams' irreverent and even occasionally reverent reflections on his rugged pilgrimage to endangered reptiles, birds, and mammals is his perception that the human cultures that surround these animal habitats are endangered, too. From the paper umbrellas of Bali, to the pickpockets and bribery of Zaire, to the surprising lack of Chinese music in China… Adams' sees that advanced twig technology is picking away at itself at an alarming rate. As he says, commenting on his Zairian guides' claims to have shot gorilla poachers and left them for dead in the forest, 'we are not an endangered species ourselves yet, but this is not for lack of trying.'

She responds to his metaphorical argument that we are all players in a grand game. We (humans) are directly related to the environment. By association, we are also then at least partially related to *all* living and non-living aspects of the environment. That there is a problem which has been placed on the table is not in contest. Following this same argument, Lynette Lamb, of the Utne Reader, says:

> The stories of the specific animals—the Komodo dragon lizard of Indonesia and the kakapo night parrot of New Zealand, among others—bring the enormity of our planet's potential losses vividly to life. (147)

And, also in relation to the conservation ecology theme, Nancy Bray Cardozo, of Audubon magazine, in reference to her own statement about the spread of eco-burnout, suggests that "Eco-burnout is spreading. A possible antidote to it is Last Chance to See" (126).

The humorous tone of the book is not lost on the reviewers, and it is interesting to note that the text's educational value is referred to in published reviews. Harvey Hagman, of the Washington Times, states that "*Last Chance* is a breeze to read; one laugh slips into the next until you're on the last page. Then you wish the adventure and laughs would continue. Oddly, you realize you've learned a bit, too" (D7), and Donna Seaman, of Booklist, suggests that the implications of the text extend to a sense of loss and mourning:

> Adams… brings his stellar wit and keen sense of irony to this report from the endangered-species front. [He] brings all the whimsy of his novels to this chronicle with vigorous descriptions, hilarious characterizations (especially of himself), thoughtful observations, and a fresh, critical perspective. A book that makes you laugh and cry and wish our species had evolved a bit further in the foresight department. (689)

An interesting inclusion here is that of Byron Rodgers, from The Times: "This is descriptive writing of a high order, something I haven't felt Mr. Adams capable of; and it occurs every time he gets to see a creature" (Features). From his basic tone, he was imminently prepared to disregard Adams' contributions to the world of scientific literature from the outset. It is worth noting that his mind is changed after reading the text:

> As the zoologist Mark Carwardine, Mr. Adams' companion reminds us, most of the extinctions since prehistoric times have been in the past 300 years. Some species were eaten out. Others, such as the Dodo, which men could not eat, were killed for sport. And some, the last freshwater dolphins in the Yangtze River for example,

> they did not even know they were killing. Mr. Adams did not get to see a dolphin, but this more than anything brought home to him what it is like to be an endangered species. (Features)

Though Adams' and crew never did get to see the Baiji, they remain proponents of its cause. The lack of availability, in this case, emphasizes the delicate nature and structure of the work.

Many readers will pick up Last Chance to See looking for a bit of light reading, but they might accidentally learn something along the way. Adams accounts for the possibility of the accidental learner by publishing a list of all of the foundations and groups he describes in the book on the last page.

Based on the published reviews, it is certainly arguable that Adams has created a highly sophisticated plea for wildlife conservation. Critic response indicates that initial responses are favorable, and that even though the text was not initially read as a method of personal education, it did tend to have that effect on the reader. I would argue that Douglas Adams has effectively achieved the ultimate goal of popular science: aesthetically pleasing educational entertainment.

III. Alan Lightman's Einstein's Dreams

Einstein's Dreams is the fictional account of Albert Einstein's development of the theory of relativity. While the story itself is fiction, the instances portrayed in the work are based on real characters and scientific theories. The book is exceptionally useful in that it humanizes the production of science. This type of popularization helps to remove science from its typical often highly mythologized portrayal. Einstein is not portrayed as a flawless person filled with devastating insight. Instead, Einstein is portrayed as a real human being—a human with friends, with family, with family problems, and with dreams.

The book is an international bestseller. It was number five on the *New York Times Book Review's* best seller list in April of 1993 (Wheeler A6), has been translated into over 30 languages (Redknot media), converted into several different stage productions (Overbye F1), and has been used by numerous universities as a "common book" (Virginia Tech, and the University of Wisconsin Oshkosh among others). In my web-research, I have found examples of the use of the book everywhere from the University of Georgia (in a student' homepage), to NYU as a class project, to interactive displays at MIT.

