# How Does Television Represent Science?

This thesis is submitted to the Faculty of Education in partial fulfilment of the requirements for the degree of Master of Arts Research in Education



Richard Zurawski

**Acknowledgement**

I would like to thank my thesis advisor, Professor Andy Manning for his many, many hours of instruction, encouragement and patience, through the weekly meetings where we thrashed out my prejudices, inconsistencies and biases from my work, as I waded back into academics after a thirty year absence. Learning that opinion is not enough was hard lesson for me, but Professor Manning with great patience and humour walked me through the rigours and process of the many rewrites and revisions of this thesis.

I would also like to thank Professor Paula Romanow, my long time friend, colleague and teacher for her patience and for humouring me on this long journey away from the absolute world of the objective into the oft times slippery subjective slopes. I would also like to thank Professor Fred French, for being on my thesis committee. My thanks also to Ruth Ann Brown for all the emails, co-ordination, setting up of meetings, making all the paperwork happen; and all with a smile.

To my Mother, thank you for the encouragement, love of learning and all her wonderful support.

No acknowledgement would be complete without me thanking my beautiful wife Susan, for the encouragement to go back to school, to fulfil my dreams and to show me its just hard work, patience and following one step after the other. She is my inspiration, my best friend and my greatest supporter.

Lastly my thanks and recognition of all those who participated in this study, who made the time and generously gave of their opinions, perspectives and wisdom.

## Abstract

This thesis examines the relationship between science and television by working within the framework of Grounded Theory, extracting data from a literature review and a series of interviews with scientists, television scientists and broadcast science producers, and then examining the collected data through a perspective provided by the works of Noam Chomsky, Marshall McLuhan and George Lakoff.

My analysis of the data concludes that science as represented by scientists and science as represented by television production are two solitudes. In spite of the fact, that both scientists and science broadcaster/producers work within a milieu each group defines as "science", neither understands the perspective or the concerns of the other. In addition, generally, there is a marked distain between the two groups based on the other's perspective of what is considered to be science. Each group works within an institutional framework that is self serving and isolated from the other.

Though there have been efforts to bring these two groups together to find common ground, they are marked more by their failures than their successes. The major science issues facing us as a society, especially with crises such as anthropogenic global warming, underscore the seriousness of this divide as it relates to the public's general low level of science, the growing lack of appreciation of the importance of science education and the loss of respect for scientists and science.

These findings are helpful in getting a better understanding of the oft overlooked place that science has in society and its importance to the health of our society. If common ground can be found, not only scientists and science broadcaster/producers, but society has a lot to gain. These two groups are encouraged to connect with each other and find solutions to bridging the divide that has grown between them.

# List of Illustrations

# Prologue

*"The television business is a cruel and shallow money trench; a long, plastic hallway where thieves and pimps run free and good men die like dogs."*

Hunter S. Thompson

I had already been involved in television science broadcasting for some 15 years when I had a small epiphany that set me on the road that has led sometimes slowly, sometimes inexorably to this Masters thesis. About fifteen years ago I was attending the 2nd annual World Congress of Science Producers, a small collection of broadcasters, producers and programmers who got together once a year to exchange anecdotes, programming ideas, commission new science stories and enjoy a glass of wine and some good food. It was my first year and the conference was in Montreal. There were perhaps 100 in all in attendance, with representative from broadcasters of science programming as well as producers and the congress lasted a total of 4 days. I had just made the leap into independent production after a long tenure at both CBC and CTV as a science reporter, weathercaster, science writer, host and creator of the nationally syndicated children's science show, "Wonder Why?". I had been invited to attend by a former work colleague who was at the time the vice president of production at the fledgling Discovery Canada cable broadcaster.

The sessions were about how to create better science programming, what constituted good science programming and how to engage the viewers in what was the beginning of the broadcast expansion into cable. The internet was just beginning to stir and was still not seen as a broadcast platform or a competitor to television.

One of the sessions that had me in a bit of a quandary was about the X-Files. The producer of the X-Files had been invited to speak to a plenary session and I was curious what we as documentary science producers and broadcasters could learn from science fiction that would be of any interest to factual science production. As the speaker spoke, it became obvious to me that there was very little about science that interested the producers of the X-Files. There was no science advisor, nor was there any effort made to adhere to any science. The plots, writing and depiction of the science in the scripts were not science fiction at all, not in the traditional sense of science fiction writers like Asimov or Clarke, but closer to fantasy and superstition, a polar opposite from what I thought it should be. However, there was no arguing with the success of the series. It went from being a small Vancouver production to being one of the most popular series in Hollywood worth billions as a franchise. And as I looked around the room, it was obvious that most of the broadcasters and the producers in the room were more interested in the show's financial success and how its model could be incorporated into current television factual science production. My eyes went from person to person seated around the gigantic round table and it occurred to me that I was alone. Even though all around me there were people who had interests in science that ranged from passionate to expedient, almost all were from the arts, journalism and broadcasting. Not

one other person in that group, called the World Congress of Science Producers, numbering less than 100, had even an undergraduate degree in the core sciences of biology, chemistry or physics. A few, all Europeans, like the commissioning editors from ZDF the German broadcaster and the BBC, the British icon had degrees in Psychology.

At the close of the session, when the question period opened up, I asked why the producer of the X-Files had been asked to come and speak to us? There was no science at all in X-Files, they had no science advisor and much of the show's premise was designed to promote false science stereotypes, present what was clearly not science and promote the public's fascination with the occult and superstition. It was not the most politic thing I could have done. My question rippled through the audience like a splash of cold water. To the broadcasters, it was all about eyeballs, ratings and ultimately dollars. To the other producers, it was about how far the science envelope could be pushed into fantasy and still be categorized as science.

It was an epiphany for me, when I realized that science television production, especially in North America, whether it is in the news, documentaries, children's production, shorts or long series, is also a financial enterprise, and the role of science in many venues was merely to act as a lens for other interests to bring in an audience, which meant increased revenues. Was science just a vehicle for the business of television? Was this a dangerous dalliance, one that had the potential to subvert the whole idea of what is science and what it is not?

I wondered to what degree this type of science programming affected the viewer. Does this type of science, the science represented by television, have ramifications for viewer educational choices, both for children and adults, how the viewers see science, what is considered to be science and influence the choices that are made by our governments, businesses on our behalf in this increasingly complex, scientific world? Skewed or inaccurate representations of science, could mean skewed and inaccurate perceptions of science by the viewers. Stereotypes of scientists and what they do means educational choices made on incorrect perceptions. Or perhaps not. Is television an entertainment medium that doesn't fit into the peer reviewed mould of scientific method? Is it the thin edge of the wedge so to speak, that spurs interest and education just by showing any science at all? Is any science good science? And is the viewer savvy and sophisticated enough to understand how television works? Television is a powerful medium and influential. Does it also have the capacity to teach, present ideas and inform the public?

In North America, television has been and remains a media juggernaut, in spite of the advent of computers and the internet and changing viewing habits. Television shows signs of adapting to the changing technological landscape and remains a powerful mass medium. How science is portrayed on television influences and ripples through all media and public forums. As an example take the Creationist stance. Through the skilful manipulation of television programming in the news and documentary format television the fundamentalist Christian right has succeeded in having Intelligent Design included as part of the educational curriculum in many school boards in the United States and in Alberta, as a scientific alternative to Darwinian theory even though virtually all

biologists who teach at a University level agree Intelligent Design is not a scientific theory nor has any basis in science at all and is just a rebranding of Creationism made infamous during the Scopes Monkey Trials more than fifty years ago. In the same way the pseudo science of the Tobacco lobby presented to the viewers on television, was able to distort medical science for decades. These conflicting messages obfuscated the real science information and education viewers received through television programming and influenced choices, causing many to become smokers, some of whom paid a steep price in the end.

In my 30 years in television programming, I have watched wholesale changes in the technology of television, programming of television and the mindsets in television science. I have watched television science production drift from traditional Nova style presentations to reality show productions, with the hosts' behaviour replacing science, and become a mainstay of almost all science broadcasters. Science on television is now more spectacle driven and anthropogenic. Science production has pushed aside pure science in the push for increased ratings as the network owners of the cable and digital channels seek to hold their audiences and advertising revenue. Gaming and competition from the internet, with its palette of immediate gratification have eroded viewer attention spans, making thoughtful presentation of difficult scientific concepts increasingly unlikely. In today's television world, if a scientist's clip isn't succinct and pithy, its fate is the cutting room floor. Has this changed the way we understand science? Has it changed the way we look at scientists and science education? So many questions.

In this thesis I explore the relationship between television science programming and science; where it came from, where it currently stands and where it is taking us. This thesis comes out of my observations over the past 30 years where I have had the opportunity to be involved in almost every kind of factual science production on television, in almost every facet. It also comes from my education in physics and mathematics, and my profound interest in helping to solve one of the greatest crises that besets our society today, global warming, through the mass media, through education and through science. From this, it could be construed that this is a positivist stance, and though it does play a role in my perspective regarding information and data, I also believe that data and information also have a subjective nature. The non-scientists, the viewers, the producers and broadcasters, all contribute to how science is portrayed on television. In fact, it could be argued that non scientists, through the popular medium such as television, and in politics, have a significant impact on scientific study and outcome.

"How Does Television Represent Science?" becomes an important question, one that we need to think about in light of the increasing number of adults who believe in non sciences presented as science. Examples of such practices include many alternative medical practices like faith healing, that anthropogenic climate change is a conspiracy, that vaccinations cause autism, that intelligent design is a scientific theory and Creationism is an alternative to Darwinism and should be taught in our schools. The public perception that authors like Von Daniken and Velikovsky use scientific method comes from a misunderstanding of scientific method. Both authors were able to

construct arguments that resonated with their readers and viewers, because publishers and producers had so little understanding of scientific method and how it worked. And when these arguments are believed by viewers in spite of their lack of veracity they have a powerful influence over our world. Television is a lens through which we see the world. How does that lens influence science, effect education and educational choices? Does it change the way we perceive the world issues, deal with scientific crises and the decisions we make?

Why is this study important? Without putting too fine a point it, it is a matter of our survival. This statement is not hyperbole. We, individually and as a society, are beset by problems from all sides, over population, diminished agricultural output, nuclear power, global warming, pandemics, ocean acidification, just to mention a few, and almost all these issues have their roots in science. The solutions to these and most of our societal threats are equally based in science. How we respond to those problems is in a large part based on how well we understand the science behind these issues. Given the fact that so much of our understanding of the science and the issues based in science potentially comes from television, television becomes an important intermediary between society and its understanding of science. How television portrays and represents science has an important role in our understanding and education in the science.

In an effort to examine the question of how television represents science, this paper is structured as follows.

Prologue

Chapter 1 presents the background to the study and is an overview of the relationship between television and Science, where the thesis question “How Does Television Represent Science?” is introduced.

Chapter 2 is the literature review.

Chapter 3 presents the method with key concepts, the resources for the study and the list of semi-structured questions for the study.

Chapter 4 is the initial analysis of the interviews, taken from the interviewees responses to the interviews, summary the analyses of the interviews.

Chapter 5 consists of the major themes that emerged from interviews.

Chapter 6 is the discussion and conclusion to the study.

Appendix A - Letter of Permission

Appendix B - FAQs - Frequently Asked Questions

Bibliography and References.

Television is many things to many people. It is entertainment, a friend, a source of trusted information and a guide and reflection to the nature of the world and society we live in. Many of the great benchmarks of our society are television benchmarks, the first landing on the moon, the Desert Storm television war against Iraq and the bombing of the World Trade Centre. Television, for many people, is the primary source of information, and an educational role model and it moulds our educational perspectives. Television is seen as truthful and trustworthy. Walter Cronkite was the most “most trusted man in America” because he read the news and was seen nightly delivering good news and bad, reliably and predictably. Today’s television personalities, though perhaps not as influential as Cronkite was, continue to advertise the mantel of trustworthiness

that television brings. CTV's commercials call their anchor, Lloyd Robertson the most trusted news anchor in Canada. If television colours or skews issues relating to science, that skewing and tinting, of what is a fundamental component in the fabric of our society, becomes important. If the television message we receive compels us to choose to ignore science because television places a low priority on science and on science education, if television tells us, through its messages, its representation of the science, that it is less important than sports or entertainment or other news, that is important.

Television has been and remains a very powerful medium and as it merges with the web, it is able to present programming of all types on demand in many different formats. Understanding how television represents science currently, will help us understand how it will represent science as it adapts to technological change, how that technological change will affect programming and in turn affect our understanding of science is an important issue.

And last, but certainly not least, the importance of television's impact on education in today's society is hard to over state. Right from its inception television was intended to play a role in education and information. In its modern form it is arguable that its role in education is if anything, even more pronounced than in the past. Numerous studies have shown that television plays a very significant role in a number of educational processes. It is a primary source of science information for the pay person. It has also been shown that what appears on TV is taken to true and that people make their decisions about the impact, importance and immediacy of science based on what they see on television. Its

relationship to science and to science education is important because of how it influences what the lay person thinks about science and science education and in turn how that influence is acted upon and how it is passed down to children. It is well known that parental influences play a large role in the educational decision that our children make.

# Chapter 1: Background to Study

## 1.1 Introduction

The intent of this chapter is to provide a background to the study of how television represents science by beginning with an examination of three concepts and ultimately, how they relate to one another. These basic concepts underly the larger question of the relationship between television and science and will provide insight through their definition, discussion and relationship.

The three concepts are as follows

1. Television programming
2. Science and scientific method
3. Journalistic method

While these three concepts have been discussed separately, in many studies, they are also related to each other, in the context of this study, through science programming on television. The fourth section of this chapter looks at this relationship and how the three general concepts are related with each other and influence each other through the production of science programming on television.

## 1.2 Television

Television is a broad medium with many facets, each with its own particular effects on how science is represented on television. The basic television categories are Network television (terrestrial broadcast), Cable broadcast television, HD broadcast television, Web Based streaming and download television and Pay per view television.
In the Western world television has been and still is, the medium (Miller, Michigan State University et al. 2006) that is the most used by the public for entertainment, news and information in North America (Robinson&Levy 1986) and Europe (Leon Bienvenido 1986).

A.C. Nielsen Co. reported in November of 2009 that 99% of US households possessed televisions and that the number of hours a television is on in the home is very close to 7 hours a day, with 66% of Americans regularly watching television while eating. In 2006 A.C. Nielson Co. reported the following facts. The average American watches more than 4 hours of TV each day (or 28 hours/week, or 2 months of nonstop TV-watching per year). In a 65-year life, that person will have spent 9 years glued to the tube. In a 2004 study it was shown to be that television is still the main choice for information, when compared to other media such as newspapers, radio and the internet. A 2006 study by Miller, Augenbraun, Schlhof and Kimmel shows that while there was a decline (about 7-10%) in television viewership in network news, CNN, cable news, news magazines, the weather channel and local news, which began in the early nineties, it levelled off by

2000 and then remained stable over the next 4 years, even showing a slight rise in 2004. The total decline in viewership in those news categories over the decade was less than ten percent. According to the Pew statistics, in 2004 local television was the most popular news source (70%) and had twice the numbers of on line news sources (35%). Extrapolating the trajectories based on the decade from 1994 to 2004, local television is still expected to be more popular than on line news for the next decade given a consistent linear rate of change based on the previous decade. CNN, news magazines and network news were expected to be superseded, in terms of viewer percentages, by on line news, according to these studies, in 2008, though in 2009 the broadcast of the Superbowl was the second highest audience ever recorded for a primetime broadcast in the US with more than 42% of the households tuned in to watch.

From these statistics it is safe to say that television is a very powerful and influential medium and it is expected it will remain so in the coming years, even though network news and others are expecting to experience some declines in viewership from on-line competition. But as television continues to make the high tech transition into cyberspace, HD, multiple platform delivery and simulcasts with other media it is expected to maintain its powerful influence.

In a comparison with other mass mediums of the past, television is unique, because it requires the viewer to utilize two senses, sight and sound, simultaneously, to receive the full impact of its programming. And as television programming increasingly becomes available over the internet it brings this uniqueness with it into another medium. It

presents information and entertainment programming in a combination of video and audio, rather than just visually, through the written word, or through the spoken word. This combination of visual and audio representation of information makes television more complex than other mediums - there is a lot of truth to the trite adage “a picture is worth a thousand words”.

Even though television has and continues to be a hi-tech medium and is based on sophisticated science technology, it is rarely used by scientists as a medium for science communication, in terms of peer review. The written word remains the medium of choice when it comes to scientific method and peer review. Television, an amalgam of video, audio and written words has never made the transition to become a truly scientific medium, used by scientists in the manner peer reviewed publications are. There may be a number of reasons for this, ranging from the cost of production of television programming vs the cost of writing, the lack of expertise in the production of television programming or perhaps the scientific world has been too conservative in its exploration of television as a medium for peer to peer research. In addition there is the time factor. It takes a long time to produce television programming. All are prohibitive factors for scientists. This has the potential to limit the understanding of the medium by the scientists and scientific community.

Television productions in science range from drama, to long form documentary, to short form documentary and science news productions. Each form of science television

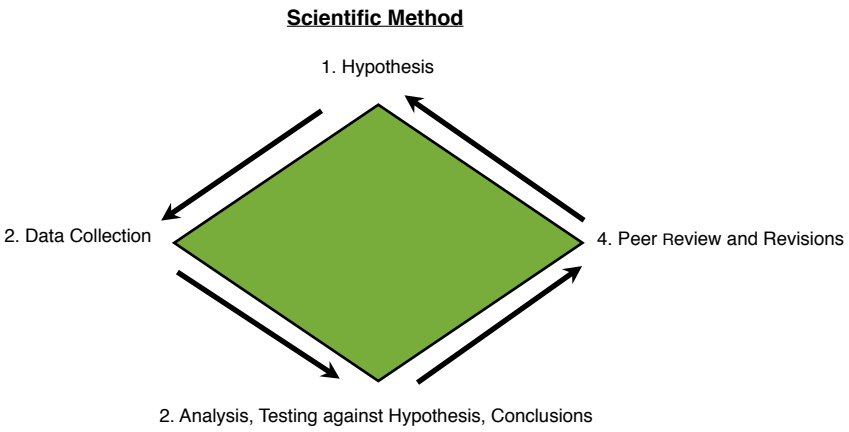
production has its own specific issues, requirements and effects, though the general elements of television production are common to each.

The key to television production is its combination of audio and video, which makes the medium more complicated that other older mediums such as print and radio. This combination also makes the comparison of different methods for presenting information quite complicated. There are two main methods of presenting science, in science television production, scientific method and journalistic method, which are presented in the following sections.

### 1.3 Science and Scientific Method

From a scientist's perspective, science is closely related to scientific method, an extremely powerful methodology that is responsible for the advances in the sciences such as medicine, biology, mathematics, physics and chemistry. Scientific method, unfortunately is not widely understood by the general public or most science producers and is often a very lengthy process that does not lend itself well to programming excitement.

Michael Shermer who writes a monthly column called the Skeptic for Scientific American defined science in his July 2009 column as follows.




*"Science begins with the null hypothesis, which assumes that the claim under investigation is not true until demonstrated otherwise. The statistical standards of evidence needed to reject the null hypothesis are substantial. Ideally in a controlled experiment we would like to be 95-99 per cent confident that the results were not caused by chance before we offer our provisional assent that the effect may be real. Failure to reject the null hypothesis does not make the claim false, and conversely, rejecting the null hypothesis is not a warranty on truth. Nevertheless, the scientific method is the best tool ever devised to discriminate between true and false patterns, to distinguish between reality and fantasy, and to detect baloney."*

Repeated studies into the relationship between science understanding by the general public and science as presented on television in the news, documentaries and drama, by researchers such as Gardiner, Young (1981) and others (Willems& Goepfert 2006), have shown that viewers are highly influenced by what they see on television. How viewers perceive science and what they remember about science can be traced to TV science programming. Their studies show that, after high school, science as represented on

television, is the overwhelming source and often the only source of science and science information for their viewers. Science as seen on television is “science” to most people.

Traditionally, scientists have used print and peer review to advance scientific research and understanding. The work that scientists present in these publications are intended for other scientists and not for the public or the lay person. Scientists have traditionally not made use of other media in the presentation of science nor used other media in the peer reviewed process. There are no science peer reviewed television programmes specifically for scientists to present their science findings and research to other scientists, the way that peer reviewed publications have been used in print.

According to many scientists, scientific method is a very important and crucial part of presenting science; even on television programmes. But, because scientific method is not well understood outside scientist circles, it can make television programming less interesting to viewers who are used to watching programmes that follow more traditional methods of production. In spite of that, many scientists feel that television science programming should include scientific method. They feel that because television programming and programmers do not use, understand or even see a place for scientific method in the discourse and presentation of science on television, most of what are science programmes are, as a result, not a true representation of science.

What is considered to be science or scientific method differs markedly between scientists and non scientists. The method outlined above is very rigourous and followed

with very little deviation by scientists. Even in print, many of the publications deemed to be scientific by publishers and authors, are considered seriously flawed with respect to science and scientific method, if they deviate even slightly from scientific method. Even when science is presented to a non scientific audience, many scientists feel that the stories suffer without scientific method.

It is also important to note that scientific method is first and foremost a method used by scientists to present research and scientific findings to other scientists and not designed for mass media expositions to non specialists. There are a number of factors which make the peer reviewed publications difficult for the layperson, including language, strict adherence to scientific method and often the use of mathematics and statistics. Much scientific research is quantitative, with a heavy reliance on the defining of the boundaries of the study through statistical methods which are virtually incomprehensible without extensive specialized education. Even for scientists who are expert within the given field of study, the papers can be difficult to understand fully.

In addition to what has been outline above, another part of scientific method, which adds to the confusion to laypeople, is the peer review. Scientific method is not definitive or absolute. It is a method of constant revision. Every study and outcome is designed to be superseded by subsequent studies and research. Scientists understand this, that studies are never complete. This can be unsettling to the layperson who has come to expect certainty and exactitude. Scientists are expected to be very critical, in a positive sense, of other scientists' work. That critical approach is part of the scientific method process.

Without understanding this aspect of scientific method, it can appear to the layperson that a scientific study is flawed because other scientists criticize it.

### 1.4 Journalistic Method

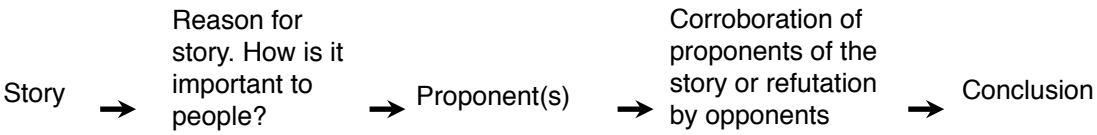
In contrast to scientific research, television makes little use of scientific method and relies on journalism and journalistic method to present information television, in order to make the production conform to the tightly constrained formats of television. And in that light Oscar Wilde (from the web site http://www.brainyquote.com/quotes/authors/o/oscar_wilde_2.html), in what some scientists would agree is an almost prescient statement that could be applied to modern television, is quoted as saying a century ago *"By giving us the opinions of the uneducated, journalism keeps us in touch with the ignorance of the community*". And for many scientists (Zurawski scientist interviews 2009) this glib rejoinder is a fact when it comes to science and most of its representation by journalists and television programmers.

Though journalistic method is probably as rigorously defined as scientific method, its application is likely more flexible, varying from newsroom to newsroom and from broadcaster to broadcaster. There are a couple of reasons for this statement. Peer review is in print and intended for critique by any and all scientists. A science story done by a journalist is basically vetted only by the editor of the newsroom of the broadcaster, who usually has a serious time and resource constraints. In addition, once the story is broadcast it is generally gone because to the nature of the television medium. This is a

distinct difference from print which can sit around for years and even decades. This makes it unlikely that a journalistic science story will receive the same sort of critique, even though its audience is probably much larger.

The general definition of journalists method is outlined as follows (web site reference http://www.suite101.com/article.cfm/student_journalism/18661).

**Journalistic Method**




In journalism, science is presented without peer review and is highly subjective, dependent on the reporter and the producers, their understanding of science and their insights and the structure of the interviews with scientists, along with the selection and length of the interviews used in the story. Though there have been deliberate scientific studies to show that peer review is vulnerable to misinformation and distortion, such as the Sokol Hoax (Sokol May 1996), scientific method is generally thought to be quite of reliable. In 1996, Sokal, a professor of physics at New York University, submitted a paper for publication in Social Text, as an experiment to see if a journal in that field would, in Sokal's words: "publish an article liberally salted with nonsense if (a) it sounded good and (b) it flattered the editors' ideological preconceptions." In spite of this, in general however, it can be argued that the success of the peer review process in

scientific method has been among the most powerful methods we have in uncovering scientific truth.

In the journalistic approach, the reporter or producer makes the assumption that the story has a relevance to the audience, that it will have an impact on the viewer and as a result will be of interest to the viewer. That interest is crucial for the production of the story, because it will either be highly anthropogenic or a spectacle that will provide the necessary viewer attraction.

In order to make the story factually accurate, the reporter and/or the producer must also ensure the facts of the story have been corroborated and verified from a number of sources. This is similar to triangulation used in qualitative research. Where it differs from triangulation is not in the theory, but in its practice. When triangulation is used in qualitative research, it generally takes place in print and supporting or countervailing arguments don't have the same time or geographical constraints as they might in the practice of television journalism. The individual scientist is also a researcher who is likely generally aware of the experts within a field of study. A reporter doing a story, in looking for a scientist to corroborate or contradict a science story is under time constraints, video constraints and probably does not have the same producer, also looks for countervailing opinions, opinions which disagree with the basic thrust of the story. The assumption is that this can be achieved by using a pro/con interview methodology to provide a story that has an equal balance and gives the viewer the impression of impartiality as far the reporter and producer are concerned.

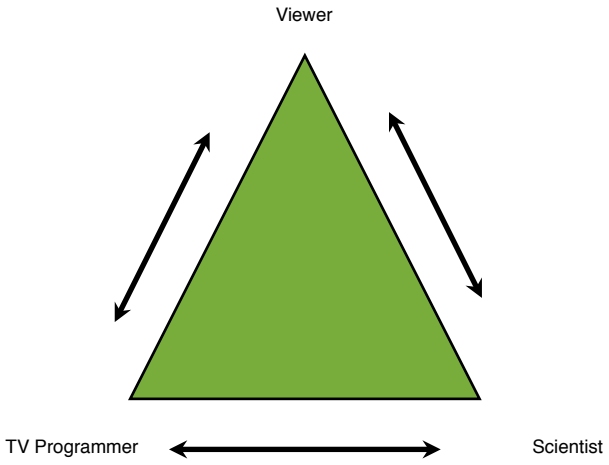
Once these concerns have been addressed the story is produced and presented. The reporter writes the story from the research notes, under the method outlined above, presents the reason for the story, either spectacle or anthropogenic with pro/con opinions from experts, and the conclusion.

Journalistic method is a distillation process. It reduces complex stories and issues, taken from the expert sources, and puts the story into a perspective that is accessible and understandable for a non expert in the story area, the viewer, in the case of television. The key assumption made, is that journalistic method applies equally for all subjects and topics, politics, current affairs and science. And furthermore, it is also assumed, any human issue, if presented using journalistic method, will be fair, accurate and an even representation of the more complex expert information.

It can be argued that there appears to be more than a passing similarity between scientific method and journalistic method. And from a theoretical stance this may be. However in practice, as has been outlined in the previous page, there are some key differences. It is also important to note that journalistic method tends to rely on the information represented by scientists selected for their stance as it relates to the story. Scientific method places a much greater reliance on the collection of the information within the field of study.

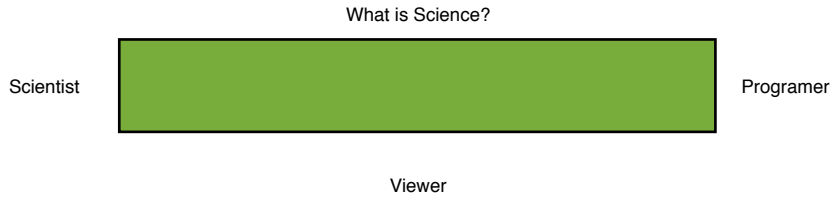
### 1.5 Science Programming on Television

Science programming on television can be visualized as a triangle composed of three apexes, at the top of which is the viewer, with the programmer and the scientists at each of the other apexes. Along the sides of the triangle there are arrows representing the flow of influence of each of the apexes on each other. The dual direction of each of the influence arrows suggests that influence is not static or one way, and is variable depending on the additional factors inherent in the apexes, such as education, methodology, length of broadcast and level of interest.




The television medium is by and large under the purview of journalists and business people and not scientists. As a result, journalism plays a large role in the production of science TV productions and scientific method rarely does. Even when scientists are involved in the production of science programming on television they rarely have control of the final presentation of the production and how they present the science is defined by the needs of the broadcaster. This often creates a disconnect between scientists and television science production.

The question "*What is science?"* takes on a new meaning when its interaction with television is considered. It becomes important to understand not only how the scientists define science, but how television programmers and programming define science, and how the viewers define science. Here the relationship can be represented with a quadrilateral, where "What is science?" is on the top with the views of the scientist and programmer at opposite ends and the viewer on the bottom. The nature of what science is, is an abstract, subjective concept, and while it might initially appear that it is defined by scientists, programmers and viewers have opinions as to what constitutes the nature of science as well. Each viewpoint can stand alone and does not depend or even affect or interact with the other views, and can and does exist independently of the views of the other groups.




It is also very important to note that even when not explicitly stated, the question *"How Does television Represent Science*", implies an effect on education, educational choices and decisions based on degree of education. By its very nature, science is not intuitive, not part of the system of analysis most people are familiar with. It is only through formal education that we come into contact with scientific method and most of the general population never progresses far enough in the sciences educationally, to gain the deeper insights of scientific method. Television rarely deals with scientific method, nor

do its programmers understand scientific method, since they share with their viewers a dearth of science education. And because of this, when science is presented on television, it has an inherent educational component, even if the intent is to entertain rather than educate. Because television is still the medium of choice for public information, it is also necessary to consider how science programming motivates educational choices by viewers, the perceptions the viewers have of science and scientists, and what, based on television science programming, the general understanding of major science issues like climate change, medicine, Intelligent Design etc. is.

Another part of this interplay between scientists and journalists and presenting science on television is the viewer and the viewers' educational threshold. "*How do education levels of the general public affect science represented by television?"* becomes another important consideration. Since the majority of viewers do not have a post secondary science education, most do not understand even basic science. According to studies by Miller (Miller 2002 and 2006), fewer than one in five adults is sufficiently scientifically literate to be able to read and understand the science section of the New York Times or similar materials. As a result, producers who want to make their science stories as accessible as possible to as many viewers as possible are faced with the daunting task speaking about topics which are in all likelihood well beyond the not only the viewers science education and understanding, but their own as well.

Studies have shown that education levels and the type of education and science education that viewers and producers have are an important part in considering the effect and impact that television science programming has on society (Hornig 1990). Science programmes that are produced above the science educational levels of the audience run the risk of not being watched by viewers and as result being subject to low ratings, which ultimately means cancellation. On the other hand, if the science in television programmes is oversimplified, the programming runs the risk of over generalizing the science to the point where it is factually incorrect. In addition, what is understood to be science by the viewer, the producer and the scientist is not the same. Science by non-scientists often has no reference to scientific method and is often bundled with technology and engineering. This distinction is important in the context of the disconnect between scientists and television science. Scientific method is at the heart of what constitutes science to scientists, and though television science programmes may have scientific facts in them, they, in an of themselves are not scientific method.

Gauging the science education level at which to present the programme is an important part of the broadcaster's assessment of its audience. Generally the audience varies as to the type of broadcast with channels such as Discovery having viewers with more higher education levels and science backgrounds than the networks and local news channels that deliver a wider spectrum of programming. Particularly in the short form science news spots, the general audiences have lower levels of formal science education and lack of formal post secondary science education in the sciences. And the reporters and producers of the short form science spots are also unlikely to have any post secondary

education. Both the viewers and the producers of science programming are unable to understand the science on a peer reviewed level or understand the importance that scientists place on scientific method, peer review and how it contrasts with journalistic method. The ability to present more sophisticated, science involved stories has an increased potential to suffer, especially in news spots, given the much shorter duration of these stories and highly competitive nature of television news in a low science educational background of viewers and producers.

Broadcasters and science producers point out that television is a business and must retain the interest of the viewer and that a story based on scientific method, education and that does not have a "story" will fail to attract viewers and as such will fail to influence, educate or even interest the public. And ultimately, a story that fails to hold the public interest in the highly competitive arena of broadcasting, will lose viewers and advertising revenue. This will mean the television broadcaster will not be able to attract revenue and fail as a business model. (As an aside, there is some indication that this may be happening within the network model of broadcast television, where Canadian broadcasters have made the assertion that they are in financial difficulty and that their ratings have declined. Whether this is in fact true, has not yet been reliably ascertained.) It will not matter if the story is accurate, educational and reflects exactly what the scientists feel it should, because it will not be seen. And to quote an old adage, (Thank you Paula Romanow) *"If a tree falls in the forest, and no one is there to witness it, does it make any noise?"*

We have, as a result, a wide gap between those who think scientific method must be included in science presentation and those who think science can be represented in a number of ways and can even exclude scientific method and still maintain the integrity of science and even enhance science, because the science programme is more watchable to the viewer. This disconnect between scientists and television science relates to both what is considered to be science and how it is presented.

### 1.6 Why It Is Important

There have been numerous studies that show that viewers get a substantial portion and even the bulk of their information and news from television (Eveland&Mihye 2000). As a result, viewers base many of their decisions and opinions about issues of the day on what they see on television. A telling statistic in the studies reviewed also brings into focus the perception that viewers have about their own science literacy is affected and influenced by television programming.

Southwell & Torres (Southwell & Torres 2006) examined the ability of science television news exposure in medium sized markets to boost perceived ability to understand science. They also found that perceived ability to understand science, in turn, predicted conversations about science. There appeared to be a positive relationship between exposure to science news programming and stories about science in the news as presented by television and the perception of understanding science. There are two issues that come about as result. The first is the key word in this, “perceived”. After

exposure to the science story the viewer felt he/she understood science. The second is the viewers treated the science news as accurate and representative of science. Both cases present difficulties. The Southwell and Torres study shows television to be a powerful medium in moulding science opinions, reflecting the work of roughly two decades ago, for example, by Elliott and Rosenberg (1987) which demonstrated an association between exposure to print media content on science and self-reported ability to understand science topics. In addition, consistent with past work (Mares, Cantopr & Steinbach; Elliott & Rosenberg, 1987; Mares et al., 1999), it demonstrates a positive impact of media content on beliefs about science. It appears that what viewers see on television, they believe. And they also believe their own understanding of science increases as a result of having viewed the news stories.

From this perspective *"How Does Television Represent Science?"* becomes a very important question. Believing that one is science literate is substantially different than actually being science literate and if television has the ability to make people feel that they are literate in science or have a higher literacy in science than they have, then we wind up having misconceptions and opinions that can have much larger consequences in society, than just science literacy questions. It becomes important to understand how it is that television presents science, because of the major science issues that we have in society today. The list is long. A partial list is human population, human consumption, alternative medical practices, intelligent design, anti-vaccination lobbies and not the least of in importance, human induced climate change. It is hard to understate the importance of these issues and they all have their basis in society's understanding of

science. Our survival depends on our society being able to successfully navigate these issues and having the correct information and science behind the issues. Because of its primary position in the information dissemination spectrum, television has been shown to have a profound ability to influence the decisions we make, through the understanding we have of the science issues facing us, as presented by television. And not a few scientists and media critics think that television has fallen short in bringing science to the public.

However it can also be argued that in order to make science programming understandable and entertaining on television, there must also be an educative process which infers that the scientific community has an onus to explain science in lay terms.

The importance of the preceding question relates to two issues, the number of people watching television and the medium's ability to persuade its audience. It presents stories using written words, audio and video, and is highly compelling to viewers. And because we have a number of very important science issues to contend with as a society, all based on our science understanding, the role that television plays in science becomes crucial. These issues, climate change, medical issues, education, technology etc., all require an understanding of science in order to understand the importance of the overall issues. How television represents those science issues and the science behind the issues become important. How television represents science affects how we approach problems like climate change and whether we should act or not act. Television can even determine what science is worthy and gets researched or not researched. Stem cell research in the

United States was put on hold after the right wing religious lobby was able to use television to pitch its agenda and convince the government that stem cell research was unethical.

Journalistic method and broadcast television science documentaries represent science differently than the scientific method used by scientists who represent science. This difference is important. If what a scientists does in science is portrayed differently on television than in the world of science, it is first, misleading to the public and secondly does the scientist a disservice. If the scientists who do the work in science, do not get their message out to the public, very often through television, they run the risk of having their funding cut from their studies or allocated to other more "hot button" studies favoured by the media. If the public is mislead by a misrepresentation of the science then crucial, important studies may fall by the wayside.

The educational impact of television is hard to understate. From earliest childhood to old age, television is a staple, found in almost all homes in North America. Television impacts educational decisions by children and by many adults through how it represents science and scientists, the stories it programmes, what is important in life by what it chooses to air and how it chooses content of the stories it airs. Whether directly or indirectly, television in how it portrays science and scientists, influences and moulds our interests. In children the effect is especially profound. It is explicitly and implicitly a part of the science education and science value systems of the person it touches.

Television is a business (increasingly this includes most PBS and public television stations) and as such adheres to business constraints which means it needs viewers in order to make it profitable and remain viable. Those television stations and networks which do not, run the risk of not being on the air as sponsorship and ad revenues fall. As a result, its stories and programmes are designed to be as interesting and entertaining as possible to engage their audiences. To hold viewer interest producers of science television programming use methods borrowed from other television programming genres which may be in conflict with traditional science as seen by scientists and that may skew the basic concepts and content of the science in the programming on television. Business and programming interests are different than science and scientific issues. This difference has the potential to affect the nature of the science decisions we make as a society.

Because many of the reporters and science producers in television production have little background in science, especially in the short form science stories seen on the news, television has the potential to reinforce stereotypical biases, like “science is hard”, “mainly male”, is for “eggheads and nerds”, science requires a “different” type of brain that the average person doesn’t have, or cool people don’t do science. These stereotypes, because of the influence of television, can have a detrimental effect on the decisions viewers make in terms of increasing their own science understanding through formal education. Television has the potential to distort how science is done, what constitutes science and choices available and why it is important.

We can further break down the general term “science on television ” into a few general television broadcast formats, each with its own particular emphasis and effect on how science is presented. They are, news journalism short format (30 second to 4 minute stories), long form documentary format (15 minute to 2 hour (feature length), series and strand based format (usually 30-60 minutes in length, the Nature of Things and Nova are prime examples).

Because television programming has so many facets and each genre is also constantly evolving and changing it is necessary to consider this aspect of television as well. When considering how television represents science, it is also necessary to examine how television has represented science in past programming, what the studies of these programmes have had to say about how television science programming was like in past years, what it is like today and where it will be tomorrow.

In the next part of this study of how television represents science, the literature review examines many of the studies that have been done in television and in how it relates to science.

# Chapter 2: Literature review

## 2.1 Introduction

The literature review was the first part of the formal examination of the thesis question, "*How Does Television Represent Science?"* and was comprised of two separate parts. The first part consisted of a review of the works of three authors on the media, Noam Chomsky's *Manufacturing Consent*, Marshall McLuhan's *Understanding Media* and George Lakoff's *The Political Elephant*. Research papers and articles published about television and the interaction between television with science was the second part of the literature review.

The review of the articles and studies about the nature of television and its relationship with science formed the underlying bed of data about science and of television. The works of Chomsky, McLuhan and Lakoff formed the "lens" through which the data was examined.

The outcome of these two parts of the literature review led to the creation of a series of questions designed to gather current data from a group of interviewees, consisting of broadcasters, producers and scientists, about their thoughts and perceptions about the nature of science and television programming.

The literature review is an important part of this study, because our understanding of the relationship between science and television, how it works and how science is represented by television, provides insights into educational choices, stereotypes in science, communications, different learning methods and the motivators within both science itself and television production. Much of the our society sees science only through television. This has important implications for how we make decisions about science, how we choose how our children should be educated in science, how we choose our elected officials to represent us in making decisions about important scientific issues, and how we behave within our society. The literature review also provided the initial data that was necessary for the creation of the questions to be used in the interview process.

The following sections consist of the analysis of the nature of "lens" provided by the works of Chomsky, McLuhan and Lakoff through which the data of the research papers was reviewed and a summary of that analysis of the literature.

**2.2 "Lens" Through Which to View the Literature Review Data**

McLuhan's, Lakoff's and Chomsky's works provided a lens through which the literature concerning how television/media consolidation, language, mass media and changing media all affect how television represents science, was reviewed. The importance of the

relationship between television and science is hard to overstate. A short overview of the importance of their works as they relate to this study is as follows.

McLuhan's work relates to the medium itself and how its intrinsic nature has an impact on everything we receive from it. If that medium is in a state of flux, through technology or through other pressures, the message it sends out is also changed.

Lakoff's work revolves around the influences of language on the messages we receive from television. The juxtaposition of audio and visual content in television can have profound influences on the information we receive from television. The use of words over images or the lack of words can modify, enhance or negate the content in very subtle ways, influencing the message.

Chomsky's work in the consolidation of media, like television, shows the influence of big business on the content of what we take as accurate news and factual broadcasting. With consolidation comes less variation in content, fewer voices and a unified, condensed output. He terms it "manufactured consent". This inherently leads to shorter stories and less variation and dissension in content. Noam Chomsky (Manufacturing Consent - Chomsky&Herman) has written extensively about the power of what he calls *"manufactured consent"* and how through various devices the media reflects the interests of the elite and the powerful in the united States and is itself one of the shapers and moulders of our society and attitudes through what we consider news in print, radio and television.

### 2.2.1. Marshall McLuhan

Marshall McLuhan famous aphorism “the medium is the message” is expanded upon in his book *Understanding Media, The Extensions of Man*. In that light, every medium, according to McLuhan has to be considered for its effect on the content within that medium.

For example, the alphabet was a technology, when introduced in in its full incarnation in ancient Greece, that caused a firestorm of controversy and changed the way we look at knowledge and how we learn. Socrates (Derrida 1972) insisted it would be detrimental to learning and lectured against its use. In the end he lost that battle, but his point was well taken in that it did change the nature of learning and led to what can be considered to be one of the greatest flowerings of the western world, Hellenism, which saw major advances in all the sciences, philosophies, medicine and politics. And it is the underpinning of our own age of technology. Science has been presented and represented through the ages by the print medium and that is where science has made its greatest impacts.

In the same way that the alphabet created a new way of learning and presenting information, television also modifies the message it presents. How it presents science has an influence on the information and story, and the medium needs to be considered when looking at how television represents science.