Does the large amount of use as an object of study constitute success? That the book itself is successful is not in question, and Lightman is not attempting to teach, per-se. He intentionally "banned any of the science-for-the-public prose from the novel because, he says, 'it would have killed the novel'" (Wheeler, A6). The success, then, comes from the fact that this text provides interdisciplinary appeal. Universities are selecting the book because it ostensibly appeals to students in all disciplines. The book,

loosely based on physics, has the potential for appeal to those in the sciences, while the elegant prose appeals to those in the arts, thus, a book with interdisciplinary appeal is created.

It is important to examine the rhetorical strategy employed both internally (content) and externally (format) in the creation of Einstein's Dreams. I suggest that Lightman's use of metaphor, tone, and the overall presentation of the subject matter in relation to both the content of the text and the visual presentation of the work as a whole accounts, in part, for the success of the book.

The book is of a very small physical size, which relates to Kumpf's category of "Heft"—the physicality of the document itself, which includes the basic categories of size, weight, and thickness. Designing a document with a specific audience in mind helps to determine the overall effectiveness: "documents deemed to long for the subject may not be read. For example, consumers expect a short instruction book to accompany the unassembled wheelbarrow they just bought. If the booklet consists of twenty pages, its excessive *heft* may prevent readers from consulting it […]" (407). In relation to Einstein's Dreams, which focuses almost singularly on the concept of time, the portability of the text adds curb appeal. L. Lescaze of The Wall Street Journal writes: "Pantheon has further enhanced the book's charm by publishing it in a small format suited to its brevity. The book fits easily into a pocket. In a spare moment one could pull it out. To read one dream takes little longer than the blink of an eye" (A8). The "hand-sized" (Garfinkel A13) book fits easily into a backpack, briefcase, or pocket, which lends itself to portability; a factor that I would argue encourages potential readers to carry the book with them.

It has short chapters. The length of the chapters lends itself both to rapid reading, and to reading in short moments of time. While this fits with the overlying metaphor of the book, it also means that it makes the book accessible to those with a fear of lengthy tomes.

Einstein's Dreams is aesthetically pleasing. The fact that the book is well-written, and many critics have pointed this out in varying forms of eloquence, provides for an aesthetic experience that produces a pleasing gut response from many readers.

The internal aesthetic value of the book is apparent even from the first pages of the text:

> In some distant arcade, a clock tower calls out six times and then stops. The young man slumps at his desk. He has come to the office at dawn, after another upheaval. His hair is uncombed and his trousers are too big. In his hand he holds twenty crumpled pages, his new theory of time, which he will mail today to the German journal of physics. (Lightman 3-4)

There is a crisp and clean aspect to the detailed physical descriptions in the text. Details are not neglected, and, more importantly, Lightman never portrays Einstein as something more than human. Rather, Einstein is easy for the typical reader to relate to. He is tired, rumpled, and entirely believable. Lightman does not portray Einstein as anything less than brilliant, however. Rather, he is always portrayed as a young man possessed by his intelligence, unable to fully interact with the society that he draws his dreams from:

> Einstein has been explaining to his friend Besso why he wants to know time. But he says nothing of his dreams. Soon they will be at Besso's house. Sometimes Einstein stays there through dinner, and Mileva has to come get him, toting their

> infant. That usually happens when Einstein is possessed with a new project, as he is now, and all through dinner he twitches his leg under the table. Einstein is not good dinner company. (52)

This type of reinterpretation of one of the grandmasters of science is something that is rarely achieved with any public success. All too often, the scientist is portrayed as a superhuman being; an Indiana Jones type of character with a swashbuckling attitude more reminiscent of Harrison Ford or Errol Flynn than the true reality of the situation, or a misunderstood monster, a Dr. Jekyll character, as suggested by Toumey in "The Moral Character of the Mad Scientists: A Cultural Critique of Science." Instead, Lightman's short glimpses of Einstein's life and interactions give a unique perspective into the creation of ideas. Einstein becomes a character that the reader can empathize with. He is driven by his passion, but his passion, like in real life, takes its toll on him.