Traditionally science over the past 400 years has progressed and been presented in print, probably beginning with Isaac Newton (Newton 1687) and his outlining of scientific method. The scientific renaissance came about at the same time as the printing press and it is doubtful science could have progressed without Gutenberg's invention (McLuhan 1962). And today, print, scientific method and peer review are still used by scientists to further science. However, this pits print, the traditional organ for science, against video and audio. It asks the question whether in fact science and science information can be presented in the current sphere of television broadcast, whether the nature of the medium distorts science beyond what is acceptable as science.

It has been stated that television excels at presenting short, emotional content. In that light, is it possible to present science on television? Television at its root is an emotional medium that does not present its material the same way that print does. It is not conducive to information the same way print is and scientific method is not represented the same way on television as it is in print, because of the fundamental difference in the nature of the two mediums. What television adds or what television detracts from science as it presents science is a question that needs to be considered.

### 2.2.2 Noam Chomsky

The first issue according to Chomsky is who controls the media. Chomsky details the rise of the modern media (television included) which has become a very powerful

business with powerful business concerns. According to the statistics provided by Chomsky a large percentage of the media is controlled by a very few people who have interests in other businesses. Though he writes almost exclusively about US media, his statistics are applicable to Canada. (Manufacturing Consent, Chomsky&Herman page 14-22). As of 1986 of the more than 1500 television stations in the United States, most were not independent and 29 of the largest media concerns accounted for almost all of the news output of the 1500 stations. In Canada (Wikipedia) the statistics are pretty much the reflective of what Chomsky has provided for the US. There are just under 170 television stations in Canada with over 120 of those controlled by seven of the largest broadcasting corporate entities. In the past decade the CRTC (Canadian Radio-television and Telecommunications Commission), the federal agency responsible for granted television broadcast licenses, has issued over 500 additional digital and analogue cable channels, many of them independent, but most these channels have failed to launch or serve very small audiences, their viewer numbers a fraction of the main networks. Most of the successful cable and digital offerings (those with the highest viewer numbers) are under the ownership and control of main broadcast groups. As a result the television landscape in spite of this appeared diversity is still dominated by the large media concerns.

According to Chomsky, this lessened diversity makes it easier for vested interests, like business, to create an artificial consensus within the public sphere, for their own purposes. Though Chomsky writes mainly about the media's political interests and sphere of influence as it relates to the media, many of the conclusions, especially when it

comes to complex scientific issues are relatable to science and television programming. Business is heavily involved in many of the science issues that affect us. For instance oil interests have funded many anti-climate change studies (www.realclimate.org) through organizations like the Heritage Foundation to create a climate of uncertainty in the public opinion regarding anthropogenic climate change, through their media reports, when in fact the scientific community is almost unanimous in its indictment of human activity as a main cause for rising CO2 levels and global warming.

Science is generally not conducive to short journalistic sound bites, especially where complex issues are involved. Science often requires detailed and long explanations. When a consolidation of the television markets occurs, we have fewer possible voices willing to present what is thought to be "boring" and beyond the reach of the average person. Less time is given over to science. Almost all the channels that we have available on television are owned by a small number of giant media conglomerates. There are very few independent voices left in television and those left in the marketplace must rely on network dominated news feeds to fill their newscasts.

### 2.2.3 George Lakoff

As television has evolved to its current state, programming, especially in the news, has become shorter and shorter, and as a result become much more reliant on language. Lakoff states that even though television is consider to be predominantly a visual medium, language plays a crucial part in the perception of a story. How that language is

used can either reinforce the pictures and the video, distort them or even contradict them. George Lakoff in his book, *The Political Elephant*, addresses the power of language and rhetoric and how its use is ideal for television. He suggests that images can be used to tell one story and the language under the images can tell an entirely different one. He posits that small, subtle, seemingly innocuous phrasing can manipulate and distort ideas and create false impressions that belie the images.

Though Lakoff's writings deal with mostly how rhetoric works to manipulate American politics, again his insights are applicable to Canada for a number of reasons and can be applied to science as well. In Canada, we are flooded with television from the United States. American dramas, documentaries, news and commercial messages also inundate Canadian airwaves. CTV and Global (Friends of Broadcasting, Ian Morrison) spend almost 2 billion dollars a year licensing American programming and most Canadians have access to American programming either directly from the broadcast terrestrial signals because of their close proximity to American broadcasters or they can access their signals from Canadian cable companies which carry American broadcast signal from CNN, NBC, MSNBC etc. Because the United States is a highly technological society, science news, documentaries and broadcasts are as common in the United States as they are in Canada, if not more so. And much of the news that we air on Canadian television is about the United States, since Canada has close cultural, business and heritage ties with the US.

In many cases it is hard to differentiate between Canadian and US newscasts, including the science stories they carry. Broadcasters and newsrooms in Canada follow US newscasts very closely and what is science news in the US is likely science news in Canada and vice versa. And when it comes to science issues like climate change, medical concerns, scientific debates and discoveries, all are of common interest to both Canadian and American audiences.

Viewers across the border can also be considered to have much in common with each other, because of the overall similarity in cultures. There is not much difference between American viewers and Canadian viewers based on the programming watched. Language is basically not an issue. Canada and the United States do have their minority languages, but English television programming in both countries is the vast majority of the total programming available.

Since American and Canadian broadcasters and audiences share similarities, the methods used to present science on television is also similar. The language is similar and the language use is similar, so what Lakoff has to say about the use of rhetoric in the United States is also applicable for Canada.

The last federal election in Canada saw a close similarity between political methods of the Republicans in the United States and the Conservatives in Canada. In fact the Conservative party employed the very influential attack ads which had their origins in the US with the Republican political machine.

Special interest groups in the United States also have branches, advertising and input in television in Canada as well. Groups like the Heritage Foundation, NRA, Intelligent Design associations all of which have their origins in the United States also have offices and media influences in Canada and are very sophisticated and media savvy.

According to Lakoff language can be used to create influence in many directions in even the shortest television stories.

Examples of this can be found in groups like the Heritage Foundation, which specializes in creating controversy in what are considered to be iron clad sciences, on behalf of big tobacco, pharma, oil concerns and religious groups. Verbal language, sound and video presentation can be used to subtly modify and distort, what seems to be on the surface, a straight forward piece of information. Simple cuts and splices in dialogue and sound can completely alter the "feel" of a story on television and distort complex issues like science. And it can also be used to create doubt in areas when in fact there is none.

And in today's television world, where brevity is paramount and concise messages often mandated by business, the choice of language on television as it presents science stories can have a telling influence. Images, impressions and doubt can all be manipulated and distorted through the clever use of language.

Even when the words used in the science story are accurate and scientifically correct, the visuals and sound have the ability to shift the focus of the stories. As reporters and producers present science stories, being able to match the words explaining the science with the pictures can present a formidable challenge. In many cases, where the science is difficult to visualize, for instance, the workings of HIV or nuclear processes, reporters have to rely on stock visuals of scientists or labs which does little to add to the understanding of the story.

### 2.2.4 Conclusion of the Lens

In order to get at the underlying issues of how television represents science the focus concentrates on four issues

1. Language: Scientists and journalists use language differently. According to Lakoff subtle changes in language can have very large effects in understanding. The language of scientific method is very precise and measured. The language of television journalists is colloquial and textured, where even simple terms can have many and even conflicting meanings.

2. The Television Medium: Scientists present most of their work in scientific peer reviewed journals. Most people get their news and science information from the mass media, especially television. There are differences in print media as used by scientists and the visual medium of television used by journalists. The interviews are intended to

focus on whether this difference changes the science message from what is presented by the scientists. Do we get a different science message from television?

3. Television as a Business: Television is a huge business and is now highly consolidated and in controlled by a handful of companies world wide. This consolidation means information comes from fewer sources, with a diminishing diversity. According to Chomsky this diminished diversity creates a "manufactured consent" with fewer ideas and streams of thought. "Manufactured Consent" happens where an underlying consensus of understanding exists, and it means stories and news items can be shorter, without background and still be understood. New ideas, especially in science, are dependent on diversity and without an underlying background understanding, are not easily presented or understood in the climate of fewer voices.

4. Education and Understanding: We make our decisions based on what we understand. Most surveys indicate that television has a large voice in how people perceive things and make their decisions. How television represents science affects our understanding of our universe, how we educate ourselves, how we decide to act in times crisis and what responsibility we have to educate ourselves and others.

The underlying basis of this thesis is education and learning. Throughout the study information, fact and understanding related either directly or indirectly to education and educational choices and underscored the importance of the study because it was so heavily involved with education.

The key concepts examined in the analysis of the research papers as they related to the lens provided by Chomsky, McLuhan and Lakoff, were scientific method, journalistic method, educational content, educational effects, education levels and their relationship to science television programming and to science understanding and understanding of what constitutes science, language use, the disconnect between scientists and science on television, and the consolidation of the television medium.

### 2.3 Analysis of the Papers of the Literature Review

The literature review of papers about television and how it represents science had a wide variety of opinions. In general there has been a lot of criticism of television right from the onset of television programming. In particular, Lafollette (Lafollette 2002) outlines how even in the early days of television vested interests often dictated science content. The 1950s science show Dr. Research illustrates the point.

" Dr. Research would then reassure the audience that science would not destroy all of life's mysteries; it had just begun the search. And at the conclusion of Our Mr. Sun, while the camera focused on a cross silhouetted against a sunset and a chorus again swelled, the cartoon character Father Time told the audience to proceed with science based measurement of the external world but to be sure to "measure the inside with prayer." (page 60)

Weigold (Weigold 2001&2002) on the other hand feels that while there is a wide variation in the quality of television science broadcasts, in his review of literature concerning science and television, he feels there is much to commend television science and recommends the training of journalists in order to produce better science on television as well as expanding the methodology of how science is represented by television. His analysis of the literature notes the following reference which is quite critical of journalists.

"Journalists almost always lack science training. One study suggests that journalists tend not to have even a liberal-arts background in the sciences. Few understand the scientific method, the dictates of peer review, the reasons for the caveats and linguistic precision scientists employ when speaking of their work"(Hartz and Chappell 1997, 22).When a journalist lacks the background to evaluate or understand complicated scientific issues, he or she is forced to deal with the subset of available scientists who are skillful at translating complicated issues into simple prose." (page 183)

Others such as Leon Bienvenido is his 2007 book (Science on Television: The Narrative of Scientific Documentary) looks at the role of television in science documentaries and has the following summary that suggests television does affect how we see and understand science and that role may be problematic.

"We do identify some key problems with science popularization: the tendency towards oversimplification, the potential for sensationalism, the imposition of simple narrative structures of complex events." (page 93)

Brian G. Southwell & Alicia Torres in their 2006 study of science newscasts indicate that viewers do associate television with science and that there is a potential improving the relationship between science and television in newscasts.

"Caveats aside, some scholars and professionals interested in addressing the documented disjuncture that currently exists between scientists and the US public (e.g., Lakoff, 2005), will view these results as encouraging. Not only do the results suggest that exposure to peer-reviewed news stories can positively affect audience perceptions and talk with others (at least in the short term), but they also underscore the potential utility of a media venue that is still widely visited, namely local television news programming." (page 348)

Gardiner and Young (Gardiner &Young 1981) sum up the importance of television science programming as follows. Though it is a British perspective, the quote could equally apply to North America and specifically Canada.

"The differences between the dramatically changing role of science and the way that it is represented on television needs to be examined with a view towards generating a much more critical approach — one which has the effect of opening up issues for public debate, rather than, as at present, leading to closure. Science, technology and medicine and their respective modes of discourse are an increasingly important component of the social formation in advanced capitalist countries. After school, for the overwhelming majority of people in Britain, science (which we will use as a generic term for science, technology and medicine) is experienced almost wholly through the film and broadcast media. For most of the general population 'science' is constructed through television science programmes, both 'serious' and fictional. In the commonly understood meaning of science, it makes little sense to talk of a discrete body of knowledge

and set of practices, apart from this representation. television, then, is the principal bearer of the social meaning of 'science', and it is our contention that such a meaning has real material effects within our society. television's construction is a lot more than a simple mirroring of scientific endeavour, an innocent transmission of scientific achievement into the public domain." (Page 1)

Television science programming is ubiquitous and accessible to anyone who turns on a television. Judging by the number of articles about science or science topics on television, it would appear that anyone who wants to see science programming should have no difficulty finding programming that are called, science shows, science news, kid's science, science dramas or documentaries. Science issues are presented on television in the news, documentaries, drama, commercials, and children's programming. In addition, the research on all and any of the areas of science television production reaching back through the years from the inception of television programming to modern productions, was not difficult to find. It would appear both from the number of articles and the genres covered, that the quantity of science programming is vast and growing, with dedicated strands on Public television (the Nature of Things), private cable and digital (Discovery Canada, National Geographic and Discovery HD) along with specific science news offerings such as Daily Planet on Discovery Canada and children's science from Discovery Kids just to name a fraction of the huge number of broadcasters and producers. From the literature it would be easy to conclude that television offers a huge array of programming it calls science.

At first glance, the quantity of science programming on television would appear to be high. But this first blush can be deceiving and is closely tied to the quality of programming which follows below.

While the quantity of what is deemed science television programming may be large, quality is another issue. And what is one person's good show on science or good news story on science is another's questionable production. It is highly subjective and because of that it is also closely tied to quantity. If the vast proportion of science programming on television is questionable in quality, then the quantity of science programming is also called into question. The two are tied to each other. What is science and what is not? Quality is a difficult concept to define and varies based on what is expected of television broadcasts.

Does the quality of science on television have the ability to influence positively, increase the science literacy of viewers? If that is the goal of television science programming, then it, according to many of the papers reviewed, which looked at the potential of television to elevate the science literacy of viewers, has failed to do so. They found its perceived potential to increase science literacy did not meet expectations. Treise and Weigold (Treise&Weigold 2002) in their paper on communication noted that science literacy from the media including television has long been an illusive goal.

"At one time, the news media were seen as having the potential to create a country of science-literate citizens. Scientists seventy years ago believed science journalism would advance an awareness of science that would elevate public understanding plus foster appreciation, literacy, and tax-supported dollars for research (Tobey 1971). However,

many contemporary scholars believe that science is not communicated effectively to the general public. At one time, the news media were seen as having the potential to create a country of science-literate citizens. Scientists seventy years ago believed science journalism would advance an awareness of science that would elevate public understanding plus foster appreciation, literacy, and tax-supported dollars for research (Tobey 1971). However, many contemporary scholars

believe that science is not communicated effectively to the general public." (page 312)

If the goal of television science programming is not education or learning, what is television science programming supposed to do? This question goes to the heart of the nature of television. Television programming serves a number of functions. It is a medium devoted to entertainment, but also informs, acts as a sales agent for business through commercials and sponsorship, and it also has programmes that are intended to communicate issues and bring facts to its viewers. And because of its ubiquity, its contact with millions upon millions of viewers, it is a very important medium. According to Gardiner and Young (Gradiner&YOung 1981) no matter what the quality, the ability of television to influence is very powerful and profound.

"How science is presented on television is not merely a matter of aesthetic nuance. It is a cliché that science, technology and medicine are impinging more and more directly and pervasively on people's lives — a true cliché. They are not merely impinging (a model drawn from the erroneous 'internal-external' dichotomy between science and society). They are reconstituting work and consumption. Television proclaims these changes and occasionally plays an impressive role in agenda setting." (page 173)

Something as simple as the daily weathercast on the television news can take on great importance from a number of perspectives. In many parts of the world and especially so in Canada, weather is important from a safety standpoint. The weather, especially during

the winter, can be onerous and hazardous, and there is a great reliance on the nightly television news weathercast for information. Weather is also part of the science of meteorology and is recognized as such by the viewers. The weathercaster is often seen to be the entry point of science broadcast news and very often science stories are scheduled next to the weathercast so the weathercaster can comment or connect with the story. Kris Wilson (Wilson 2008) writes

"An important, but mostly overlooked aspect of science communication is the potential role US television weathercasters may perform. In some cases, these specialists may be the only source of scientific information that some people encounter on a regular basis. Audience research indicates that the weathercast is the most-watched part of the local newscast and the primary reason people choose a local television news product. But very little is known about the qualifications of weathercasters as a group and their inclinations as individuals to educate viewers about scientific topics." (page 1)

Again, the issue of quality is subjective. Is television science representation about education, the qualifications of the individual, the ability to teach? In weathercasting during the news, a few facts might be proffered, but because the there is very little meteorology in television weathercasts, especially on the regional, local and national network newscasts, the weather forecasts are short and laden with conditions of the weather, augmented by colourful graphics .And because almost all weathercasters have little formal university science education, the viewer receives little in the way of the science of meteorology. We then also have to consider the issue of time allotted for the weathercasts according to Kris Wilson(Wilson 2008).

Television is a business of precious time. A local 30-minute newscast likely contains only 18–20 minutes of content when calculating commercial advertising (Smith, 2000). Although consultants report the weather segment is the most-watched part of the local news, it is often considered the“accordion,”because it gets squeezed or stretched regularly (Sealls, 1994–5). One television weathercaster reported having 10 minutes of air time during television’s early days (Youle,1952),but only one previous study has measured weathercasters’on-air time. In that smaller study of large market weathercasters,the average amount of time reported for the weathercast was 3 minutes and 23 seconds. (Page 81)

If quality is tied to time, then no matter how good the weathercast, in terms of education, the viewer receives precious little education given the time constraints and therefore the quality is lessened.

Television programming is changing just as technology changes. The demand for audience within the different genres of television programming coupled the recent introduction of games and internet content has created a challenge for television programmers to retain viewers. As a result, there is evidence that television programming, in the news, documentaries and even children’s programming, that show a push to less content and more entertainment is happening.

Dale Kunkel (Kunkel 2008), communication professor at The University of Arizona, was one of the lead researchers in a new study by Children Now, which shows that only 1 in 8 children's education television programs meet high quality standards. According to ScienceDaily (Nov. 13, 2008),

"Commercial television broadcasters are required by law to air a minimum of three hours per week of children's educational programming. The goal of the Children's television Act (CTA) is to increase the availability of high-quality educational programs, such as PBS's Sesame Street and Mr. Rogers' Neighborhood. However, the guidelines that determine what qualifies as an "educational" program do not address the quality of the educational content."

In spite of the fact that television has evolved and changed its programming to include more entertainment, television remains a powerful information source. Much has been made in recent years about the demise of television and how the internet and other forms of entertainment are superseding television. A recent paper (Thorson 2009) points out that despite the surge in web sites, blogs, traditional media, including television, television is still the choice of most people and the trust of information much higher than for the new media such as the web, blogs and other internet sources. According to ScienceDaily (April 8, 2008)

"Researchers from the University of Missouri School of Journalism recently completed a comprehensive comparison of citizen journalism sites (news sites and blogs) and traditional media Web sites. They found that despite ongoing reports of financial troubles and cutbacks, legacy media are more comprehensive and more technologically advanced than citizen media and bloggers."

Television has always struggled with the concept that it should be an educational medium. Whether it is the traditionally core natural sciences or the human sciences, media literacy stresses the use of television as a learning medium. According to Dillon and Crifasi (Dillon & Crifasi 1993)

“The "reading" of television and other mass media, known as media literacy, holds important lessons for educators attempting to infuse multicultural influences in their curricula through televisual media. The concept takes into account that viewers need to be critical and active in their media consumption; it stresses knowledgeable use of television rather than blind acceptance of it. It suggests that the social and economic systems surrounding the mass media communicator are likely to provide clues about video production technique, content inclusions and exclusions, and political viewpoints undergirding the program itself.” (page 56)

In terms of soft education, shaping opinions and bringing viewers information in the sciences, television has a very strong ability to influence viewers through the soft education of information. According to Jon D. Miller et al (Miller 2006) even though there is a tendency and even a desire by the viewers for science news, it is not a priority of broadcasters, especially in smaller television newsrooms.

The past two decades of Pew studies of media use in the United States (Pew Research Center for the People and Press 2004) have shown that the most widely used source of news and information is the local television news (see Figure 1). Like newspapers, most local television newscasts are comprehensive in character, covering a few major national or international stories and a mix of local news stories, weather, and local sports results. Bennett, Rhine, and Flickinger (2004) report that the audience for health stories in the media is larger than the audience for national or international news and that this pattern has been stable since 1989. In recent years, local television newscasts have included an increasing number of reports on health and science topics. Larger television stations frequently have a health, medical, and science reporter (often the same person), but many smaller stations have no staff assigned to a science or health beat on a full-time basis and depend on wire service and network feeds for stories in this area (Kurpius 2003; Rosenstiel, Gottlieb, and Brady 2000; Tanner 2004). (page 217)

Passive learning through television programming has been a topic of research, conjecture and papers for as long as television has been broadcasting. A paper delivered by Krugman and Hartley in 1969 outlines the potential that television had in active and passive learning. The paper suggests ways television programming could augment the best wishes of society, through learning (passive and active) for all segments of the population, such as teaching non-violence, fortifying accepted good habits (non smoking, moderate alcohol consumption), presenting visualizations of conduct in foreign societies, educating children, presenting complex issues with a visual analogue, just to name a few uses.

Even something as seemingly benign such as the nightly weathercast can be seem as having an influence on education. According to Kris Wilson, (Wilson 2008)

"While ample attention has been paid to such agents as school, family, religion and the workplace, the influence of the media as community educators is just beginning to be appreciated, let alone understood (Brookfield, 1990). Limited research shows that most adults learn the bulk of what they know about contemporary science from mass media (Durant et al., 1989; Atwater, 1988), although the focus of that previous research was newspapers. The purpose of the weather forecast should be to help people make better weather-information-dependent decisions (Brooks et al., 1997). In addition, this research argues that television weathercasters already serve as more than just forecasters and act as mass media science communicators" (page 83)

Weather casting is just one part of the equation. Newscasts also present science stories. And because of their ability to influence people, how television represents science has come under scrutiny. A study by Southwell and Torres' (Southwell&Torres 2006)

indicates it has the ability to influence conversations, understanding of science, perceived understanding of science and even education and educational choices.

"Caveats aside, some scholars and professionals interested in addressing the documented disjuncture that currently exists between scientists and the US public (e.g., Lakoff, 2005), will view these results as encouraging. Not only do the results suggest that exposure to peer-reviewed news stories can positively affect audience perceptions and talk with others (at least in the short term), but they also underscore the potential utility of a media venue that is still widely visited, namely local television news programming." (page 348)

Southwell and Torres' (Southwell&Torres 2006) study and quote above, that science news has a positive effect on the understanding and the perceived understanding of science by the viewer can also infer that science programming on television can also influence how the viewer perceives the scientist. It would be reasonable to think that if a viewer was positively influenced by a science news story, then that influence would extend to the viewers perception of the scientists appearing in the story as well. However, while the science story on television may have a positive effect on the viewer in terms of science understanding and even education, the presentation of the science and the image of the scientist may be stereotypical and misinformed.

Southwell and Torres tell us that there is a disconnect between television and scientists. And this disconnect comes from a variety of sources that is rooted in basic differences between television and science, both direct and indirect.

When scientists are portrayed on television expounding on the opposite side of a given scientific argument, they are almost never talking with each other, but rather artificially juxtaposed against each other by the editors of the television programme. As Gardiner and Young (Gardiner&Young 1981) put it:

"When scientists disagree on television, one talking head is followed by another, and they are almost never in direct conversation, much less in debate; e.g., *Horizon, Open Secret*. Similarly, the telling of the story does not convey direct conflict but rather the solving of a mystery, the fitting together of pieces of a puzzle. Stark disagreement is an interruption in the plot line. Science and its telling are synonymous with progress and convey a sense of authority and the advancing edge of objectivity. By these devices and conventions, among others, a special status for scientific knowledge is assured. It is positivist in that it privileges scientific knowledge above other forms of inquiry and in that it separates facts from their contexts of meaning and represents them as above the battle of competing interest groups and classes." (page 178-9)

Very often the scientist in a television science story or a documentary is seen in a lab coat working labs, or peering through microscopes or other such stereotypical activities that may in fact have little to do with what the scientist does or has done as it relates to the science story. According to an article called Mediaology by Greg Dahlmann, (Dhalmann 2005) when the scientist makes the transition from scientist to media scientist there is a profound change in the image as offered by the scientist and what is seen on television. In the real world of peer reviewed papers and discourse with other scientists, the individual scientist has time, common methodology and a peer level of

education. Once the transition is made to the media, the scientist loses all that and becomes constrained to limits of television.

"Let's turn to that other "oxymoron" problem: the role of the scientist as popularizer. In the real world, we want to make a lasting impression and ensure that our ideas are heard and our suggestions are followed, yet none of us is granted unlimited time to explain the nuances of complex issues. We are forced to be selective in our disclosure of facts, or we risk being ignored. However, intentionally distorting the likelihoods of certain outcomes is just dishonest. Balancing the need to be effective in sound-bite situations with the responsibility to be "honest" (i.e., fully disclosing complexities) is what I call the "double ethical bind." (page 5 of the article)

In this role as popularizer, the scientist is trapped by television. The simplification or even over simplification of complex scientific issues that seem simple on the surface, can artificially place the scientist in a role unintended by either the scientist or even the broadcaster. I.C Jarvi (Jarvi 1990) points out that even the best intentioned documentaries cannot present the scientist in a perspective that truthfully represents who the scientist is and what that person does in science. Science is often the result of painstaking research that may take years, and is subjected to rigorous peer review, none of which may appear in final television representation and which in the best of times only have the scientist, whose work is being summarized for a television, talk for a few minutes in short clips lasting a few tens of seconds. Even in the case of the highly crafted and world renowned series like Nova, Susan Hornig (Hornig 1989) in her study of two of these PBS episodes finds that the television medium, through its editing and production techniques, used to create entertainment, often obscures and distorts both the science and the scientists.

In terms of dealing with specific science based issues, it is valuable to look at how television programmers deal with one of the great issues of our time, climate change. I will begin with the paper called “Mediaology” (Dahlmann 2005) which deals specifically with the disambiguation of climate change. This paper outlines the frustration that climate scientists feel in their efforts to debunk the artificial controversy that is created by television. Climate scientists are forced to debunk the same questions over and over again while trying to educate the public as to what is really happening in to the world as it relates to anthropogenic climate change.

"The fundamental question related to climate change, then, is: how can we make, or at least encourage, advocates to convey a balanced perspective when the 'judge' and 'jury' are Congress or public opinion." (page 2 of the article)

In a recent paper from the University of Illinois at Chicago (Doran 2009) it was found that 97% of climatologists active in climate change studies from a survey of 3400 scientists, believed that climate change was enhanced by human activities. And again in the media, specifically television, many of the stories presented give the impression that the scientists involved in climate change research are divided and that there is no consensus among them. This study, the largest of its kind to date, points to exactly the opposite conclusion, yet when the paper was published, it received almost no coverage in the television newscasts.

“Doran and Kendall Zimmerman conclude that the debate on the authenticity of global warming and the role played by human activity is largely nonexistent among those who understand the nuances and scientific basis of long-term

climate processes." The challenge now, they write, is how to effectively communicate this to policy makers and to a public that continues to mistakenly perceive debate among scientists." (As quoted in ScienceDaily Jan 21, 2009)

The media, even after studies showing conclusively that there is no debate of any consequence between climate scientists, especially television, continue to pose climate change as a scientific debate among scientists, when in fact there is none. The sources critical of how science issues like climate change are represented on television and other media (Gavin 2009) have begun to criticize the media, television included and have begun to address the reasons behind the artificial controversy, such as the poor scientific education of reporters and powerful lobby groups with vested interests.

"Dr Neil Gavin, from the School of Politics and Communication Studies, believes the way the media handles issues like climate change shapes the public's perception of its importance. Limited coverage is unlikely to convince readers that climate change is a serious problem that warrants immediate and decisive action.

Researchers found that the total number of articles on climate change printed over three years was fewer than one month's worth of articles featuring health issues. The articles offered mixed messages about the seriousness and imminence of problems facing the environment." (ScienceDaily Feb 25, 2009)

There appears to be the opinion among almost all scientists who understand scientific method and peer review, those without a vested interest and/or sponsorship from vested interests or business, that anthropogenic climate change is a widely proven fact. None of the many papers cited in this report gave any indication from the authors of other papers cited within their researches that there was any reason to doubt this fact. Yet the media consistently displays contrarian stories regarding climate change. This has brought ire

from the science community who have to answer the same questions over and over again in what seems to be a never ending, futile round of battles with the vested interests of the anti climate change lobby.

A recent paper by Dr. Gavin adds credence to that opinion. (Gavin 2009)

Dr Gavin explains: "Our research suggests that the media is not treating these issues with the seriousness that scientists would say they deserve. The research company lpsos-MORI found that 50% of people think the jury is still out on the causes of global warming. The limited amount of media coverage - which tends to be restricted to the broadsheets - means that this statistic is unlikely to alter in the short-term. (ScienceDaily feb 25, 2009)

Susan Hornig (Hornig 1989) in a paper delivered in May of 1989 examined the process of making two documentaries on the widely acclaimed broadcast strand NOVA, by PBS and found there was a wide discrepancy between the way that NOVA portrayed science and the way scientists portray science. Her conclusion was that science on television even in the best productions with huge resources represent science in a way that is different than how science is represented by scientists, based on the need for the creation of sensation in order to keep the viewer entertained and tuned into the shows.

Treise and Weigold (Treise&Weigoldand 2002) and a number of others have written extensively on the subject of how science should be presented on television and one of their conclusions is that communication between scientists and the media, in this case television, needs to be improved in order to improve television's representation of

science. Treise and Weigold also recommended that reporters covering science be trained in the sciences.

### 2.4 Summary Literature Review

There are a number of major issues that the review of the literature shows.

1. In general, there is a large disconnect between scientists and broadcasters, because of the perception of what is considered to be science. Broadcasters have a broader definition of science that most scientists do not share. Especially in newscasts, science stories tend to exaggerate, skew or have incorrect science facts. Broadcasters have a free hand in airing pretty much anything they want and labelling it as science.

2. Literacy and science understanding is falling from past levels. For the most part the viewer gets his or her science information from television and reflects what television portrays as science in its science programming.

3. Broadcasters and viewers have comparable science literacy levels and are unlikely to have any post secondary education in the sciences.

4. Broadcasters see science as a low priority and it is only set at a higher priority if it appears in the news, such as a major disaster related to science or a major discovery.

5. Scientists are disenfranchised from television science production. Scientists rarely participate in science production on television, and when they do it is usually as a scientist being interviewed for a short clip as a proponent or refuting some science story.

6. Stereotyping of science and scientists is common and they are often put into pseudo scientific, stereotypical settings. The stereotype of the socially inept scientist, or mad scientist continues to be perpetuated. As well, science is portrayed as being difficult or beyond the understanding of most people, and it takes a "special" person to do science.

7. Science is often reduced to spectacle and is over simplified. Many of the documentaries being produced are based on spectacle, using the "the biggest" or "the greatest" theme, which non scientists portray as science. Science is also highly anthropomorphized. The "what does this mean for me" reporting requires the science story to be "relevant" to the viewer. How will it affect the viewer?

8. When left to the private networks, the quality of science on television suffers. Ratings are the most important qualifier in television. In television broadcasting the general perception is that science is "boring" and of little interest to the viewer. In the private networks where ratings determine fiscal health, science is likely to be cut first and few resources are available for quality science production.

9. Journalists are not able to do science stories credibly. The least experienced journalists, who incidentally also most often have no science backgrounds, are usually

given the science stories. As a result science stories are often wrong, based on wrong information or poorly conceived.

10. Most of the public receive their science information from television. Television is the dominant media, though it is receiving competition from the internet. What is seen on television by the public is seen as fact.

11. Good science is rarely achieved on television, though the science on television is generally thought to be better than much of what is available on the internet. The reporter on television does have to screen the stories past an editor and producer, whereas much of what appears on the internet as science is opinion and not vetted.

In general the literature review shows up a host of issues about the reporting and coverage of science on television. Of all the television genres, newscast reporting of science fares the worst, with public television documentaries faring better. It appears that as brevity of the story increases, the quality decreases. Longer format stories, such as documentaries, seem to present science more favourably, though longer length of story does not ensure a good science story.

The literature review provided a valuable unpinning to this study, which, in addition to providing data, also led some interesting questions about the relationship between television and science. The nature of those questions, as well a method to uncover some answers to the questions become part of the next chapter. The following section of this

thesis will examine the method of this study, how the study was undertaken and the reason for a Grounded Research method of study. It also details how the interviews were set up, considering both the interview questions and the selection of the interviewees.

# Chapter 3: Method

### 3.1 How the Questions Were Addressed &Why

Grounded Theory was chosen for this study because of a number of factors. Science as it is represented by television programmers and science as it is represented by practising scientists are very often at odds. What is considered science, how that science is presented and what are the important parts of science are different for television producers/broadcasters and for scientists. In addition, television producers and broadcasters of science programming are rarely versed in scientific method and scientists are usually not cognizant of television journalistic production methods and what needs to be part of science production on television to maintain audience interest.

In accordance with the methods formulated by Glaser & Strauss (Glaser&Strauss 1967), this thesis was set up as a Grounded Theory study. I sought to generate a systematic theory from the data collected from two sources: a series of the interviews with three groups made up of broadcasters/producers, television scientists and scientists and the literature review. This data was comprised of both inductive and deductive thinking from these sources and was to provide insight into the complex relationship between television programming and how television represents science to the viewer which was intended to create a Grounded Theory.

The conceptual framework for this study was extracted from the readings of Noam Chomsky (media consolidation and how it relates to manufacturing consent), George Lakoff (use of language to create doubt and confusion by vested interests) and Marshall McLuhan (media influences, how information is influenced by the nature of the medium), and a "lens" through which to view and analyze the collected data was created. This lens was then applied to the literature review about science and television programming, the information, both deductive and inductive, in the literature providing a background and baseline of information regarding studies on television and science.

During the review of these studies in the literature review, additional data was collected with the purpose of creating a series of semi-structured questions that would be asked of the interviewees, whose answers would provide an additional source of data to be analyzed concerning how television represents science. The semi-structured nature of the interviews allowed the participants to not only direct answers to the questions, but also gave them the opportunity to be circumspect, add their own caveats to the answers, and express their concerns, insights and experiences about science and television through each question posed. In the course of the interviews the interviewees were encouraged to comment on what they felt was important, using the question as a springboard for a broader range of commentary than would have been possible had they been restricted to a narrow, direct answer to each of the interview questions.

The broadcasters, producers and scientists were asked to use each question as an opportunity to present their particular views about science and television. As a result

they were able to provide information about the rationale for various production methods used, their thoughts regarding the relationship between scientific method and television journalistic method, the relationship between science education as it related to television's representation of science, and how television science programming is designed to achieve that end, the differences in approach and content of the various genres of television science production, and the goals of television science programming in general.

References to climate change appear almost daily in all media and is representative of how television deals with science issues like climate change in its newscasts, documentary production and drama. The general consensus, on television, is that anthropogenic effects as they relate to climate change are, as yet, unproven. From the climate researcher's perspective the opinion is virtually unanimous that human activity is changing the Earth's climate.

Scientifically, climate change generates a huge volume of peer reviewed articles and studies by researchers, most of it overwhelmingly illustrating the effects of anthropogenic climate change. As a result many scientists have been a very vocal advocating strong and immediate action to mitigate climate change and many have chosen to speak out about it to the public, because of disagreements with how the media, particularly television handles the issue.

Yet, because scientists provide the raw science content for all television science, which is interpreted and disseminated by the producers of television science programming, any disconnect between the two groups has a profound influence on science programming and the science information received by the viewer. The importance of studying and analyzing how science is represented by television comes from the fact that television programming is a major source of science news and information to the public and influences educational choices, opinions about scientists and science, and what we deem as important in our daily lives.

### 3.2 Selection of Interviewees and Categorization of Interviewees

The interviewees were from both Canada and the United States, because of the similarity between American and Canadian programming and because American programming is ubiquitous in Canada and Canadian audiences have such extensive exposure to American programming.

The interviewees were categorized into three distinct groups of participants. The first was the broadcaster/producer group responsible for science television programming. The second group was comprised of research scientists with little experience in television production and the third group was comprised of scientists with experience in television production. Within this breakdown there were generally two distinct perspectives, a scientific perspective and a journalistic perspective, as well as subset of the two, a perspective from the participants whose experience and expertise straddled

both television production and science. This third group, as a result of their overlap, dealt with neither scientific method nor journalistic method exclusively, but had extensive familiarity and experience in both.

The first grouping was the broadcaster/producers. Though most of the broadcaster/producers had great experience in producing television science programming, and had remarkable empathy and interest in what they saw as science, few had any formal science education past high school in any of the sciences. It appeared that work experience and in some cases, chance got them involved in television science production and broadcasting. The broadcast/production candidates had a wide spectrum of different broadcast and production experiences in television and related media. Their expertise covered science newscast stories, children's science programming (including drama) and long form documentary and series formats. In addition, they also had extensive experience in local, regional, national and international markets.

In the science grouping, all were scientists who spent almost all their time working within the scientific community doing active scientific research. Their experience in television production was limited to commenting in short interviews with television reporters about their scientific work and their understanding of television and television science production that was limited to requests from the media to provide science content or answers to specific scientific questions.

The third group, was a connection between the first two groups, an overlap grouping who were exclusively composed of scientists who were actively involved in the media, especially television, in not only the science content, but also in the production, perspective and consultation as it related to the production of television science programming from newscast to long format production. Though these scientists were first and foremost scientists and in some cases continue to be active research scientists, in most cases their expertise and experience in broadcast television science was comparable to the non-scientist broadcaster/producers. They participated with or had great experience with science production, information and broadcasting of science stories in television, and were more than just science content consultants.

All participants were interviewed using the same method of semi-structured questions, and were asked the same list of questions. All were told they had as much latitude as they needed to answer the questions.

A total of 30 requests for interviews were sent out, through phone calls and email. 14 of the 30 affirmed they would participate. The 14 who decided to participate provided a cross section that represented most of the genres of broadcasting (news to documentary to drama) and science. Most of those who were not able to participate in the interviews indicated it was because of time constraints. Two of the potential interviewees who were contacted did not answer the requests for interview.

In the broadcaster/producer group 6 out of 12 decided to be interviewed. In the scientists group, of the 10 contacted scientists and 4 decided to participate. In the third, crossover group of scientists who were also media personalities, of the 8 contacted, 4 decided to participate. Each interviewee was a specialist in television production, science or both. The interviews were each about 30 minutes long and audio recordings were made. Each interviewee was part of one of three groupings. The groupings and interviewees were as follows.

Four television scientists - The host/producer of a daily science news show, a chemist with extensive media experience in television and radio, a neurobiologist who is science personality on the most popular science broadcaster in Canada, and a meteorologist and science expert who is a national media personality with a public Canadian broadcaster

Six Producer/broadcasters - a senior producer of Nova, a PBS executive producer of children's science shows, a senior executive of National Geographic Channel in the US, a senior executive of Discovery Canada, a news director with more than 20 years experience nationally and regionally, and a television local personality and news director for Canada's largest network.

Four scientists - Senior executive and researcher with Environment Canada, a post PhD researcher with the Canadian Hurricane Centre, Senior researcher at the Bedford Institute of Oceanography, and a marine biologist.

### 3.3 The Format of the Questions and the Nature of the Interviews

All the interviewees understood and agreed that there was a complex and sometimes contentious relationship between, what is perceived in a general sense, to be science and television programming. The qualitative, semi-structured format allowed the interviewees the time and flexibility to address the general questions and be able to parse the various aspects of the question they felt to be particularly important. The conversational tone of the interviews was also deemed to be more effective than list of true/false questions or a series of detailed survey-like questions, or a quantitative approach because of the nature of the question required opinions from the participants. These opinions were deemed important and desired because in each of the interview cases they come from participants who have been deeply involved for long periods of time, in some cases for decades, in the nature of television and how it represents science. Each interviewee also offered a unique perspective and insight that was deemed to be best served in a conversation that allowed for the interviewee to place the question into the context of their own experiences, education and their own perspectives.

In many cases during the interview process, the conversation flowed in such a way that intended thesis questions were addressed without explicitly being asked for and followed naturally from one to the next in a comfortable conversational method.

The interviews were each roughly half an hour in length which was sufficient to address the questions in detail with the interviewees, though one interview was almost an hour long. Each interview was recorded on a USB flash digital audio recorder.

### 3.4 The Analyses

After the interviews were recorded, the spoken data was transcribed by the interviewer. After the interviews were transcribed, the information was coded both through the use of a computer programme specifically designed for coding of interviews and by coding of the hard copy transcripts using memos. After the transcripts were "memoed" on hard copy immediately after the interviews, they were translated into an RTF format for input into the MAX QDA software package in the Mount St Vincent coding computers in the computer lab. This software programme let me apply initial open codes and categories to the transcribed interviews, compare interviews with each other and note the similarities and differences for the various groups and within the groups themselves. The data was categorized into topics such as "scientific method", "journalistic method", "television science" and other relevant concepts as it dealt with comments from the interviewees about the thesis questions. After the initial memoing and open coding, I was also able to further selectively code for subjective views regarding the questions asked, such as what constitutes "good" or "bad" science programming on television, or even the relevance of trying to qualify television science programming as "good" or "bad". The key points are marked and extracted from the text for an overall summary

and analysis. The codes are grouped into similar concepts, differing concepts for cross group comparison and intergroup comparison for each of the interview questions posed.

For example, in coding the question dealing with the amount of science television programming on the air, what was immediately noted and memoed during the coding was the lack of common viewpoints between the broadcast/producers group and the scientists and television scientists on this question. There was a very strong polarization between those with a scientific background and those who had no formal science in their backgrounds. The scientists viewpoint was that this question was subjective and unanswerable as long as the context of what science was, was undefined, whereas the broadcaster/producers answered this objectively, without any reference to the nature or the need to define what it was that "science" actually was.

After the selective coding process, I proceeded with the theoretical coding where the data was applied to my theoretical model laid out at the outset of this study based on the work of McLuhan, Chomsky and Lakoff, "lens" of their works. Here results of the coding and analysis were related to the consolidation of the television industry, how television uses language and how the medium of television inherently changes the information it receives.

### 3.5 Interview Questions

After having reviewed the literature, the following set of questions were composed for the interviewees.