Einstein's friend Besso is Lightman's camera. Through Besso, we see Einstein's weariness as the dreams affect him:

> "I'm making progress," says Einstein.
>
> "I can tell," says Besso, studying with alarm the dark circles under his friend's eyes. It is also possible that Einstein has stopped eating again. (98)

Through these brief glimpses, Lightman's portrayal of Einstein as an emotionally-charged character pulls the reader along. He makes sure, however, to include real-life examples that show Einstein's frailty, genius, philanthropy, and capacity for human emotion. When Besso asks Einstein if he has examined the plans for a new bottle centrifuge, Einstein's response, and Besso's recollections are as follows:

> "The shaft will vibrate too much too much to be useful," says Einstein, "but the idea is clever. I think it would work with a flexible mounting that could find its own rotation axis."
>
> Besso knows what that means. Einstein will work up a new design himself and send it to Rasmussen [the original creator] without requesting payment or even acknowledgment. Often, the lucky recipients of Einstein's suggestions don't even know who revises their patent applications. Not that Einstein doesn't enjoy recognition. A few years ago, when he saw the issue of *Annalen der Physik* bearing his first paper, he imitated a rooster for fully five minutes. (100)

Lightman's portrayal of Einstein as a real human continues all the way through to the end of the book. The description mimics real life, as anyone who has ever had a driving desire to complete a dream or a project can attest: when one dedicates time and energy to a project, that project's sense of completion also comes with a sense of emptiness. The time during the day that once was filled with productive chaos now seems empty and in need of a new project to fill it with. This is exactly how Lightman's book concludes. The reader sees Einstein hand his typist the final copy of his theory of time:

> Einstein gives her his manuscript, his theory of time. It is six minutes past eight. He walks to his desk, glances at the stack of files, goes over to the bookshelf, and starts to remove one of the notebooks. He turns and walks back to the window. The air is unusually clear for late June. Above an apartment building he can see the tips of the Alps, which are blue with white tops. Higher up, the tiny black speck of a bird makes slow loops in the sky.

> Einstein walks back to his desk, sits down for a moment, and then returns to the window. He feels empty. He has no interest in reviewing patents or talking to Besso or thinking of physics. He feels empty, and he stares without interest at the tiny speck and the Alps. (179)

Lightman's attention to detail creates a focused piece of work. While the book is creatively written, it is also very focused in its scope. He constantly employs the metaphor of time, primarily because the text is in relation to Einstein's theory of relativity, but also because of the length of the chapters, and indeed, of the whole book itself. The text is designed to mimic what it speaks of, and it speaks of time often. Every vignette focuses on differing aspects of possibility; what would happen to the world if time existed differently than it does in our own.

Looking at only one vignette, 24 April 1905, it is possible to truly examine Lightman's focus of purpose. "In this world, there are two times, there is mechanical time and there is body time" (23). Immediately, the reader is set up for the differences between the two. "The first is as rigid and metallic as a massive pendulum of iron that swings back and forth, back and forth, back and forth" (23). The language is heavy, mimicking the clock pendulum of which he speaks, and enforcing the notion that this particular form of time is solid, immutable, and repetitive. The aesthetic impact is that of weight and consistency. "The second squirms and wriggles like a bluefish in a bay" (23). This second form of time is alive, slick, animal, and variable. The wording implies zest and vigor, change, and the ability to adapt. Lest the reader completely miss the implications of the style and wording, Lightman helpfully provides a key: "The first is unyielding, predetermined. The second makes up its mind as it goes along" (23-24).

This is one of the key factors of Lightman's writing. Each chapter starts with an extended metaphor, a lengthy, artistic, initial description that seems to be geared to the more aesthetically inclined of his readers. He then always follows with short summaries, geared towards those that just want the facts, the bare bones of the story so that they may more quickly move through the text, taking from it what they would. This style, Lightman's use of multiple presentational styles in one book, allows for multiple types of readers. Each reader will get out of the text what each wants, and each will be able to enjoy differing styles of writing without having to look for outside interpretation. The book, then, is self contained, for even though it is open for analysis, there is also a very readable surface message that Lightman's style makes apparent.

Lightman maintains a strict sense of focus in the presentation of his subject matter. Looking at the same vignette, 24 April 1905 (beginning on page 23), there are no less than thirty-four references to time, which include descriptions of the day-night cycle, time-pieces, and personal time references, and of these thirty-four, seventeen are direct variations of the word time itself. All of this occurs in a short five pages. This focus, eloquently written with little or no fluff, keeps the reader fully engaged both in the aestheticism of the text, and in the subject being discussed. It is impossible to read the book without having thoughts about the mysteries of time.

That this book is based on fact is not in question. *How factual* is another matter altogether. The text itself consists of 30 vignettes, ostensibly of Einstein's dreams, during the formation of his theories on time. The times and places are right, the physics involved less so, yet still factually based, the treatment entirely fictional. Yet this is not

entirely a work of fiction because of the care taken by the author to accurately represent instances of time and place within the novel.