The importance of the questions are firstly, that they allow the interviewees time to "get into the questions" and to allow a fully rounded discussion to take place where we could explore all the avenues the interviewees felt were pertinent to their answers.Semi Structured Interview Questions Based on the Literature Review:

***1. What are your thoughts about science and television?***

*This question was designed to illicit a general overview of what the interviewee thought was important or outstanding or noteworthy regarding science and television. It was a starting place for the interviewee in their discussion with me, a place where they could ruminate about what they felt was important.*

***2. What do you think of the amount of science on television?***

*This question was designed to see whether television reflects the world we live in from the interviewee's perspective. In the non broadcast world, no matter where we look today, science is everywhere and highly influential. It is also at the heart of some of the most pressing problems our species and planet has ever faced. What is enough, too much or not enough science on television? Does it reflect the science of the everyday world? This question deals with answers from groups that came from radically different*

*backgrounds and perceptions about science and what is enough science on television and provides an opportunity to express the depth of those different perspectives.*

***3. What do you think of the quality of the science on television?***

*This question was designed to see whether the labels of "good" or "bad" could be applied to television science programming and whether it was even appropriate to do so. It is a subject question that opened the door to criticism from both scientists and broadcasters. Quality is always an important question, but its definition requires skilled reasoning and support.*

***4. As television evolves from being primarily network broadcast to internet on line broadcast, do you think this affects how television programmes about science are made for television? Is it different?***

*This was a question to provoke a look into the future. It is one that broadcasters are acutely concerned about since technologies like gaming and computers have begun to seriously erode the core television audiences and jeopardize revenues and even fiscal viability. From a scientist's perspective, it means having another venue made available to communicate science to viewers without an intermediary, which might be attractive.*

***5. Does television have an effect on educational choices? If so how?***

*This question is key to this study. The question of education and how television influences it has been studied for many years. Given the rapid proliferation of cable, digital, new technology and computers, how education is affected by television has huge ramifications for the coming technologies.*

***6. How are scientists portrayed? Positively? Negatively?***

*This again has to do with education. Children are deeply affected by what they see on television. Even science drama and how it portrays science and scientists can affect the educational choices children and even adults make. If scientists are poorly represented, as misfits or stereotypically all male, this reflects poorly to viewers and can change what viewers think of science or scientists in terms of career choices or even general education.*

***7. Does science, as portrayed on television, affect how we see science issues such as climate change?***

*The case study of how the media, specifically television, represents climate change, gives valuable insight to how television overall treats science and scientific issues. Since*

*the science content is being transmitted from one media format (peer reviewed print) to another format (television production) there is an inherent media influence and it and other factors can create misunderstanding and misinformation. It can even obfuscate the issues enough so that the general opinion of science issues can be totally out of step with reality.*

***8. Do you think climate change is anthropogenic, human caused?***

*Climate change is arguably the gravest threat we have facing the planet. According to scientists it is real and immanent. According to the public, many feel it is not. Where is the disconnect and how much of it has to do with television?*

***9. Does science on television represent science the ways scientists represent science? Do you think it should?***

*If television does not do a good job representing science, the ramifications are serious. What should be done in that case? Are scientists remiss in not getting involved? On the other hand should scientists, who know nothing of such an important medium, be given control of it?*

This responses to the above series of questions by the interviewees rounded out the data collection of this study. Once the interviews were completed and transcribed, the next

part of this study consisted of doing an initial analysis of this data. The intended goal of this analysis was to look for overall concepts, differences and commonalities that emerged from the analysis of the interviews.

# Chapter 4: Analysis of the Interviews

This chapter presents the initial analysis of the interview data. Following the work on Grounded Theory by Glaser and Strauss (Charmaz 2006), all the interviews were analyzed or "filtered" a number of times. The filtering began with the use of the coding software package, MaxQDA, where the transcribed interviews were converted to rtf format, inserted into the programme and memoed and coded. The memoing and coding consisted of a number of steps. The first was looking for commonalities in the answers given by the interviewees and noting to which group they belonged. The second was looking for differences in responses and again cross referencing that to the group. The third and fourth parts of the initial coding consisted of noting intergroup commonalities and differences, and finally intra-group differences and commonalities. In summary, this section consists of noting the major issues that were raised by each of the three groups, and focussing on the general commentaries that illustrated intergroup and intra-group similarities and differences. To limit confusion, The Broadcaster/Producer group is referred to Group 1, The Scientist group as Group 2 and the Television Scientists as Group 3.

## 4.1 The First Analysis

### *1. "What are your thoughts about science and television?"*

This question was a starting place that would set the tone of the interview as semi-structured and open for ruminations. It was intended to let the interviewees see the interviews as a broad discussion, taking them outside a survey of "yes/no" type of answers, giving the interviewees an opportunity to express thoughts and opinions around and about the questions. Since it has already been widely noted that there is a disconnect between how scientists see science and how it is portrayed on television, this question was also designed to gauge how close to the "surface" this disconnect was, whether the interviewees' opinion would reflect what was found in the literature, and whether their thoughts about the disconnect would appear even under this broad question.

The answers to this question were wide ranging and varied. At first it seemed as though all the interviewees from all three groups agreed that science was well represented on television. A closer inspection revealed differences, however.

Group 1 was most positive in their assessments about how science was represented on television. They expressed the view that, by and large, science was done well on television, perhaps not uniformly, in all areas of programming, but in many areas. This group expressed the opinion that, if the viewer wanted to find science programming on

television, it was more available than ever and in many cases done well. As a group they felt that television programming had improved given the proliferation cable and digital channels. All six interviewees of Group 1 had many positive things to say about science and television and on balance it was much more positive than negative.

Group 1 also made a distinction between news science reporting and documentary science programming. Those producers who were involved in documentary production seemed to think the news science reports suffered by sometimes being too short and oversimplifying news science issues. Those (4 of the 6) who mentioned the proliferation of cable channels, viewed it as a benefit to science television programming, in that it meant more science production and a greater variety of science programming. Two of the interviewees talked about how past science programming on television influenced their lives.

The following quote was indicative of the feeling of Group 1, that there was a positive correlation between science and television and that there was split in quality between documentary science production and news.

*"I think of a lot of incredible shows that have actually changed my life and changed the direction of my life and changed the way I look at the universe. And I know that sounds like a self serving thing, but it is true. I can't say that I was particularly engaged in science in school. In fact, I dropped every single science class I could in school. There is lots of good television out there as it relates to science. The big void is in news. Its (science) not treated fairly nor does it get its due. Reporters have little BG in science and place little value on science. Documentaries however are good. We try to do science by looking at many experts and then seeing what the consensus is. If 99 say one thing and 1 says another we have to go the 99."*

Group 2 was also positive though less so. One of the scientists starts off on a positive note, but winds up qualifying his thoughts, especially when it came to science news on television.

*"There's good and there's bad out there. There's some very well done shows detail, well balanced and there's a lot of sensationalism, pseudoscience, news, I find. I'm really finding it frustrating with this swine flu stuff. Sometimes I can't watch the news, its just such confusing info out there, and quite often poorly presented and about sensationalism in many channels. It varies a lot. PBS, Nova, things like this, sometimes give a very well balanced, as does the nature of things, CBC, sometimes give a fairly well balanced, so there's some excellent stuff and there's some, well, garbage."*

As the conversation about their thoughts on television and science continued, more issues and qualifications came out and a clear division of opinion appeared between the scientists and the broadcast/producers. Most of the qualifications were negative and pointed to a disconnect between scientists (in Groups 2 and 3), and Broadcaster/ Producers (Group 1), over what appeared on television as science. The television scientists and scientists groups lined up on one side with the broadcast/producers group on the other. The scientists of Group 2 were the most negative, particularly about the science on newscasts and some of the comments they had were diametrically opposed to the thoughts expressed by the broadcast/producers.

This following comment is indicative of the general opinions expressed by the scientist's groups. As the conversation on the first question progressed the comments from both Group 2 and most of Group 3 became more and more negative.

*"There really is no science on television. Its interesting, but not science. You are not going to find science on television. Television plays with science and it popularizes things but its not even close. There is no science on television."*

The opinions of Group 3 were the widest ranging. And while they were critical of television science, they also defended the relationship television had with science. One of this group, a well known Canadian personality and science spokesperson, pointed out that there is good science news to be found on television newscasts as well as in documentary production. It is noteworthy that this television scientist had the greatest and widest experience in television science production and other media, of all the television scientists.

*"There is a belief that the only good science on television is lengthy science, but there are some very good short news pieces as well. Daily Planet for example has shown that. The impact on the lives of people is important, because it creates an atmosphere where people want to know more. There is much that is good about how television represents science in the same way that there is much that is not good about how some scientists represent science."*

This was a great split in Group 3. The other three of the four television scientists were quite critical of television science in all formats and noted the lack of scientific method in all television science programming as well as a great lack of understanding of science by reporters reporting science news. They also noted that few if any reporters had any formal science education. Three of the four also expressed the opinion that a lack of understanding of scientific method was a critical, contributing factor that leads to the

sensationalizing of science and the creation of anthropogenic perspectives prevalent in the newscasts of science news stories.

It is also interesting to note that two of the four television scientists had much of their experience in television in the local television in Halifax. It was noted that the local television in Halifax is a smaller market than the major centres in Central and western Canada and as a result has fewer resources for new productions. These scientists said they were wary of the local Halifax television news, because they felt all of the stations were unable to represent science accurately on television. Two of the four of Group 3 no longer owned televisions and watched television infrequently.

However, one of this group expressed the view that television was a beneficial presence and could present science in a way that was different from the way it is presented print. He expressed the view that scientific method wasn't a necessity where television science was concerned and that it could even be, in his opinion, an impediment to science stories on television. He felt this method was a beneficial and a positive addition to science without needing to focus on scientific method.

When questioned about their thoughts about television and science, many of Group 2 said it was not something they thought about directly, that this question was the first time they considered the relationship formally as part of study. Two of the four expressed initial surprise that the two had any relationship with each other. However, as they qualified their responses it became evident that all the interviewees of Group 2 had

dealt with the relationship between science and television in some form or another for some time, even though not much thought was given to it.

It should be noted that Groups 1 and 3, because of the nature of their involvement with science television programming, had the most tangible and direct exposure to the television-science relationship and as a result had considered the first question on their own, in many cases in quite some depth. Group 2 on the other hand, had the least exposure to television production, at best appearing on television only as "talking heads", to answer a reporter's questions about their researchers when science issues were deemed reportable. Furthermore, Group 2 thought the relationship between scientists' work and television science reporting and production, was not an important one and was not part of their (scientists') work. Most of Group 2 said that television was not part of their general considerations of science, how they did science or even how they presented science, that peer reviewed print was the overwhelming medium of choice within the scientific community. They did not see television and science, at the time of the interviews, as having an important link with each other as far as their researches were considered. This comment speaks to that point.

*"Television and science is not the first thing that comes to mind. I don't focus on television when I think about science. I think of print as a medium when I think of science. And when I do look at television science I look for entertainment rather than content, because television does not present content well. I wonder what people are going to get out of this. Television often stretches things and makes inaccurate conclusions. And it is unbalanced and without a science background it is easy to be mislead by the rhetoric that television presents. It presents a great problem for scientists, especially when related to public policy."*

As far as the scientists of Group 2 were concerned, television did not have an important place in the role of a scientist's work. Scientists were either generally ambivalent about how television and science interacted, or were critical of the science as it was presented on television. Though they felt television was important and influential, they didn't extend that importance to science programming on television. It was not something they thought about much. All of Group 2 felt television science news to be extremely limited and lacking in scientific credibility, even when they participated as interviewees.

All of this group said they enjoyed longer format documentaries and two commented on how interesting many television science documentaries were, especially those by NOVA on WGBH. Most of the Group 2 scientists said television was for entertainment and not a good medium for science because of the lack of understanding and presentation of scientific method, which they said is crucial for scientific research. They felt that television as a medium was not conducive to scientific method.

***2. "What do you think of the amount of science on television?"***

This question was intended to open qualifying discussions about television science programming. Though still general, the question begins with a large statement that is ostensibly simple, but challenges the interviewee to consider what is meant by "the amount" of science programming on television, the changes that television production has experienced over the years and even what qualifies as science production. By

thinking about how much science there is on television, it was hoped the interviewee might be able to define what is enough or not enough, what constitutes science, how television defines science and whether it is reflective of how scientists see science.

At first, most of the interviewees in all three groups were of the opinion that the amount of television was adequate, that there was plenty of science programming on television. But as the interviewees qualified their responses and the discussions continued, it was obvious, especially in groups 2 and 3, the question was not as easily answered as initially expressed. The issue of quantity was not easily considered in isolation, without defining other related issues. These related issues are presented in more detail further on in the next few paragraphs.

Group 1 commented that the amount of science on television was much larger than it had been in previous years, especially in the area of long format documentary production. This increase was generally viewed to be good by the entire group, even though it led to qualification that more programming didn't necessarily mean all programming in science was of good quality. They did feel more programming also meant more good programming.

One of the broadcasters noted that trying to qualify whether there was enough or not enough was a null issue, since it depended on the public, the viewers who, if they wanted more, would spur initiatives to produce more science programming on television. Ratings would reflect an increase in interest, which would increase

advertising revenue and in turn spur science programming. And if there was a glut in science programming, viewers would not watch, which would ultimately reduce the amount the programming on television through the reverse process. It was his opinion then, that there was as much science programming at any given time as needed because programming success/failure is highly monitored and determined by such market pressures as ratings. He viewed the entire issue of "amount" to be one that would be decided by the viewer and through the viewer only.

Group 1 also had a very broad definition of what constituted "science programming" and though they didn't express it directly, they didn't have any difficulty in defining what constituted science programming. To this group technology, medicine, home building, engineering, machines, military, social interactions, and reality shows could all qualify as science programmes. The Daily Planet news science show on Discovery Canada was noted by most of the group as evidence that even though there was less science newscast programming by the television networks, especially CNN, which has cut its entire science news staff, the cable channels like Discovery have more than made up any perceived shortfall.

It was also acknowledged by two of the broadcast/producers that network, regional and local science news coverage on television was not high in quantity or priority, because of the lack of understanding by producers and reporters of science issues. This meant it was less likely that coverage of a science issue would take place unless it was also a major social story, like an earthquake or disease. And when science was covered, the

focus was more about anthropogenic effects and the spectacle rather than science. Overall though, this group was impressed with the quantity of science on television

A major difference between the groups made itself apparent as follows. Every one of the interviewees of groups 2 and 3 connected quantity with the definition of science, to what science actually was and how it was constituted and defined. None of the broadcast journalists commented on this link at all. It was something all the broadcast/producers missed entirely and had no comment on.

Group 2, the scientists, felt generally that there was more science on television than there used to be in past years. However it was also said that most of what passed for science on television was debatable and subject to interpretation. It was noted that television cable channels that once produced a stable of documentaries in the NOVA and Nature of Things format were now producing reality based programming with military themes and other anthropogenic programming where the personalities and circumstances of documentaries were more important than the science. Group 2 were highly critical of the quantity of science news coverage in general on the network, region and local news shows.

On the other hand, while the scientists and television scientists focussed on the issue of what science was on television, they did not consider the audience in the equation and what the audience considered to be science as it related to quantity. In addressing this

aspect one of the broadcast executives pointed out the importance of the viewer in how much television production is given over to science by the broadcasters.

*"Yup. There is enough. If the public demanded more science, people like you would be producing more science shows, commissioning editors that run science devoted channels, or channels that have a thematic programming strand towards science would be commissioning more programs because they'd be sellable. Its not as important today as it would have been 5 or 10 years ago. There's more science programming produced today than there ever has been on television, which is a direct impact of the profile that science is taking in every day life, whether or not its from the greenhouse gas effect to global warming to the swine flu to the pollution in the Halifax harbour to how to properly insulate your home. I think that's part of the re-education, which is the retuning of what's on television. If people demand to watch that type of television, there will be a bigger demand for people to produce that type of television, because at the end of the day, there's just as many commercial minutes in a show on the Discovery Channel, as there is on a show at YTV."*

It was stated by all three groups that with the proliferation of cable and digital channels, now available to almost anyone who wants it, there were many channels dedicated to entirely to science, like Discovery and National Geographic. However, it was pointed out that this may in fact constitute a decline it total television science exposure with the total number of people watching science programming declining. According to one of the specialty science channel executives.

*"I think that the rise of the specialty channel has been good for science because there are channels devoted to scientific content that didn't exist before. Like Nat Geo and Discovery channel. There is Smithsonian network in the US. And there is a lot more interest in technology that ever before. On the downside I think other channels have decided to get out of that area because it is being done by others. And the reality is the conventional channels like CBC and CTV do reach huge audiences. I am not sure they are giving as much...I don't see as much kids science*

*programming at all. We have been over run by Disney and Nickleodeon and I think that's an area that a lot more could be done."*

With the lower budgets of the cable and specialty channels a US executive producer of a science channel felt there was a chance the higher budget type of documentary productions would suffer and decline, but be offset the greater variation in production.

*"There are the cable channels like Discovery, Nat Geo etc with almost full time programming. But since the establishment of cable television and Discoveries and Nat Geo, I think there have been far better science on television in terms of long format documentaries and though it may not it may not all have be in the form of a highly promoted landmark specials as they did on PBS or the networks, the range makes for a better mix and variety and quality."*

Groups 2 and 3 felt the question of quantity of science television programming was one that dealt with the definition of what constitutes science. And most, if not all of what appears on the cable, digital and specialty channels that purports to be science, was, in their opinions not. So, if anything, science was not represented at all on television. They also felt the trend towards sensationalism by television science programming, in documentaries and in the news, had a deleterious effect on the science programming. This television scientist's statement echoed what the others had to say within the two scientist groups. He was also the lone voice in these two groups, suggesting that science programming was not about the scientists' definition of science. He expressed the opinion, that what works in peer reviewed magazines would be highly counterproductive in television science programming.

"This is a slippery slope question. You have to define what science really is and then you can have an idea of how much of that there is. In a way it is audience dependent. If the audience wanted more or less then you would have that, because they would demand it or not watch, which in any case would settle the quantity question. The definition of what is really science is what this all come back to."

Group 3, the television scientists, felt the question of quantity hinged on what was actually science. All the interviewees of Group 3 remarked on this aspect and said that if what constituted "science" was the criterion, then it would be subjective and not easy to answer the question. The consensus was that even though there might be more programming that was deemed "science" being shown on television, there was not more "real science" according to what scientists' definitions, being shown. Especially in the newscast short science format television, it was felt that whatever science was presented was ill presented and not accurate, creating the perspective that there may in fact even be less science programming today, than in the past.

It was strongly noted by all groups that the quantity of science newscasts on national, regional and local television newscast seemed in decline, but the cable channels, especially Discovery with the Daily Planet broadcasts more than made up the difference.

There was little common ground between the three groups. The scientists and television scientists were on one side, focussing on the definition of science, whereas the broadcaster/producers had no expression of the concept and instead relied on what the viewer might consider to be science. The scientists in particular said there was little that could be considered science on television, the way that science is defined by scientists,

represented educationally and in peer reviewed publications by the scientific community.

***3. "What do you think of the quality of the science on television?"***

The third question is an explicit specific, subjective qualification. The interviewee is forced to consider science programming and make a subjective comment about it. It introduces the recognition that quality exists, that there is good and bad science programming on television. It was, in fact, recognized by all interviewees of all groups as such and responded to as such.

As to what constituted good and bad programming was said to be a difficult question by everyone interviewed. All agreed that erroneous, biased, agenda driven science programming was bad in general. Again the issue of scientific method came up in both scientists groups. However, whether it was possible to do science programming of value on television without scientific method, was an issue on which all interviewees differed. The broadcasters in general felt that because of the proliferation of cable and digital broadcasters, the amount of what they defined as science programming, had increased and as a result the bar on quality had also been raised. More programming meant that more "good" programming would be available for the viewer.

The broadcasters/producers, Group 1, were unanimous that commenting on the quality of science on television was a very slippery concept and was highly dependent on what

type of programming was being produced. They were unanimous in noting that there were more documentary productions than ever and they were of a higher calibre than ever before. But they felt science reporting in newscast was poor. One producer noted.

"Where I think the big void is happening is in the news side. I still think science is sometimes treated as separate subject that is not integrated into society. It doesn't get its due. Its sometimes treated as the funny kicker story at the end of the newscast. I think that reporters and journalists in general who have grown up in the arts world tend not to put a lot of value or tend not to understand science content. I think that science programming and news programming are areas where probably the public deserves more attention. But certainly in the documentary are we are seeing more science documentaries than we ever have before."

And it was also noted that with animation, CGI and sophisticated editing techniques science stories could be told in a more entertaining fashion, adding substantially to content. There was a recognition that "science" programming on some of the cable channels and networks used "reality show" techniques at the expense of "science" and story telling of science. However, all the broadcaster/producers said that quality on the whole had improved, because quantity, editing, animation and the proliferation of channels meant an expanded palette of television science programming, especially in the long format documentaries.

The broadcaster/producers' opinion was also that, in the science newscasts of national, regional, and local news shows, science was not being served well at all. The brevity of the newscasts, the lack of understanding of science by the reporters, the lack of interest in the face of other news deemed to be more pressing were all listed as contributing

factors. However, when science was the primary news of the day, Group 1 felt that the science news was covered well, especially where the resources of the national newscasts came to bear, as in the H1N1 flu stories of this past year. They did note that some stories were sensationalized, and commented that on the whole the public was well served by television when science becomes the news, though four of the six commented specifically that they had also seen programming on television newscasts where the science in the television newscasts were served poorly.

Group 2 was unanimous. In national, local and region newscasts, all these scientists had all dealt with television as interviewees in consulting roles, where their expertise was required in the presentation of a science news story. All listed instances where they felt their input had been marginalized or what they had to say was distorted by the reporters, either through the brevity of clips, resulting in over generalizations or distortion of what the scientists considered to be the science behind the news story, or through a total lack of understanding the reporter had in the science story being covered. They also said that anthropogenic, people centred, spectacles dominated whenever science as news was broadcast on television. One scientist noted the general nature of what we define as television today makes it difficult to have "real" science on television.

"I think what you are looking at is, if you are looking at television and saying you're looking at it for scientific facts. You're really not going to find the scientific facts, because television isn't there to bring across the facts in science, television is to identify what's going on in science, look there's something going on in this area, and to get your interest. And to get that more across as news, rather than science, because if they were trying to bring science forward into the general public they wouldn't be having a very large audience, because most people wouldn't be able to

understand the in depth science and that's why we don't see that part of the science. I would say quality of science, you can't get the science across, so you're missing a quality of science. And when you have television, its not like you have a peer review process, where they're talking about good science and science in general. The quality of science is probably quite low, because you are taking it down to the lowest level to get people's interest, to say, gee this is interesting, but its not quality science that they're trying to bring across the table."

Three of the four of group 2, had a list of television reporters with whom they would no longer deal with because of what they deemed as poor coverage on the local news.

In the longer format science documentaries group 2 expressed satisfaction with the Nature of Things and Nova type programming, but did note that some of what appeared as television science programming documentaries and series on the cable channels such as Discovery and National Geographic was probably not science as far as they and their peers were concerned. They also expressed concern over the lack of scientific method and the perception of what science was by the television reporters and producers.

Two of the four in Group 3 said television in general was a wasteland which offered very little in the way of quality, and all four agreed that much of the reporting of science news was inferior and subject to hyperbole, exaggeration and suffered from a lack of understanding, by the reporters, of even basic science and scientific method. However two television scientists remarked that the presentation of scientific method was not needed to present science on television and that science received beneficial exposure through journalistic method if it was thoughtful and based in science facts. This caveat hinged on the ability of the reporter to understand the science and receiving the on-air

time necessary to present difficult concepts above the average science understanding of the viewer. They also noted there were some reporters who were able to consistently turn out good television science reports.

"You know, I mean some of it is good, some of it is bad. It really depends and also it depends on what you call science on television. If you're talking about the anti vaccine woman McCarthy being on Oprah, I mean you could argue that's science or that, or you know perverted science. It still a discussion with a scientific tone to it. Well you know its just crap, but its there, if you read the National Post's weekly denunciation GW, well that's a scientific topic, views are ridiculous. The views are uninformed, you see that is the thing. There are some good writers at the Post and they can be quite eloquent, but I am also at the same time convinced they don't Know the research and they don't know the data. That's bad as well. On the other hand at the other end of the spectrum there can be, though it doesn't make the newspapers or television very eloquent and very deep analysis of science that very few people read or listen to or watch. So quality to me is do you get across interesting, accurate ideas about science that people actually take in. There is no point in standing on a soap box in the corner of the park talking if nobody is listening to you. Scientists miss that very important point, that's its really about the audience. It is not about what you want to say, so much as what you are actually going to say that people are going to internalize. And if you take that point of view, then a lot of the complaints that scientists might have about the inadequate coverage of science really just reflects back on them."

In the longer format documentary and series productions, it was noted that in the past when land mark broadcasts had very high budgets, networks aired some very respectable science broadcasts. They lamented the trend of the cable channels to produce personality based pseudo science series which had little science or scientific method in them. A PBS executive noted that PBS quality science programming, in her mind, had made science a process the viewer could understand.

"At Nova we look for narrative, science stories that tell themselves in order to engage the viewers. We try to be cheerleaders for science. We try to get involved in the process of discovery, which is not what many others do, so the viewer understands the process of science. Programmes used to have journalists who were actually involved in science and understood what the scientists was doing and understood the science. But that is not done anymore. We are trying encourage scientists to become better communicators to be able to bring their stories to us. We deal with particular aspects of a story, that which people will find interesting and not the whole story. Most reporters do not understand the science that they report. What we try to do at NOVA and what we've been successful at doing I think, is finding the science stories at a certain point in their trajectory where what we're telling is kind of the mainstream understanding of a particular thing. And what we'd like to try to do is to find a narrative where the science and the scientific discovery is what drives the narrative forward so that a person is engaged with the investigation or the discovery or the expedition. And the characters who are engaged in that work and through that come to an appreciation of how the scientific information is being used and discovered."

This narrative, in her opinion gave science television programming its value, without the need for explicit references and use of scientific method.

In general the idea of what science was and was not, was a concern to the scientists, whereas the broadcast/producer group was not concerned about the concept. The scientists stressed scientific method, the broadcasters did not, even though they conceded that much of science programming on television, especially science newscasts is not good science.

***4. "As television evolves from being primarily network broadcast to internet on line broadcast, do you think this affects how television programmes about science are made for television? Is it different?"***

This question addresses the fact that television has evolved and continues to evolve, both technologically and artistically and this has the potential for an effect on television science programming. In the 1950s television networks were the only option for viewers searching for television science programming. Today, there are digital offerings, internet casts, DVDs and a host of other types of formatting that are constantly changing. Artistically, programming has also been transformed. Non linear editing, CGI, animation and graphics as well as electronic recording devices have changed the television production pallet available for the creators of television science programming. The purpose of this question is to allow the interviewee the opportunity to comment on how observations about changes to television in the past might be applied to the television of the future as it relates to science programming.

Group 1, broadcast/producers, all agreed television was a dynamic, changing medium and that programming was highly organic and was evolving quickly. This was a question that seemed to provoke some of the longest responses, with all Group 1 interviewees saying they had considered this question for some time. One broadcast executive had this to say.

*"I think overall there is going to be more and more need for programming that is going to be interactive. People don't want their information delivered to them in a passive way, in a classroom setting where they are just sitting receiving information and not being able to control the information or control their interests. That think that programmers are going to try to create content where the audience is at the helm, and they can channel content where the editorial is going in. Second of all is the 360 degree approach, which is science programmes and programmers in general want to touch viewers, their audience in every possible way they can. Television is effective in conveying video and graphics and emotions. The internet is more effective at conveying statistics and information and interactivity and gaming and so you know science...the era of science documentary maker is going to gone and we are going to have content creators who from the creation of an idea are going to be thinking about that content can best be delivered on multiple platforms. And you know that is going on now and is going to become more prevalent over the next 5 years. There is no doubt that the story telling has changed. There is a huge importance placed on programming that is more entertaining. The competition for eyeballs is immense. Is it more effective or not, is I guess question. Certainly after decades and decades of more educational science based programming that we grew up with. Science literacy surveys I don't think have shown in terms of people understanding the basic science principles. Today people have a better, they understand that science is more relevant to them and it is more relevant. But if our sole measure was a literacy test, I am not sure that things have changed very much. But I don't think that that's the way that we should necessarily gauge the effectiveness of science programming."*

It was also noted that the changes due to cable, digitization, the introduction of HD, ipods and other technical innovations have had a great effect on the science programming of television. They felt that changes would continue and television's evolution would probably accelerate. Another PBS executive noted that no matter where technology takes us, entertainment will play a role in what people want, even in learning.

*"Television is evolving and there are lots of studies that show that. But no matter how it evolves there will always be an appetite for quality programming and the studies show some surprising results. For instance working there is a*

*study that shows that men, working class men like to learn through entertainment. A pilot programming effort based on this to answer questions about what type of programmes work and what doesn't."*

In the long lasting documentary strands like Nova (Nova has been on the air since 1974 having created 640 episodes), it was noted that throughout its lifetime it has had to respond to changes in technology, like the introduction of videotape, digital editing, non linear editing, animation, CGI (Computer Graphic Illustration) and HD television.

Group 1 also said television was also being adversely affected by the introduction of the internet programming, computer games, cable offerings, hard drive storage and other technical innovations. Because television was ultimately about fiscal viability, a constantly changing technological landscape has an effect on the ability of private television to sustain a cash flow. And financial viability ultimately affects programming. If changes are too rapid and fragmented, television would cease to be fiscally viable and programming would cease. It was stated this was a challenge that not only television programmers faced, but also scientists, who need to consider the impact of the changing technology of television as it relates to their ability to get their science messages and works out to the public. A Discovery Channel Executive had this to say.

*"Where technology is taking us, is the way science is covered by the media, whether in short form or long form, is it going to have to adapt, attention spans ... the date with the television is no longer there, in order to draw people in whether television is on the internet, will the programming have to adapt. television not as important today as it would have been 5 or 10 years ago. television is no longer the leader in news dissemination, across the country, across the world. The internet is fast outpacing conventional and specialty television in the number one source for info. No matter the medium I think that science will have to adapt to television. Its a reverse onus that you're looking*

*at. Scientists and science they have important things that they're working on. They have to adapt their vehicle to allow the population to know what they're doing. They can't rely on the population to come to them. Or a television producer, who is covering all these different genres of programming will say, okay guess what, the environment is my top story today, well why is it? Because science should come to television and sell that as a top story."*

All the interviewees of group 1 expected there to be changes in television programming, some of which would be detrimental to the quality, as well as positive effects due to technology. It was noted by all interviewees, that the competition for "eyeballs" is immense and in some way or other the model of convergence had television and the internet combining to produce programming where the scientists and the viewers could come together in a much more expanded type of science programming, and would allow for niche perspectives to be available to viewers. They foresaw a broadcasting and production environment where the viewer played a far greater role in choosing the type of programming he/she wanted. It was also noted that interactivity in programming would come to play a much larger role, where television could take on some of the aspects of the interactive gaming world.

The scientists in group 2 felt that programming was in general becoming shorter and shorter and as a result, this affected the quality of science being broadcast. They also felt that as the emphasis of news shifted away from television to the internet, science programming would have a hard time competing, because of the general low back ground and interest of the reporters in science, and the fact that science programming does not easily fit into short spectacles sought after by the newscasts. They felt the inability of the audience to watch longer science stories would also be affected because

of the “culture of immediate gratification” inspired by computer games and the internet, something with which they felt, science cannot compete with. The Environment Canada scientist was especially concerned with the shorter science segments that pandered to what was perceived to be a much shorter attention span of the viewers.

*“Well you have to recognize that there is only so much that you can do in such short hits. You want the public to be captured enough by that short hit that they are going to go elsewhere to learn on their own. Whether it be a book or the internet. So the stories that come on television that capture my attention...something as simple as a book review or movies review. Those kinds of things can have a lot of value if it is done credibly and it captures your attention. And I go buy a book or I go see a movie or I go to a certain internet site. Because people's attention spans are fairly short. I mean if people have to wait while their computer boots up. They are sitting their twiddling their fingers. Its amazing...I mean everybody has ADHD...its crazy. Media and technology has changed the way we behave and there is an acceptance that that's a fact. What I need is something that makes it worth my while to take the time to go elsewhere. Even to read a book. A book is something that is an amazing peaceful thing to do. It is so contrary to what our internet television whatever has changed and sped up our world so quickly. Look at the poor newspaper industry. Television has a role, but its not an independent role. It has to be is a complementary role to take people to books or to the internet. Most people who want more information, should the not be satisfied with that one little clip. Those who are satisfied with the clip should go away somewhat more informed, but the people I want to touch are the people who are curious enough or interested enough to take the time to inform themselves. Because it is like anything else. When it comes to public opinion, the decision is the individual's decision. When an individual makes the decision to become more informed, then that individual ...in a debate you can head butt people...but until an individual actually listens.*

*As low quality as it may be, science news on television has a vetted process, whereas science programming on the internet can come from any source and is extremely variable in quality, with groups with vested interests able to distort the science for their own needs and ends.*

All felt the internet would make television with its structured format and schedules, less and less attractive to a younger viewing audience and that science programming of all sorts, including documentaries and series would suffer in quality, as television science production adopts more sensational programming methods in order to retain its audience. One of the scientists was especially concerned that no matter where technology took television the same issues would continue to be controversial as far as scientists were concerned.

*I would say right now what television is trying to do is trying to capture a larger audience, everyone is trying to look at, we have more interesting science programs than others, as a consequence, myself, I think what you realize, that there's so much out there, how much of it is real, how much is not, so what is the quality of the programming, so whereas before you would have the 1 or 2 programs like the Jacques Cousteaus, which were focussed on a few well known people that were in science, but at least it was a standard of what you expected in terms of science, this was somebody who had a bunch of scientists working with him, as part of his team that would evolve, evolve each week or the National Geographic type programming. Whereas now, you've got everybody coming up and talking about science and sometimes you wonder what is the quality, even today, in the newspaper, which I'm sure will be on television, you've got somebody in a science fair in Nova Scotia, saying that this child is in a high school, he's got this project looking at the chemicals in green tea and the advantages, and he's making great findings. Let's get serious, he's a grade 12 or high school student in a science fair, and I'm sure its good science, but he's not going to make some dramatic claims that they have in the paper, which will be in the same claims that will be on the news and on television. so that gives you an idea of quality of science vs bringing science to the interest of the people.*

Group 3, the television scientists, felt that television science programming would continue to evolve as technological innovations make traditional television broadcast, if not obsolete, then conform to face the changing financial realties of access on demand rather than traditional scheduling. Television would take on aspects of computer,

internet and gaming, with animation and CGI also playing a larger role. In addition, they felt the concept of scheduled television programming was going to come to an end. The documentary would be the beginning point for the viewer, providing the motivation and the stimulus for further learning, while at same time not become a teaching experience. Further learning and science information would be found on the web and through other interactive sites, as well linking to more traditional science learning media like magazines and books.

It was the opinion of Group 3, that science news would continue to decline in quality as more and more people turned to internet driven programming for their news. The group noted that even today much of what purports to be science news and fact, is not, because it comes from questionable sources on the internet. It was expected that science programming would continue to deteriorate as television science news and the internet science news coverage converge. One television scientist was the most optimistic hoping the ability to tell great science stories would be enhanced by the changing technology

*We have evolved, but I think in a peripheral ways, so that everything is a little bit slicker. Everything looks nicer, animations are a higher quality, of course there is, we at the DP (Daily Planet) haven't moved into HD yet but we will and so we just did an hour on the rescue mission to the Hubble telescope on our regular show Monday, but there is an HD version that is going to air this weekend and that will be I think stunning. But stunning doesn't get at content except indirectly. If something is stunning, I think it holds your attention more and so I think all these things I would call stylistic/technological advanced can hold your attention more, but necessarily and in the end its still all about story telling and you tube is a testament to that. The quality is crap, but who cares, the people are intrigued by the stories that are being told. So you got this peculiar thing happening, where on the one hand you've got things like*

*YouTube and twitter and Face Book where messages are shorter and shorter and undependable. On the other hand you've got science shows in HD on television where the appeal is to the excellence of the resolution of the image not the opposite as it is on You Tube. So I think what has to hold and still holds is if you don't tell a good story, it doesn't matter how good it looks, it has to be a good story. Has it changed the way we tell stories. I don't think so. Has it changed maybe a small percentage of the impact of those stories have on people? Maybe just because its more compelling.*

However, another television scientist felt that no matter what, television was a wasteland and as technology and the increased need of the viewer to be entertained changed the nature of science on television, the gap between television science programming and scientific method would widen and be almost impossible to reconcile. He noted scientific method is not entertaining and dynamic, and runs counter to the ever increasing pace of television.

*"Television is unsalvageable. When you have 50 channels. When we go away Kathy and I go into a hotel and we watch the channels. She sits there are bang, bang bang and after about a half hour she gives up and I don't think it is because her thumb got weak. Looking for something you have a few interview shows that are good because they have really good interviewers interviewing good people, but the scientific method is not dynamic, not sensational enough to ever sell. It is failing because it is not visual in the first place."*

### *5. "Does television have an effect on educational choices? If so how?"*

This question was designed to tap into what is implicit in all science programming, its educational component. This question attempts to get the interviewees to speak to the issue of the "value" of science programming, to step outside the fiscal and entertainment mandates and consider the education impacts of television science programming.

Educational concerns, in many cases, may run counter to entertainment and financial imperatives in television science programming. In this light, how television represents science in terms of educational considerations becomes an important consideration.

Group 1, the broadcasters/producers group, felt that television was very influential, especially in the case of children's programming, in the selection of educational choices. Children's science shows such as Beakman's world, Mr. Wizard and Bill Nye were all mentioned as positive shows with positive effects on educational choices.

A local News Director was clear in stating that in general he did not believe that television science programming at the network level, especially the news, was there to educate the viewer about science. His opinion was that it was there to inform about the news, whether it was about science or not. In addition, his assessment was that if there was any educational value it could be found in the specialty channels.

*"The power of the medium of television is in its ability to inform, get things into the layman's terms. Its not there to educate. I am speaking of the news. But science isn't necessarily our forte. I don't think at all. So, if I'm doing a story, or I'm instructing someone in our newsroom, to do a story, that's the way I try to think of it. You know, I don't really understand this, I don't understand this H1N1. Where did it come from? Can I get it just by walking in a room? Let's find out what's really going on. The specialty channels is a different story. To find science on television I would go there not the networks."*

The Nova Producer felt their method of constructing science programming led to the education of the viewer and that the viewer considered that in making the decision to watch Nova programming.

*"We do try to educate our viewers. We want our viewers to use other media like the internet to seek more answers. We don't talk down to the viewers. We want the viewers to feel smart. But we aren't teaching them math or physics. We want to show them a window of what the scientists are doing. Television is a medium for storytelling. We are interested in teaching scientists to become better story tellers. Right now they are funded for research not to be story tellers, so we have to teach them about communicating. Television affects the perception of science and what people think about science. And we have found the harder the science actually the more our viewers liked the show. But if we do kind of softer the science, things that you might find on cable our viewers they are not our viewers."*

Group 1 felt, in terms of overall impact, science drama and science documentaries had the greatest impact on educational choices. They listed CSI and Star Trek as examples of high profile, successful drama series that placed science and scientists in the forefront of the spotlight. In the science documentaries, Nova and the Nature of Things were noted as having a great potential to influence science education decisions.

Most, but not all the of the interviewees of Group 1 remarked that television was not there to educate, but to inspire and stimulate through dynamic presentation. It was through this method that television had the greatest impact.

According to a Discovery Channel executive,

*"I think it is not so much to educate as it is to inspire. And I look at my experience, my personal experience and feedback I get all the time. So you get...somebody may watch a documentary on Stephen Hawking's universe not necessarily understanding very much at all, but does inspire them to do a google search on Stephen Hawking and his work and more that way. I think that really television is great at opening the door and because it is still broadcasting, still has the capacity to engage people and get people attention on a subject they may not of heard of or thought the would have been interested in before. It too much to expect of television, which is still an entertainment medium to actually inform in a way that makes the information stick. I think that has to happen in a follow-up. Until the internet came along the follow-up was...really there wasn't much follow-up frankly. I mean it came through the school system, primarily, now I think the internet is the follow-up system and we try to make it as easy for our audience as possible. Once they are engaged by a subject to follow through and learn. And for the educational process to take over, at that point. To use the old circus analogy, you have to get people into the tent first and interested before you can follow-up and absorb it."*

Group 2, the scientists group, was somewhat less enthusiastic about the positive role of television's effect on educational choices. It was felt, especially in dramas, the role of the scientists was distorted and that this would lead to disillusionment rather than enthusiasm for those who made their educational choices based on what they saw on television science dramas, when the reality of what it was, that scientists actually did, sets in. They noted though, that television was very influential.

They felt in science documentaries the role of television in the selection of education choices was more positive than with dramas. It was also noted that in North America, documentaries are seen by a much smaller audience, than of the successful science dramas.

They felt the news had little impact, if any, on educational decisions, with the exception of the science news of the Daily Planet. A climate scientist felt there was an opportunity in this and that the opportunity was both for scientists and for the viewer.

*"I think education content on television is important. There's more opportunity to actually educate the viewer, but it depends on the target audience. If its a children's program, of course that's different, but I think we might see ourselves, we might see media educational type programming aim for a little higher level, more educated level, just knowing more people out there are becoming more versed in these subject areas of interest."*

Another scientist was concerned about the misunderstandings and the lost opportunities in television science as it related to the weather.

*"There is a huge opportunity to educate the public. And the awkward things is that there probably are not enough members of the public that see meteorology as a science. They see it is an art form...there are a lot of jokes. Some of them are jokes, but some of them are based on substantial misunderstandings of what we do. And you have to do is look out the window in Boston and that is what we are going to get the next day. Statements that are as simple as that. Why do we need a weather service?"*

Group 3, the television scientists felt that in children's programming, documentaries and in dedicated science news like Daily Planet on Discovery channel, television had the greatest and most positive educational impacts. In the local, regional and national news, the impact was somewhat more negative because of what they considered to be poor coverage of science in the news. They felt drama had a great effect and generally positive role though it was thought to distort science and the work that scientists did

somewhat, resulting in misunderstanding, by viewers, on the reality of what scientists do and their work.

One of Group 3 felt television had no impact whatsoever in the educational choices.

*"I don't think its very important. I think other media are probably more important. Because television isn't trying to sneak it into other things. Its very rare you see a science consultant on a drama, unless its like CSI. To me science is everywhere, but its not everywhere on television. Its hard for me to say because I don't watch the programs that possibly would be able to do that. I do know that the public has a big appetite for science, and I don't think radio is a big time waster, because you can listen to the radio and do something else. With television you're really parked and vegetating, so I think that's why I'm more negative about television."*

But that opinion was not shared amongst all of this group. Another television scientist thought television did have influence in educational choices.

*"Well you know its really a flow of information. I talk to lots of people about our show because they stop me in the street. I point out to them that we don't set out to be educational. We set out to entertain, but if you look at, and I don't know how you would do this, but it could be measurable. If you look at the sheer amount of information, factual information that we get across in an hour, 43 minutes of actual air time, its significant and we are on every night. And we are repeated endlessly every day. So everyday 250,000 people in Canada say on average. And they are quite different people so at the end of the week the Discovery channel claims that we have a reach 3 million people, But regardless, who cares, lest's say its a few hundred thousand or a million, whatever. Even if you are reaching those people for a few minutes every week, its a torrent of information and while its not designed by educators it has ultimately that kind of impact I mentioned at the beginning, that it is not a detailed factual intervention, although with young kids and we have a lot of 30-35 thousand kids under 18 watching the show every night. You talk to them and they remember detail. But people older than them don't remember detail but they they none the less have, get an impression that science is interesting, exciting, that people doing it are curious, sometimes odd. They can be compelling, they might not be, and all of that, I think, serves an indirect educational purpose."*

In general interviewees in all three groups felt that television had an impact on educational choices. The broadcasters were the most positive about the educational impact. The scientists were more divided. Some felt it had a positive impact on educational choices and some felt the reverse.