In determining a novel's success, it is useful to employ close textual-intertextual analysis, which involves examining the novel both as it stands and in looking at reviews and responses to the work in order to determine its *actual* impact. The majority of the published reviews that I found (in the New York Times, Washington Post, Christian Science Monitor, etc.) said nearly the same things as those written in the cover of the book. While it is argued that "Einstein's Dreams is, of course, hardly a novel. No plot. No character development. No characters except Einstein" (Lescaze A8), the common theme, as is evidenced by the reviews contained in the covers of the book, is that this book is "brilliant," "provocative," and "marvelous." "If Einstein's Dreams were a painting, it would have been painted by Marguerite. Its images are beautiful but disturbing, meticulously rendered trompe l'oeil exercises with a haunting philosophical subtext" (Kakutani C16). While these reviews speak well of the text, and support the assertion that Einstein's Dreams is popular and well-recognized, as well as providing a humanist appeal to the sciences while introducing though-provoking questions regarding time and reality, of more interest is the ready-made data-set gathered from Amazon.com.

IV. Public Response: The Amazon.com Reviews

In my research, I found that there was a ready-made repository of criticism, outside of the realm of "professional-for-money" writing, focused on the books in question. Amazon allows anybody and everybody with a computer to electronically post reviews regarding books that Amazon.com sells. In the case of Einstein's Dreams, there were 169 reviews, dating back to 1996 (the most recent was May of 2004), and for Last Chance to See 149 reviews, the most recent of which was from March of 2004, the rest also dating back to 1996.

The Amazon.com reviews are of particular interest because they are not solicited, and represent any reader that felt strongly enough about the book to write in. The review pages consist of not only good reviews, but warnings to potential readers. The reviews are not refereed or moderated, thus, they represent Amazon.com's public's reactions to the text. While the writing ranges from the eloquent to the atrocious, examination of the reviews begins to answer one of the fundamental questions of this study: "who reads this stuff?" Based on an examination of the 318 reviews, readers of these texts have multiple levels of education, and vary widely in their levels of literacy.

Amazon.com uses a five-star rating system, and, based on a tabulation of reviews, both books were primarily judged as excellent reads. I judged four to five stars to be good to excellent, three stars to represent the book as average, and one to two stars to represent below average to poor. In relation to Last Chance to See, 58.39% of reviewers gave the text a five star rating and 22.15% a four star rating, yielding a total of 80.54% of all reviewers who found the book to be good to excellent. In relation to Einstein's Dreams, 68.64% of reviewers gave the text a five star rating, and 17.75% a four star

rating, suggesting that 86.39% of all reviewers considered this text to be good to excellent.

Analysis of the Amazon.com reviews suggests that these texts have some effect as educational texts. Using a series of search strings (Appendix I) within the N6 software package I looked for occurrences of words suggesting that readers had achieved some sort of knowledge gain by reading the texts. Of 24,413 text units, 211 text units (0.86%) within Last Chance to See referred to some aspect of learning, while within Einstein's Dreams 59 of 27,886 text units (0.21%) suggested some aspect of learning, leading to a combined total of 270 text units out of 52,299, a total of 0.52%.

Repeating the search string implying knowledge gain without the word "see" within the string (because of the title of Adams' text) yields a significant difference: 74 text units out of 24413 for a total of 0.30% within Last Chance to See, and 43 text units out of 27886 for a total of 0.15% within Einstein's Dreams, for a combined total of 117 text units out of 52299 for a combined percentage of 0.22%. Hence, while the results suggestive that readers are actually learning something from the text, a hypothesis supported by reading through the on-line reviews, it is apparent that non-context specific analysis is somewhat limited in its ability to provide real and relevant data. I *can* suggest, however, that these results do support the hypothesis that, to at least some extent, these texts function to educate and inform a lay public on subjects about which they initially knew little.

In reference to the popularity of the books, 208 text units out of 52,299 (0.40%) indicated that readers found the books "entertaining," while only 24 out of 52,299 (0.05%) indicated that readers found the texts "boring." Tied in with the goals of the

book, primarily that of Last Chance to See, 42 out of 24413 (0.17%) of text units suggested that the book was "humorous," compared with 8 of 27,886 (0.03%) in Einstein's Dreams, for a total of 50 of 52,299 (0.09%).

In relation only to Last Chance to See, 120 of 24,413 (0.49%) text units made reference to "endangered," and 22 of 24,413 (0.09%) to "ecology," suggesting that Adam's message of ecological awareness and conservation issues was not entirely lost.

These books are also being used as pedagogical tools. 15 of the 149 reviews relating to Last Chance to See originated from Coalinga, CA—apparently the book had been assigned as a class project.