***6. "How are scientists portrayed? Positively? Negatively?"***

This question had a number of purposes in the study. The first, the direct part of the question was to see what the interviewees thought about how television portrayed the people who studied and researched science, the scientists. This was important, especially from an educational perspective, since the portrayal of scientists on television would certainly affect how a viewer might be influenced in considering an education in science or even the veracity of the evidence and content a scientist might add to a science story as part of viewer's personal education. The second part of this question was a little more oblique and was to examine in closer detail the question of how television represents science by looking at how scientists were represented by television.

This question was also designed to see whether, in the opinion on the interviewees, the representation of science on television was linked to the representation of scientists on television.

The Group 1 responses to the question were mixed in their assessment of the how television portrays scientists. They generally felt that scientists came off poorly on television and that in all genres of television science the role and images of scientists were distorted and inaccurate. A US television executive however, felt the portrayal was extremely positive.

*"I think it is a huge positive. I think that in many cases a good producer and you are one, you know that quite often the image of scientists is scientists in the lab with white lab coats. Time and time again from promotions to channel ids to commercials to everything, people will continue that image. But as a good producer you know that is not where audiences are after. There are geologists climbing up a ridge to get to a striation that will reveal a fossil or they are inside a submersible with the scientist going down to mile and half or two and half miles down to the Titanic to do an analysis of how the wreck sank, I mean how the ship sank. So those elements that show science as an exciting endeavour that allow you to go around the world, have adventures, see things, formulate hypotheses, whether it is at the mountain top or sea floor. Those I think are very positive images for scientists and the least I think that is what permeates most of the best programming on cable. It doesn't mean there aren't elements where scientists aren't in lab coats."*

The others in group 1 still felt there was an element of geekiness or stereotypical portrayal on television as far as scientists were concerned. Especially in the newscasts, they expressed the opinion that where time was short and the stories condensed, both the science and the scientists came off poorly. The lack of understanding of what scientists do and who they are by the reporters and the producers were the most to blame for the poor portrayal.

The scientists of Group 2 felt television represented scientists poorly and stereotypically, giving the public a poor understanding of who scientists were and what they did. They said that most often it was the geeky, forgetful, unkempt image of the scientist that they found irritating and frustrating. They also blamed the media for the poor impression they felt the public had of scientists and a poor understanding the viewers had of who scientists were in real life.

*"I think they've portrayed scientists as geeky and with poor communications skills. If you think a scientist, according to the media, you have in your mind, a person who doesn't have the personality skills, he/she's missing a few things there, because they are so involved in their work. And yet scientists cover a whole range of people, but the public has this perception of what a scientist is because of the media."*

All the television scientists, Group 3, felt that the scientists' image, who they were and the nature of their work, suffered as a result of the portrayal of scientists on television. In this group, one interviewee, a chemist, used episodes of CSI to teach her chemistry students about how poorly television portrays scientists.

*"I think they don't get exactly the right idea. CSI, I do watch that occasionally. And I often discuss it with my students because sometimes they show stuff then we can use it as a starting off point in a lecture because they do stuff that is fantastic, as in not possible. Or they just bungle up how they even say the names of compounds, those sorts of things. Its a good starting off point, many of the students have also seen it too. They portrayed the scientists as too nerdy and all the women as wearing extremely low cut tops. This is exactly how all, and I'm just flabbergasted, and I drew this conclusion a few years ago, and I've not seen it refuted yet. The men talk in staccato ways, like they're robots, the women are all sex symbols in these and they don't show many just ordinary sort of people and they still make scientists they want to be somewhat extreme in some way, so they pick these ways and that's the way they're portraying them."*

In summary there was an almost unanimous opinion that scientists were poorly represented by television, though there was a bit of disagreement by two of the interviewees from group 1, who felt that scientists were better represented in current television science programming than they were in the past because today we have more diversified science reporting today than in the past. The remainder of interviewees, including all the scientists, were in a consensus that where television did the poorest job in representing the image of scientists was in the newscasts, with the caveat that science news shows like the Daily Planet of Discovery Canada did a very good job in science news and representing scientists. They again felt that the short clips and the general lack of understanding led to the poor representation of scientists, as well as the representation of science in newscasts.

***7. "Does science, as portrayed on television, affect how we see science issues such as climate change?"***

This question was intended to focus on concrete examples of how science is portrayed on television. By focussing on specific topics, it gave the interviewees an opportunity not only to level criticisms, but to point out examples where television enhanced the public education and information of important issues related to science.

Group 1, the broadcast/producers all felt television had a huge responsibility in the way it represented the science issues on air. They all felt that there were many cases where

television programming, especially in local and regional news casts, through a combination of a lack of resources to cover science stories properly and through a lack of science understanding, did a poor job in relating the importance of the science in a given story to the viewer. As a result many news stories gave the wrong impression of the impact of science on the story or got the facts wrong. Another local television and radio executive's opinion was that in the news, it depended on the resources and inclination that the station had.

*"I think that depends. National magazine shows, national conventional television has probably done an okay job covering it. I think that local television stations are not equipped to cover those types of stories, they don't have generally the experts to draw upon to tell the stories, often they're not significantly impacted where they can then just push off and say well the network won't cover that, we'll have our science and technology reporter cover that. Here in Halifax I think the television stations do a little bit better job because we have access to BIO and some of the folks at Dal, that are literally experts in their field in this country, but the trick then is generating enough public interest that an interview with them or a 4 or 5 min story explaining what they're doing, still has to be interesting to a pretty conservative almost non informed viewer. The uninformed just don't read up on all those things. And if it comes out of the blue, they're just not going to get it."*

In terms of documentaries Group 1 felt that in general, television science came off well and presented the science and the science issues well to the public. But there was also the recognition that documentaries could also misrepresent major science issues in the quest to achieve high ratings at any cost. Documentary makers had a serious responsibility to present science as accurately as possible, but could be swayed into hyperbole and exaggeration in order to grab higher audience shares. A specialty channel executive was able to illustrate that point with the following comments.

*"I think we have to a huge responsibility. I think you know of the doc that was produced in the UK called the great global warming swindle. Here is what we did. We looked at all the information. There was binders and binders of back provided both by channel 4 the producer, the scientists that were involved in the project. Some of whom thought they had been misrepresented. We had the enormous advantage of having someone like Jay Ingram on the staff. We had the volume of the material submitted to Alfcom, the British regulator. And we could take all that information and then we could make an informed decision. Now that took place over months and there were enormous pressures to put it on the air and say let's put it on the air and maybe have some counter programme running after it. But as you have said the overwhelming body of work is that global warming has been impacted by humans. And so we thought it would be irresponsible to present this and give it the same weight. Now journalists often don't have the same kind of luxury time and ability to consult that we do. And I do think its a real copout that journalists have to just kind of present all this stuff and equal weighted and let the public decide. It really is giving people a bad impression. Its going people….if you have 99 experts saying one thing and one another. To present them with equal weight is not going to create…enable somebody who knows nothing about the subject to make an informed decision. So we do have to take responsibility for that and there is no doubt that science producers and science journalists jump on the next hot thing."*

All of the scientist group, Group 2, felt that when it came to the issues of science, the media had a penchant to pandering to the lowest common denominator and in the quest for ratings let that skew the true impact of the story. They felt that television news especially was guilty of anthropomorphizing and distorting the science in the news. In documentaries, they felt television productions were of a higher standard, but were also caught in the ratings trap. They noted that, especially in some of the recent productions of Discovery and other specialty science channels, productions had strayed away from the core science to sensationalize the stories. A fisheries scientist's comment was indicative of what the group had to say overall about the influence of television science.

Again the understanding of science and scientific method came up as an important point according to this group.

*"I think it can, people have their agenda, and they're pushing it. Climate change is an example, the deniers. Other ones, I think probably more the news aspects would be, a study comes out on something in science, the change in the Labrador Sea, and suddenly they blow it up, way out of proportion, this shows that climate change is not happening. No, that's not the case, its one little study. They're ignoring the way science works and the complexity of the environment and sometimes tune in on a single issue and blow it out of proportion. The fact you had a cool summer last year, for example, somewhere will raise the question that maybe climate change is not happening. So they can, there's the agenda driven ones, where they know what they're doing. They're pushing an issue, and other ones I think it maybe just lack of understanding of the methods that by the people reporting it. They're not scientists, they have very little training and some of the ones I've done with interviews."*

The scientists also felt that the news was opportunistic, with little motivation other than spectacle to attract viewers. As another scientist put it,

*"I think because some producers think a certain story isn't going to catch the audience, because the in thing is what's on the news at the time, producers play the science on the news. Right now you've got the swine flu so they talk about science of swine flu. If you have the disaster on the Challenger, now we're going to talk about the engineering aspects, and the science behind seals. You know on the space shuttle. We don't hear about that science until it becomes news and then they look into a little area to highlight the news. The same happens with climate change and other issues."*

Again with the exception of the Daily Planet on Discovery Canada, it was felt by all groups, the coverage of television science news was poor. In the documentary format television the science coverage was thought to be better though there was still much science misrepresentation. In drama the attention to the science facts was non existent.

One of the television scientists of Group 3 comments were very short and to the point.

*"Basically awful. They don't get it."*

This opinion was also shared by another television scientist.

*"This is a case of a little knowledge being a bad thing, that they don't have a whole framework to put this against and also I guess the internet is very good for passing on misinformation and figuring out how to sort things out or just how to read info, in a logical way, that takes quite a bit of training, because if you just believe everything you read, its way worse with the amount of info on the internet, that is posted by who knows, what they're actual motivation is, to sell something or whatever."*

In summary, all groups again felt the newscasts were the major problem in how television represented science issues and that documentary television science did a better job, though there were some very pointed references to sensationalist documentaries trying to capitalize on higher ratings through the creation of artificial and contrived controversy.

Both the broadcaster/producers of Group 1 and scientists of Groups 2 and 3 had a consensus of opinion that science issues were worst represented by the news and best represented by documentary production. All agreed as to the reasons, short time allotted for stories and little understanding of science by the reporters.

***8. "Do you think climate change is anthropogenic, human caused?"***

The climate change question is perhaps the largest science issue in the world. The IPCC study is the largest scientific study in the history of science and how it is portrayed on television in the news, drama and documentary can illustrate very effectively how science is being portrayed on television. It is also a question that deals directly with the disconnect between scientists and television. Scientists who study climate change are virtually unanimous in their support of anthropogenic climate change, while television news and documentaries tell their viewers, through their productions, that scientists are divided. This question is designed to bring into sharp contrast, the differences between the two groups and to find if there is any common ground between the two.

All the interviewees in all three groups, to a person, expressed the belief that climate change was anthropogenic and also expressed dismay at the ability of the anti climate change lobby to receive traction with the public. A Discovery Channel executive is already quoted relating his decision at Discovery Canada in pulling the documentary "The Great Global Warming Swindle", in spite of the fact they had co-commissioned the documentary with Channel Four in the UK. In making the decision to reverse the decision to air the documentary he had the luxury of having a television scientist with enormous experience in the media, especially television, to rely on. He also had the confidence in this person's assessments of the intent and impact of such a climate change stance. In spite of the fact that 97% (Doran 2009) of all the climatologists in the

world who study climate change, publicly agree that humans bear the responsibility for climate change because of our $CO_2$ emissions, the potential for stories to air on respected national and international broadcasters, which are incorrect and whose whole thesis is a sensational rating grab, is there.

What is especially interesting is the absolute unanimity in the opinion expressed by all the interviewees of the human responsibility and culpability for climate change. It was not only affirmative, but a vehement affirmation. The broadcasters as well as the scientists were absolute in there opinions, with no doubt at all expressed.

This view contrasts sharply with their viewers' opinions and especially with the stance of our governments. Viewers are nearly evenly divided between pro and con and studies widely reflect those statistics. Yet the people who produce the programming on science and issues like climate change do not reflect the popular consensus presented in the media. Programming gets to air that clearly runs against the stream of the expressed consensus of this study and it is having a serious impact on public opinion and through public opinion how our various governments respond to climate change.

***9. "Does science on television represent science the way scientists represent science? Do you think it should?"***

This question was designed to illustrate the differences between the different media. Scientific method through peer reviewed print media has been very successful in

furthering science in society. By asking whether, in its programming, television should emulate peer reviewed print, we are illustrating the basic inherent differences and the similarities of the two media (McLuhan) and bringing in the issue of language (Lakoff). We are also directly asking the interviewees to consider a wholesale shift in potential television science programming and what the ramifications of that shift might be.

Group 1 felt that scientists didn't basically understand the nature of television and the programmes needed to attract viewers and the methods used by producers. They also felt television should not represent science the way scientists represent it because science production on television is a much different medium than the peer reviewed process in print. They also noted peer review is designed for other scientists, whereas television science programming is for a viewer who likely has little formal education in science. A Discovery Channel executive felt, as did the others in his group, that scientists should participate in the making of documentaries and news stories, but that scientists didn't understand the true nature of television and making science stories the way scientists represent science in peer reviewed magazines such as Nature and Science would not work.

*"I think in general it doesn't work. I think there has to be a partnership and I think that means there is a contract that takes place. The scientist has to be able to make some compromises in terms of technical accuracy to engage the viewer and I think on the other side the producer has to be able to work at really to capture without simplifying but to make something that might be incredibly difficult, understandable in a way that is not going to make the scientists look ridiculous or open to criticism. I think there has to be a sensitivity on that side to. So it is very much kind of working together. We have had for many years I think is an antagonistic approach where the scientist saw the producer as somebody got in the way of communicating his story. And the producer saw the scientist saw the producer*

*as incapable or unable of taking something that should be relevant and interesting and being…you know making it complicated and boring."*

Group 1 stated that scientific method, while very important for the making of science and advancing our society cannot be used very effectively as a tool in any of the television genres. They felt the most effective methods for getting the message of science across on television and having an audience stay with the programme is through the methods currently being employed to produce science television programming. If that methodology were modified to represent science as scientists wanted it to be it was suggested that no one would watch. If that was the case then the broadcasters would cease to exist because of the financial model dependency on viewers.

Group 2 was divided on this question and felt there was a place for scientists and detailed science on television and pointed out that it was successfully implemented in other broadcast regions such as Cuba. This quote from one of the scientists illustrated the point.

*"Absolutely, just as an example, in Cuba for example, the meteorologist there for hurricane situations, the media goes right to the weather centre and they broadcast the warnings, the meteorologist broadcasts the warnings. The meteorologist speaks directly to the people and I think they have a very effective response to hurricanes in Cuba. Whereas in the North American society and culture, the US and Canada, there's a lot of different private weather companies, media, who you don't have the actual meteorologist there giving the warnings, it might be someone that its not their field of expertise. So it tends to get misconstrued, messages are mixed. That is just a small example of for television misses the boat."*

This opinion, however, was generally not shared by the other scientists. The shortcomings of the current broadcast television science content were noted, but in spite of having voiced many concerns, the scientist group did not think television science programming would necessarily benefit from having it represented the way scientists represent science in print, in peer reviewed papers. The scientists thought it might be better to either have science journalists with post secondary science degrees or train the scientists themselves in television science.

Interest in science and an understanding of science was mandatory for doing television science, in the opinion of this scientist, and a very important step in improving science programming on television.

*"No, I think if the journalist is interested in reporting on science, for instance, the people working with fisheries, they have to have an understanding of the scientific method. There'd be some education, but it wouldn't be start from scratch and they also would have an interest in doing it and take their time to do it. If who they're working for is not that interested in doing all these followups on science, then is it in their best interest to spend the time on it."*

According to Group 2, science should be part of a science journalist's pallet and there was a need for newsrooms and broadcasters to take science seriously.

None of the television scientists in Group 3 thought it would be a good idea to do science on television the way scientists do science, i.e. using scientific method. The reasons were, that in this era of shorter attention spans due to competition from computer games and the internet, coupled with the fact that most people have little

understanding of what constitutes scientific method, viewers would probably be uninterested in scientific method programming and tune out to other programming, which would be counter productive. In order to circumvent the problems encountered in modern television science programming in science newscasts and other areas of television science programming, it was felt that, either scientists needed to become trained in broadcasting of science on television or that journalists needed to have training in science as well as a journalism background, in order to understand the complexities of science and scientific method.

A television scientist commented directly to the question:

*"Oh god, not in the process. You know why, because another thing that most, I am not including here all scientists, but most scientists do not appreciate how much work and how many years of work it takes to become a really effective communicator. And they have been mislead, I think, by repeated admonitions over time. Stay away from jargon keep your sentences short and all that bullshit is supposed to make you a good communicator. Where that advice almost never addresses, you know you gotta make this interesting, you gotta tell a story. Its got to be conversational. Its got to include all the basic elements of normal human communication, which means taking the audience, you know if you are having a normal conversation with somebody at a coffee shop, you do the communication properly, you use body language, you take into account the audience, you allow yourself to be interrupted, all that kind of stuff and in the media you have to utilize as many of those types of components as possible to make your message effective. Most scientists and most specialist who aren't communicators don't understand that and so they think I can just tinker with this or that and I will be a great communicator. Well that's wrong. So to have them involved in the process...the only way I'd involve scientists in the process is to actually have them watch what we do. And get a significant amount of exposure to what we do. But that is never going to happen because they would have to stick around for a week.*

Another television scientist said:

*"Not really, but I guess maybe I would defend television for a minute. I think one thing that television can do is that it can whet people's appetite for getting more info, so if it can show them something then they'll want to go out and read more detail about it, then or find out through other mechanisms, then I think it does bring topic to the discussion point. Go back to the isotopes, probably because they've been in the news every night and then a few months ago, when the reactor was down before, same thing, probably some people agree now getting more info, it may be word of mouth, maybe other sources, but television is not going to necessarily bring out the full story."*

All groups felt, almost without exception that scientists should only participate in the production of television science if they were trained and educated in television production, though some of the scientists of Group 2 thought that scientist production could only help, given the uneven production currently presented by television science.

The main problem for most of the interviewees in having science represented as scientists see science, was the difficulty in today's broadcast climate, of representing scientific method. Ultimately, under the current broadcast conditions, the general consensus was that scientists were better off doing science, but letting the broadcasters do the science stories.

**4.2 Summary of the First analysis**

The polarization between the groups was quite clear and defined. Those who were scientists generally lined up on one side with the non scientists on the other side. There were some commonalities, however, such the agreement that the science newscasts in

general handled television science poorly, that reporters in all markets and genres were under prepared to cover science, that science had a very low priority among most non-specialist broadcasters, such as the major networks, and there continued to be large stereotype problems in the portrayal of scientists.

The interviews with the three groups in general reflected the consensus of the literature review. The disconnect between television science and scientists was immediately apparent from the answers to the first question. The broadcaster/producers group was of the opinion that overall television represented science well and had a very broad definition of what constituted science programming. Most of the scientist group and television scientist group, on the other hand, were critical of television science and felt that much of what the broadcasters called science was not science.

All three groups felt that news coverage was the weakest part of factual science programming on television. The consensus was that reporters generally did not have a background conducive to accurate and credible science reporting on television and that science reporting on television newscasts was not a priority. All groups felt that longer format science television productions like documentaries had a wider range of quality and that Discovery and public broadcasters like PBS produced the best of what television had to offer in science programming.

All three groups felt that as far as keeping the public informed with accurate reports about science news issues like climate change, the influenza pandemic, nuclear power

and other major issues, television did a poor job and often misrepresented what was actually happening in the science of the news. The science reports tended to skew and distort the science because of a poor understanding of science, creating an impression of controversy, when there was none or pandering to vested interests who deliberately distort the science with poor science methodology or a total disregard of science methodology.

The question about what constituted science programming was a constant theme with the scientists. In contrast it was not addressed at all by the broadcast/producer group. In the opinion of the scientists, programming on television that was labelled as science, was not science, but rather entertainment. The feeling of the scientists was that much of what was purported to be seen as science by the broadcasters and the producers and is presented to the viewers as science and accepted by the viewers as science, was not. As a result, television distorted science, the perception of what science was, as well scientists and the public's understanding of scientists. Every scientist interviewed was able to list at least one occurrence in both the news and in documentary television science production where they felt the science to be questionable science, wrong science or the production had mislead the viewer.

In terms of education, the producer/broadcast group felt the public received much of their science information from television and that there was a lot the viewer could learn from television about science. They also felt television science had a fairly large influence on the learning and educational choices their viewers made. They also viewed

this to be a major role and responsibility of television science programming. It was there not only to inform but to be the stimulus for further education and impetus into science interest. They viewed television to be the thin edge of the science wedge, where it was important to excite and entertain the viewer as opposed to conforming exactly to the science a scientist might present. They thought the medium of television was a vastly different medium than the peer reviewed magazines or text books about science. They felt it would defeat the purpose of television science and actually disenfranchise the viewer if scientific method or scientists controlled television science programming.

A few interviewees of both the scientists group and the television scientists group felt that television was probably not as influential as the broadcast/producers group thought it was, in affecting and influencing opinions about science and science education decisions by viewers, though there were notable exceptions. Groups 2 and 3 did agree that television science was probably very important in children's programming and influenced their learning and their educational choices.