One final aspect of these texts must be examined, and that is the simple question: do they actually teach us anything? Does Einstein's Dreams teach us science, Einstein's theory of relativity, the basics of time management, or give us the ability to wander into an upper level physics class and immediately comprehend the basics of what is being discussed? Does Last Chance to See teach the intricacies of conservation ecology, or how to preserve a species? No, not by any stretch of the imagination. Yet both books *do* provide a gateway for increased learning. Several Amazon.com reviewers express this same sentiment in relation to Einstein's Dreams: "This novel allows for the reader to have an imagination they never realized they had" (June 23, 2003). "I can not insure that it is a book in which all readers will praise as a life-changing experience, but it is definitely something to look into if you enjoy tinkering with the world of your imagination" (December 21, 2000). And, in one final review, "Cheers to Lightman for his outstanding ability to capture the imagination of his reader with realistic alternative realities. Absolutely mind shattering, paradigm obliterating, and awe inspiring material"

(March 12, 2000). In an interview with E. B. Fein of *The New York* Times, Lightman expresses his own views on his writing:

> [He] said he hoped through his fiction to illuminate the world of science the way Scott Turow has done for the legal profession as a lawyer writing fiction about the law. "I can say something that many others can't say," he said. "If you can use your background in your writing, you can bring a different point of view, a new perspective on a mysterious world." (Fein C15)

In relation to Adams' text, numerous reviewers suggested that "this book is very good and interesting and should be read not only for its creative writing and the humour but also because of the message it brings to the forefront" (November 13, 2003) and that:

> The lessons to be learned in this book are most profoundly related in Carwardine's parable at the end: by losing these animals, and others like them, we are losing integral parts of the universe, important pieces to the puzzle of life. Once they are lost, there is no regaining them, and the world can never be the same. (December 28, 2000)

As many of Lightman's reviewers have mentioned (both professionally moderated and unsolicited) this text *does* offer new perspectives on looking at the problem; of particular interest in this setting, the historical aspect of Einstein's work. What if, indeed, things had turned out differently? The idea that there are variable ways of perceiving ones natural world is a common theme throughout both Einstein's Dreams and Last Chance to See. Consequently, I would have to argue that yes, these books *do* indeed teach the readers something, thereby aiding to alleviate the knowledge deficit, though it may not be the kind of formulaic knowledge that is commonly associated with

the concept and descriptor “teach;” instead, these texts may only stimulate thought and interest, and is this not one of the primary goals of teachers worldwide?

Conclusion

Last Chance to See and Einstein's Dreams meet the six criteria established for effective science popularizations. Both texts are single or co-authored books, both are commercially published and readily available, and both primary authors have previously gained reputations. Analysis of the texts and consideration of reviews suggests that Adams and Lightman are both able to appropriately convey scientific information, the information is researchable, and neither author has improperly sensationalized their chosen topic. As such, further analysis of these texts as examples of well-written science popularizations could continue to enhance understanding of science popularization's place in the literary canon, as well as suggesting possibilities for effective methods of conveying specialist knowledge to a non-specialist public.

Coda: Implications for Real-World Application

Many different texts fall under the heading of science popularization. Any text that is mass produced in order to bring a social or scientific area of discussion to a reader in an easy to access format may be considered for classroom use. Within composition and rhetoric, these types of texts often fall under the larger subheading of "Public Writing."

In a chapter entitled "Rethinking Public Writing: Discourse, Civic Life, and Composition Studies" within his book Moving Beyond Academic Discourse: Composition Studies and the Public Sphere, Christian Weisser examines the impact of public writing within the classroom setting and begins to outline the benefits of acknowledging these largely non-traditional texts in the composition classroom. Public writing has become more and more important in recent years. Newspapers, the Internet, television, and the relative ease of access that the general populace has to popularized versions of specialist information is continually growing, and, as a result, society is becoming increasingly publicly aware. Weisser briefly encapsulates public writing in the following definition:

> […] Public writing consists of written discourse that attempts to engage an audience of local, regional, or national groups or individuals in order to bring about progressive societal change. Such discourse *intends* to be free of any coercive constraints or forms of domination, and it hopes to influence […] "public opinion." (90)

Weisser views this form of discourse as a means to invest modern students in the political realities of their world. All writing that takes on a public persona embodies cultural, ethnic, political, religious, and scientific views designed to persuade or convince the

reader. These pieces stimulate thought, and, when considered as works presented within the classroom, responses to these particular works have the potential to affect previously held concepts of social and political issues. Weisser suggests that:

> Students see public writing as more 'real' than, for example, an essay about what they did last summer or the analysis of a particular piece of literature. Public writing can help students see the value of adopting a particular rhetorical stance, since public writing is often directed toward a particular audience who might be influenced by the student's writing. (92)

Public writing, when used as grist for debate and analytical thought, helps students to realize that what they are doing is no longer the simple production of documents necessary to satisfy a teacher's syllabus or grade standards. Instead, interaction with real-time issues gives the student a sense of empowerment. Response to real-world issues or hot-button topics is meaningful. Though students may disagree with ideas brought to the table by public arguments, it is possible for them to see that a response might actually carry with it some sort of social effect. These effects can be seen within the classroom based on interactions with other students; outside of the classroom in the form of the publication of letters to newspaper editors or works written for publication in activist newsletters; or even from non-classroom social interaction and discussion.

Discussion of public writing in the composition classroom need not be entirely centered on the information contained within a chosen document. Instead, discussions should surround the issue of what constitutes "the public." Weisser suggests that a re-conception of the public as a social, political, and cultural entity lets students realize their own thoughts and impressions on a subject and find an outlet and forum for their writing.

Prior definitions and assumptions of the public as "unencumbered by political, social, and cultural forces" (95) has historically led students to assume that writing for the public sphere can be accomplished by anybody that is able to distill the essence of a subject into an easily comprehensible, grammatically correct document. When students begin to realize and accept that the public is made up of unique individuals and groups of individuals with specific ideologies and personalities, they are then more able to see themselves as able to contribute to discussion, and are also more likely to view themselves as *important* contributors to society. This is all tied into the "misunderstanding that public writing must be confined to matters of 'common concern' to all members of a society" (107). Common assumptions hold that there is a clear delineation between matters of public concern and matters of private concern. By overcoming these boundaries and by seeing that private issues may have public impact, and vice versa, then students become aware that "the notions of public and private can be vehicles through which race, class, and gender disadvantages operate" (110). The students may become empowered by the realization that even discussions held within a composition class environment speak to them on multiple levels, and that realization and examination of these levels leads them to adopt a form of personal investment in their work (Weisser 90-115).

Many of Weisser's observations on the importance of reconceiving the public in both the minds of students and the minds of the teacher come from Susan Wells paper on the value of public writing entitled "Rogue Cops and Health Care: What Do We Want from Public Writing?"

In her paper, Wells investigates the reality of the conception of the public sphere. Many of the problems of bringing public knowledge into the classroom revolve around the fact that the teacher ends up conceiving of the student as fully capable of entering the realm of public discourse. Conceptions of "the public" assume an apolitical, acultural, areligious environment where anyone, regardless of race, class, or gender, is free to speak. Wells argues that this is not the case, and that "we need to build, or take part in building, such a public sphere; [that we need to accept] that the public sphere is always constructed; and that it cannot, in our society, be unitary" (326). She argues that we have "appl[ied] a deficit model to public discourse" (327) one in which a real public is lacking—students are not capable of entering it because of misconceptions that such a public space occupies a real time and place, when in reality public perceptions are always mutable.

The assumption that the public is a delineated safe zone open for any person with something to say is a gross misconception: "The public is not simply a neutral container for historical events: it has its own history, its own vexed construction, its own possibilities of growth and decay" (328). Conceiving of a safe form of public consistently leads to the classroom misconception that there is only one version of the public sphere—instead, the public should be reconceived as an active space with its own agendas and problems; a living, arguing environment where sentence structures carrying cultural identifications have meaning to members of the culture(s) or tradition(s) that an author chooses to write in. There are multiple, consistently morphing, public spheres. There can not be only one public sphere, for if there were, then the public could not disagree with itself, or with aspects of itself, because when a member of the public

implies that the public disagrees, then that speaking member could no longer be a part of the public. A problematic conundrum to be sure. Wells brings the matter of the public sphere into the classroom quite effectively:

> As citizens, we cannot abstain from the public sphere or wish it away; we cannot fight it, although we can fight in it. The public sphere as it has crystallized and shattered in modernity does not represent, and cannot represent, the experience of the subaltern classes; it does not even represent all the significant experience of the ruling classes. It is a specific, historically textured, means of political representation; partial but not illusory. Our life in the classroom is marked by the same inevitability, partially of representation, and historical contingency. (332)

Constructing viable definitions of the public in the classroom leads straight to the heart of the matter. As students become more aware of the realities of situational rhetoric, they become more able to write themselves into the picture. By bringing texts into the classroom which open these particular doors of inquiry, students become able to function more effectively both in a changeable public sphere, and in relation to the more personal private sphere. As Wells points out:

> […] our work establishes a point of exchange between the private, the domain of production, and some approximations of the public sphere. It is not directed at the political opinions of students, however progressive or retrograde, but toward the production and reading of texts that move between the public (the political, the abstract, the discussable) and the private. (335)

She concludes by discussing and suggesting possible ways of construing the classroom as a form of public. By developing ideas in a public setting consisting largely of peers, then

examples can be made which relate to the larger public outside of the situation. At the same time, "analysis of public discourse" (338) in the classroom leads to discussions surrounding both the reality of the issues themselves and the rhetorical strategies with which they are presented (Wells 325-340).

Science popularizations prove to be pedagogically multifunctional in that they not only help to introduce student readers to the sphere of public writing, they also work to foster discussions of and about the aesthetic value of reading and writing. Science popularizations evoke a form of didactic aestheticism.

Sidney I. Dobrin discusses the relationship of the natural environment to the process of composition in his paper entitled "Writing Takes Place." The suggestion that composition is ecologically oriented is based on the idea that even the basic metaphors that are often used in discussion of writing are natural in historical basis, for instance, the "nature of writing," the "writing environment," and the "classroom environment" (11). All students, all teachers, all writers in general, write from a place, a topoi, and that topoi is their environment where writing takes place (18). Dobrin suggests that as students and teachers, we might do well to regain some form of acknowledgment about the physical spaces that we occupy:

> Does our postmodern mistrust of scientific inquiry keep us from turning to the science of relationships in order to develop our own methodologies? Does our concentration on the human activity of language encourage us to separate our studies from the natural world? I find that ecocomposition becomes the site from which we must ask these questions, the place in which ecology and rhetoric and

> composition can converge to better explore the relationships between language, writing, and discourse; and between nature, place, environment, and locations. (12)

Ecocomposition often is viewed as the naturalist's approach to writing, the "green" form of classroom interaction that does not take into account the vagaries of everyday life. Yet by acknowledging that place and placement influence all writers at all times, the field takes on new meaning:

> Ecocomposition […] asks that we extend […] inquiry beyond social relationships to examine all relationships not just those with other writers and readers. Ecocomposition asks that we examine relationships with other texts, discourses, other organisms, environments, and locations, that is, ecocomposition posits that writing is an activity that affects not only other writers and readers, but the total relations of discourse both to its organic and inorganic environment. (20)

Acknowledgment of place and placement in the classroom setting can allow for a deeper understanding both of the natural world and of the academic world. Realization that the idea of place includes religion, politics, gender, and cultural affiliations helps to give writers a deeper understanding of their sphere of influence, and, conversely, of the influence that those spheres have on them (Dobrin 11-24).

In the actual classroom, science popularizations have proven to be exceedingly useful pedagogical tools. One particular instance is my own use of "I Love My Glow Bunny," an article written by Christopher Dickey and originally printed in *Wired* magazine, then later in The Best American Science Writing 2002. The work itself describes the saga of a man named Eduardo Kac and his rabbit Alba. Alba is a GFP bunny, a rabbit that has been bred using green fluorescent protein so that she glows green

under blue light of a certain wavelength. She was originally designed for use in research—the protein makes it easier for scientists to remove organs for study. Interestingly enough, Alba is not unique—she is certainly not the only GFP bunny in existence. Eduardo Kac did not create her, did not come up with the idea for GFP creatures, and had absolutely nothing to do with Alba's life until he called up a research center one day asking if there was a way that they could make a glowing creature for him, and they responded that they not only could make one, they had several! Kac wasted no time in traveling to France's Institut National de la Recherche Agronomique and claiming a rabbit of his own. The first that he picked up struggled; it was put back in the cage. The second seemed nice enough, so, since the institute refused to actually give him the creature, he had his picture taken with it and off he went. Kac then proceeded to sensationalize the entire experience, even going so far as to have posters of a glowing green Alba put up all over France. The outcry was enormous and the discussion commenced (Dickey 136-150). The story continues, and summary can not even begin to do the writing, or the story itself, justice.

In the classroom, however, the possibilities are limitless and the composition teacher has an endless supply of teachable material at his/her fingertips. First is the material itself. It encompasses everything from the natural world to questions regarding the idea of what constitutes art, to animal testing, to moral and ethical discussions centering around public versus intellectual property. Secondly is the way Christopher Dickey writes the article. It is an aesthetically pleasing narrative that includes personal perception, interview, and scientific information. What is his agenda? Who is he writing to? Why is he writing the piece in the first place? What constitutes his public? Who is

the audience, and what does he stand to gain from their acceptance or disproval? Why does he write the article in such a humorous tone? Again, the list is extensive. The piece functions on so many levels that a brief description of possibilities is nearly impossible. In the end, the text functions, and functions well, because students read a well written science popularization where they see real people in a real world doing real things, and not all of these real things fit nicely into standard conceptual boxes. Students begin to realize that works like this give them opportunities to begin to give voice to feelings they may have, be they moral, ethical, based on science, based on art, based on literature, based on expression, based on gut instinct, and based on a need to create a work of writing for an audience that demands that a work meet certain criteria. Christopher Dickey's "I Love My Glow Bunny," Douglas Adams' Last Chance to See, and Alan Lightman's Einstein's Dreams help students, and readers in general, achieve a sense of personal investment in a public sphere of discussion.

Effective popularizations stimulate thought and interest and function as effective gateways for increased learning and environmental awareness (environment, in this case, referring to anything outside of the self). Science popularizations may function to stimulate interest in topics that enable people to make better informed decisions regarding their world. As specialist and non-specialist groups begin to become more aware of each other, we may finally begin to see an end to the perceived gulf between the sciences and the humanities, and increased appreciation on both ends of the spectrum.

"Whatever happens to another happens to oneself."

Oscar Wilde, *De Profundis*

Appendix I
N6 Search Terms and Strings

Boring (uninteresting)
[Boring|arid|bromidic|characterless|cloying|colorless|commonplace|drab|dull|flat|humdrum|insipid|interminable|irksome|lifeless|monotonous|mundane|plebian|repetitious|routine|spritless|stale|stereotyped|stodgy|stuffy|stupid|tame|teadious|threadbare|tiresome|tiring|trite|unexciting|uninteresting|unvaried|vapid|wearisome]

Ecology
[ecology|ecological|conservation]

Endangered
[endangered|endanger|threatened]

Entertain (amusing/pleasing)
[entertaining|absorbing|affecting|captivating|charming|cheering|clever|compelling|delightful|diverting|enchanting|engaging|engrossing|enjoyable|enthralling|enticing|entrancing|exciting|fascinating|fun|impressive|inspiring|interesting|moving|piquant|pleasurable|poignant|provocative|stimulating|stirring|striking|witty]

Humorous (funny/comical)
[humorous|amusing|camp|campy|comic|droll|hilarious|jocose|jocular|jokey|laughable|laughing|merry|playful|side-splitting|to funny for words|whimsical]

Learn (with "see")
[learn|learns|learned|ascertain|ascertains|ascertained|detect|detects|detected|determine|determines|determined|discern|discerns|discerned|gain|gains|gained|gather|gathers|gathered|see|sees|understand|understands|understanding|attain|attains|attained|gain|gained|gains|grasp|grasped|grasps|educate|educates|educated|cultivate|cultivates|cultivated|develop|developes|developed|discipline|disciplines|disciplined|edify|edifys|edified|enlighten|enlightens|enlightened|foster|fosters|fostered|improve|improves|improved|inform|informative|informs|informed|instruct|instructs|instructed|nurture|nurtures|nurtured]

Learn (without "see")
[learn|learns|learned|ascertain|ascertains|ascertained|detect|detects|detected|determine|determines|determined|discern|discerns|discerned|gain|gains|gained|gather|gathers|gathered|sees|understand|understands|understanding|attain|attains|attained|gain|gained|gains|grasp|grasped|grasps|educate|educates|educated|cultivate|cultivates|cultivated|develop|developes|developed|discipline|disciplines|disciplined|edify|edifys|edified|enlighten|enlightens|enlightened|foster|fosters|fostered|improve|improves|improved|inform|informative|informs|informed|instruct|instructs|instructed|nurture|nurtures|nurtured]

Appendix II
<u>One More Chance</u>

If you would like to make a contribution to help with the conservation work for any of the animals featured in this book, please send checks payable to the organizations listed below. Don't forget to state which project you would like the money to go to.

Madagascar:	Madagascar Fund World Wide Fund for Nature 1196 Gland, Switzerland
Indonesia: Komodo Dragon	c/o PHPA Jalan Suwung 40 P.O. Box 320 Denpasar, Bali Indonesia
Zaïre: Rhino Anti-Poaching Operation and Mountain Gorilla Project	c/o IUCN Regional Office: Eastern Africa P.O. Box 68200 Nairobi, Kenya
New Zealand: Kakapo Recovery Program	c/o *Threatened Species Trust* Department of Conservation Box 10420 Wellington, New Zealand
China: Baiji Dolphin Conservation Project	c/o *People's Trust for Endangered Species* Hamble House Meadrow, Godalming Surrey GU7 3JX UK or: c/o *West Coast Whale Research Foundation* P.O. Box 1768 Santa Cruz, CA 95061 USA
Mauritius: Mauritius Wildlife Project	*Mauritius Wildlife Appeal Fund* 10, Dr. Ferriere Street Port Louis, Mauritius Indian Ocean

(From Adams and Carwardine, <u>Last Chance to See</u>, page 219-220)

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Professional Organizations

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