This initial analysis of the data illustrating the similarities and the differences between each of the groups and between individuals within a group, confirmed the findings of the literature review which pointed to a profound disconnect between the way scientists saw science and the way television presented science. The focus of the next chapter will be to examine the underlying themes related to these findings.

# Chapter 5: Major Themes Emerging from the Interview Data

After the initial review of the interviews as outlined in Chapter 5, this chapter presents the major themes that emerged from the interviews and literature review data. The initial analysis of the interview question answers made it possible to look at the underlying issues behind the comments, using the lens provided by the works of Lakoff, McLuhan and Chomsky as outlined in the introduction of this paper. It should be noted that although there were many specific areas where the scientists and broadcasters differed profoundly there were also some notable commonalities that spoke to the connections between the two groups. During the subsequent analysis of the commonalities and differences three major themes were extracted. And of the three themes, one, the disconnect between how science is represented by scientists and how it appears on television, predominated.

This next chapter was coded without the use of MaxQDA and was a paper edit because the volume of information had been substantially reduced by the initial coding, making a subsequent paper analysis preferable.

### 5.1 Theme Introductions

Three major issues that came out of the analysis of the interviews and literature review which are as follows.

1. The disconnect between how scientists represent science television's representation of science is the major theme that came out of the interviews. In examining this disconnect, the concept of scientific method, which is the main tool scientists use in their process of the investigation of science, became a major issue. This discussion concerning scientific method pointed to inherent differences between, the peer reviewed print process used by scientists to represent science for scientists, and how producers, broadcasters and journalists represent science on television for their viewers.
2. How the consolidation of television as a business is affecting the diversity and quality of the representation of science on television, by diminishing the number of voices and manufacturing simplistic and distorted models of science for viewers. The consolidation implicitly exacerbates the first issue outlined above, the disconnect.
3. How the language difference between scientists and television producers/ broadcasters furthers the disconnect between scientists and television science representation. Scientists use language very precisely and very often this use is at odds with how the same language is used colloquially. This difference is exacerbated and sometimes exploited by vested interests, creating confusion for the viewers and disenchantment by scientists with television's

representation of science. Again, this difference in language points to the disconnect outlined in point 1.

The discussion of each of the major themes follows, beginning with the central theme of the disconnect between scientists and television.

### 5.2 The Disconnect Between Science and Television

Science as represented by television and science as represented by scientists has very often, according to the literature and numerous studies, been at opposite ends of a knowledge spectrum. It is a disconnect that has, for the most part, been wide and profound and is threatening to become even wider. This has the potential for serious ramifications for society, in terms of education and the quality of science information available to the public and science understanding. The data of chapter 2 of this study supports the assertion that there is a disconnect.

In trying to understand the underlying reasons behind why this disconnect exists and appears to be widening, the works of Marshall McLuhan suggest a number of explanations. For clarity, what follows is a further dissection of the groupings of the underlying reasons as they relate to the McLuhan's "Understanding Media".

### 5.2.1 Scientific Method and Peer Review

In the summary of the literature review, it was noted that there is a substantial disconnect between science as represented by scientists and the science represented in television programming. Scientists use a peer reviewed process, where scientific articles are researched and then presented for publication in periodicals specializing in publishing scientific papers for review, critique and criticism within the scientific community. Though there are always exceptions to every method of study, the peer review process nonetheless, is rigorous, structured and lengthy. This print based process is a medium that has served the scientific community well since the renaissance and has made scientific method one of the most powerful intellectual tools in human history. Virtually all scientific advances and discoveries are a result of this process, though it is important to note that it is not without its detractors. Its method for extracting truth, has in recent years been questioned, especially in the humanities. Nonetheless, scientific method remains a very powerful method that has had great success.

Television, on the other hand, is never used in the scientific process by scientists, as a medium for peer review, critique and publication, no matter how important the research or discoveries. Yet, as has been noted in the literature review, a substantial number of people use television science programming as their major source of science information and science news. It has also been shown that most people who watch television agree with the representation of science on television, in spite of the fact that most scientists,

including the ones surveyed in this study would dispute much of what is said by television producers and broadcasters, to be science.

But when asked whether television should produce science shows to reflect scientific method, most scientists agree that in today's broadcast climate, it would not be realistic to produce that type of science programming, in spite of the fact that television's science programming is often fraught with scientific errors and misrepresentations. One television scientist interviewed for this study was particularly pointed and succinct in his summation as to whether scientists should produce television science.

*"Oh god, not in the process. You know why, because another thing that most, I am not including here all scientists, but most scientists do appreciate how much work and how many years of work it takes to become a really effective communicator."*

The main reason for this appears to be that scientists, for the most part, just do research and use the medium which allows them to best represent their work to other scientists, peer reviewed literature. They view science programming on television as entertainment for non scientists. It is not part of their peer review process nor does it further their research, communication and review process. In spite of the fact that television science programming has a profound influence on how the public sees science and scientists, and ultimately determines what the public wants funded, scientists generally feel that scientists should stick to traditional science. Most scientists understand the potential impact of television science, but do not want to involve themselves in another medium,

particularly one which has no influence on their scientific research. As one scientist interviewee explained,

*"...most scientists don't have that ability or the time to sit down and write down to the level to explain everything to the public, because they are the top of their field, trying to advance what they're doing and you're trying to educate someone off on the side...."*

### 5.2.2 The Medium is the Message

The medium of television is inherently different from print. In his book *Understanding Media*, McLuhan (McLuhan 1964 page 63-67) points to the fact that each medium has an inherent influence on the content it presents, over and above the intent of the creator. In his chapter on media as translators he illustrates how each media "spells out" the information uniquely, puts its stamp on the information in such a way that the information is "translated" into that medium.

For example, to understand a written peer reviewed science article, the reader must be literate in the practice of scientific research, its process and presentation, and not only be highly educated, but must also be highly educated in the field of the article. Print requires years of study and literacy and very little of most of the science articles appearing in peer reviewed publications is intellectually accessible to the non scientist or even a scientist outside the field of publication. Peer review is also a mature technology and in spite of the advances in technology, peer reviewed articles are relatively unchanged over the centuries. Technological changes in computers, word processing and

graphics have enhanced the ease with which researchers produce and illustrate their researches, but basically not affected the process of research or content of the publication. Not only does the appearance of peer reviewed publications remain largely unchanged over the years and even centuries, but so is the process of peer review and methodology. Looking at a how papers are peer reviewed, a paper 20 years ago would have gone through the identical process it would today.

In contrast, the viewer watching a television science story does not need to be literate in scientific method or require a lengthy science education, to view the television science programming. Nor does the viewer need to understand how television represents science.

Television is also a relatively new and rapidly evolving medium. There is even some question as to whether television as it exists today will be recognizable in a decade. Science programming even a decade old is outdated and would not be commissioned by today's television science broadcasters. Technology plays an active role in not only the appearance of medium itself, but also the science content, with HD, digital editing techniques and animation, evolving month by month as computer power grows.

In addition, peer review is a scientist to scientist communication and interactive, whereas television science is not. Television science is produced by producers and broadcaster, not viewers. And the viewer rarely has any feedback into the product, other than through the television ratings process.

### 5.2.3 How The Makeup of Our Brains is Related to "The Medium is the Message"

Marshall McLuhan underlined the inherent bias each medium has on the information being purveyed in the early 1960s. He stated the medium is the message. Why this should be so appears to come from our evolutionary makeup. The reason viewers, producers and scientists cannot reconcile the differences in science representation between the two mediums points to a biology that underlies McLuhan. To illustrate this point, one of the television scientists interviewed summarize this as follows.

He said that television as it exists today, for all its ability to influence, inform and entertain viewers, does not and cannot teach or educate. Nor is it attractive or successful when programming is created to achieve those ends, because of the differences in how we process information from different media.

*"Television cannot sustain itself in a way that can do valuable time because going back to our animal backgrounds. Our eyes are, our visual system, has evolved to be attentive to moving things. Hubel and Wiesel have shown at Harvard, because, Hubel at Harvard, who won the Nobel prize for understanding how visual cortex was mapped. He has been a professor at Harvard and the last 10 or 15 years he has been studying what we are attentive to and what we are not. And actually in the last study....go on his web site it is brilliant...at Harvard, because he'll have something...a visual field ...look at this something which doesn't move and then there's things outside. And you stare at this point and you notice there's these two points disappear. You don't see them. The brain said if it is static, its not moving, I should not worry about it. Its not going to eat me, I can't eat it. I think the example of this..."*

He stated this was based on the research of David Hubel in the 1960s showing that because of television's unique combination of video and audio it triggers a different part of the brain than do still pictures or even text. This scientist, a research neurobiologist, said that Hubel's work suggested that because of the evolution of humans, we were hard wired to notice moving pictures and sounds, no matter what the content. He noted that movement and audio was of particular importance to people, because of the way our brains work, because we are predators and constantly cued by movement and sound, from a prey standpoint and also from a danger standpoint. Both threats and food generally move, and the evolution of our brains, as hunted and hunter, make sound and movement a survival priority. Television relies on sound and images and duplicates the triggers responses that he feels are almost unconscious and involuntary.

This perspective, that each medium brings with it a "bias" to information and content, is further supported by the literature review material from the works of Marshall McCluhan. McLuhan notes that each medium puts its own "stamp" on content and information, that has nothing to do with intent of the creator of the content. For example, if a scientific work is presented in a peer reviewed publication, and then an attempt is made to represent it in a television science production, no matter how good the abilities of the scientists, writers, producers and no matter how earnest their efforts to maintain the scientific integrity of the work, the two works will be inherently different, send out different messages, be perceived differently by the viewer and have a different impact. This is unavoidable. Its a sort of "Heisenberg's Uncertainty Principle" for media. Heisenberg, an early 20th century physicist, said that the universe imposes limits on our

ability to measure and understand its nature. In an analogue to Heisenberg's Uncertainty Principle, each medium also imposes inherent limitations to our ability to manipulate and disseminate information. Because of the way our brains work, because of our evolution, each medium has an inherent message or bias that cannot be overcome and that is part of its intrinsic makeup.

### 5.2.4 The Education Gap

It was also stated in the scientist interview that when biologists compare brain activity created by watching television to the brain activity created by static pictures and images it appears that we lose interest in looking at still images much more quickly than we do moving images. His feeling was that this is the reason television has progressed to shorter and shorter sequences of images and smaller content segments in television science productions. It is because this kaleidoscopic approach of constant change is ultimately more attractive to viewers, because our brains are hardwired to respond quickly and to be attentive to constant change, that the trend to shorter clips has found audience favour. As a result, the faster the images, the shorter the duration of the static pictures, the smaller the content, which all play to an unconscious response, one that holds our attention, from one high point to another. He feels this makes television inherently unable to focus on content and substance, and particularly difficult for science and scientific method, since it would be necessary to have more content and a slower pace. All this runs counter to the trend seen in modern television science production.

It was noted by all groups that scientific method comes out of writing and peer review. It was also noted that the modern television representation of science rarely includes scientific method. The science programming on television is controlled by its visual and audio nature, as noted above. This nature runs counter to peer reviewed scientific publications of a written medium, based on scientific method. The scientists interviewed for this study remarked often that science as it is presented by scientists provides little of what the viewer expects of television science, because so much of the time there is little going on. The exciting "Eureka" discoveries and epiphanies are few and far between. Many, if not most scientific studies take years and very often, during that time, what a scientist does is little more than read, write and converse with colleagues. None of which makes for exciting television production.

And to compound the disconnect with the viewer, when real science, especially scientific method, does appear on television, the public has so little background in it that there is little resonance, interest or empathy for the process. This trend of not illustrating scientific method in television science productions is important for the following fiscal reason. If television science productions were to spend substantial time on scientific method, they would run the risk of alienating the viewer, who would then potentially switch to more exciting programming.

It was suggested that some background and education in science would be required by the viewer to allow the incorporation of scientific method in television science production and maintain high ratings and viewer interest. As a result, there is a need to

either spend substantial amounts of time teaching rudimentary science to viewers or scientific method has to be abandoned and the story has to be simplified. Simplifying the story adds another concern. Because the people who produce science on television most often have no background in science, having a clear understanding of science and scientific method does not enter the production mix. And often times, as a result, the science story becomes inaccurate or incorrect, when an attempt is made to simplify the science story, especially in the very short time constraints of science news. What happens then is that television producers try to solve the interest and science content problem by anthropomorphizing science stories through scientist stereotypes, making science stories a spectacle and controversial, or by looking at science as something of value only when it has the potential to affect the viewer.

### 5.2.5 Mature vs Evolving

This disconnect between science and television is profound and deep, and inherently based in the differences between media, between writing, and moving pictures and sound, which are further based in the biology of the brain. And as television has become more and more affected by changes in technology, allowing for a greater variety of editing, images and sound, at cheaper and cheaper costs, the trend has been to create science production that panders to less content and more "flash" to entertain the viewer.

Though the longer format television science documentaries have done a better job of bridging the gap between scientists and science producers than have the shorter science

newscasts, they too are following in this trend to shorter clips, numerous editing changes and CGI.

In contrast, the peer review process is mature and static and has not changed substantively in decades. Any of the technological changes in peer review, do not change the content of peer review, whereas technological changes in television actually change the medium, making it morph from one entity to another. This further complicates the efforts of scientists and producers of science production to find common ground in the presentation of science on television

### 5.2.6 A Bridge

It is important to note that it was strongly stated by one of the television scientists that in his opinion it is possible to present science on television successfully and make the productions entertaining, without scientific method, even in science newscasts and still maintain the integrity of science. To do this he believes that both scientists and producers of science programming must appreciate the qualities and the differences between the print medium and television production medium.

*"So quality to me is do you get across interesting, accurate ideas about science that people actually take in. There is no point in standing on a soap box in the corner of the park talking if nobody is listening to you. Scientists miss that very important point, that's its really about the audience. It is not about what you want to say, so much as what you are actually going to say that people are going to internalize. And if you take that point of view, then a lot of the complaints that scientists might have about the inadequate coverage of science really just reflects back on them."*

Even though this runs counter to many scientists' views of what science is, especially scientific method, many of the scientists interviewed commented that entertaining science productions have a role in science education and viewer understanding of science. As a result many of the specialty long format broadcasters, were seen by the scientists as representing science best to the public, though this was not, by any means, in their opinion, a solution to bridging the gap.

The entertainment needs of television science productions were a substantial part of the broadcast equation. The focus on the need for new discoveries and making science exciting were part of every production by the documentary broadcasters. And even in the most expensive productions, such as a Nova production, focussed more on the need for stimulating stories to engage the viewers, than the science.

To illustrate how television, in her opinion, can modify science production from what scientists consider science and still produce educational and factually correct programming, this interviewee, a Nova producer outlined the approach Nova, which is probably the highest profile science story producer in North America, uses.

*"Well what we try to do at NOVA and what we've been successful at doing I think, is finding the science stories at a certain point in their trajectory where what we're telling is kind of the mainstream understanding of a particular thing. And what we'd like to try to do is to find a narrative where the science and the scientific discovery is what drives the narrative forward so that a person is engaged with the investigation or the discovery or the expedition."*

The divide between television science representation and scientists is also about how the different mediums represent education, how they inherently affect education and how the television trend away from education in television science is a consequence of this divide. A National Geographic executive's comments highlighted this. His viewpoint was that television was not there to teach, but to stimulate interest in science. It is the spectacles that bring in the viewers.

*"There are iconic topics, audiences have chosen to watch time after time. But that means there are other elements that they have chosen not to watch. So if you said there is no science of hydrology on the air. I would say that's right. But there is plenty of science about in shows about floods about tsunamis. If you said there's no meteorology being taught, I would say you know you're right, but if you look at all the programmes about inside weather disasters or hurricane chasers or those, they all have a substantial element of science in them. And on and on. I could go on for geology and all the other disciplines. So I think that it is there. To the science community, they may feel its not."*

And indeed the science community is on the other side of the divide. Scientists do recognize that a great gap exists between scientists and the broadcasters and the reasoning behind how science is represented on television, but feel on the average, the presentation is often so skewed to hyperbole and spectacle and stereotypes that what they consider to be good science programming is overwhelmed by the general fare of many broadcasters and producers. One of the Environment Canada scientists felt there were some good representations of scientists and science on television, especially when scientists were allowed the time to speak for themselves and given the time necessary to express themselves.

*"I think the opportunity for the least amount of distortion exists for the longer format documentary type programming or science shows, like Daily Planet. It is a nice example of that, where they do interviews with scientists and they're not just little news bits, they're extended segments where the scientist gets to express an opinion."*

In summary, the concept of the "the Medium is the Message" as outlined by Marshall McLuhan, appears to be a manifestation of our basic brain makeup, and finds its roots in the work of biologists. These differences have led to the disconnect between television and scientists. Our technological advances in television have changed the medium of television again and again and will continue to. And with each change, the mandates of McLuhan shift the medium of television and its message again and again, with all the attendant ramifications in science education and understanding. This cascade of change is almost kaleidoscopic in an of itself and further exacerbated by a number of other factors like the consolidation of the business of television and the differences in language by scientists and the television medium, which is discussed in the following segments.

### 5.3 Consolidation vs Diversification According to Noam Chomsky

The second part of this chapter deals with how the interview data supports the contention that consolidation of the business of television has contributed substantially to the disconnect between scientists and how television represents science. This section looks at the disconnect through the lens provided by Noam Chomsky in his book, Manufacturing Consent (Chomsky 1988). According to Chomsky, as the trend of consolidation takes place in any medium, the number of independent voices decline.

When the number of voices decline, the remaining voices have a proportionately larger influence on the whole and the reader/viewer/listener finds the diversity of opinion and interpretation of the content and information provided by the medium, impoverished. The consumer of the news is then left with a smaller variation in the messages he/she receives. As the consolidation continues a progressively larger fraction of the news projects the same message. A de facto consent is manufactured by that medium. Repeated often enough, with no independent counterpoint, the news becomes accepted by the viewer/reader/listener as the "truth". Because of its ubiquity, eventually this message acquires a veneer of validity that requires little or no verification and is taken to be a "proven truth" because it is common knowledge. As a result news stories are able to become shorter and less complex, with less proof of content needed because the consumer of the news has already accepted certain facts and the process of presenting the story as true. The news story is considered accurate and valid and is not in need of yet more verification and cross checking.

This leads to a number of important consequences. Because of the paucity of variety of independent platforms, dissenting voices that run counter to this manufactured consent, will be viewed as suspicious and even inaccurate. These stories will find fewer and fewer forums for their messages because firstly, there are fewer forums, and secondly, they run counter to the prevailing wisdom. Furthermore, when an opportunity for expression does arise in these forums, the story faces the additional challenge that the viewer/listener/reader will need to be educated in the story background in order for the story to make sense to the viewer. This process of education slows the pace of the story

which has the unwanted effect of making the story inherently less interesting to the viewer, especially in comparison with other stories which require no background education.

The aim of this segment is to examine both a consolidated television market and a diversified television market and compare the science productions in each of them. By using the lens provided by Noam Chomsky in Manufacturing Consent, both types of markets are examined for their "symptoms" or "effects" on the science stories on television.

What follows is the examination of the television industry and how consolidation and diversification contribute or mitigate the disconnect between scientists and the representation of science on television.

### 5.3.1 How Consolidation and Diversification of Television Effects Science on Television

While the interviewers did not talk directly about consolidation of the television industry during the interviews, they did relate to the symptoms created when a medium consolidates to a very few dominant players. The concerns they expressed around the poor quality of science news stories on television were very clear. What also became clear was that the disconnect between scientists and science on television was greatest in the reporting of science news where the consolidation was the greatest. In the realm of

cable television, there was an expansion in the number of stations, the opposite of what was happening to the networks. Both the broadcasters and the scientists talked extensively of the effects of consolidation and expansion on the quality of science programming on television.

### 5.3.2 Effects of Television Consolidation on Television Science Stories

Beginning with the literature review, the evidence for both consolidation of the media and of the effects of the consolidation, as outlined by Chomsky, as it relates to science stories on television becomes apparent. In 2007 a report (Nordcity 2007) prepared by the Nordcity Group outlined the massive consolidation of the Canadian broadcast industry over the past 20 years, where by 2007 only a few broadcast behemoths remained (CTV, Canwest Global (which is now currently in bankruptcy protection), CBC, Corus and Rogers) and virtually all the television stations in English speaking Canada were under the control of only three networks and multimedia concerns. In the late 1980s, in Canada, there were many independent television broadcasters such as Baton, CHUM, Allarcom, WIC, Global, CTV and the CBC, just to name a few, as well as powerful single station independent broadcasters like CHCH in Hamilton and CITYTV in Toronto, that were part of the Canadian English broadcast landscape.

On a global scale, according to a quote in Manufacturing Consent (Chomsky 1988), the consolidation of media is even more dramatic. Chomsky states that according to Ben Bagdikian, when his first edition of Media Monopoly was published in 1983, fifty giant

firms dominated mass media around the world. In 1990 that number was twenty-three and as of the 2002 nine media giants dominated the world media.

Though this consolidation of independent television broadcasters does generally not lead to fewer stations, it does lead to a reduced number of independent television newsrooms. Technological innovations have made it is possible to cut costs by consolidating the number of independent newsrooms, and create a few central news dissemination centres servicing what used to be independent stations. Both CTV and Canwest Global, by far the largest of the private TV broadcasters, have also acquired newspaper, internet and other news gathering media which further consolidates the news across the multimedia spectrum and reduces the need for news gathering in television, since the news can be culled from print and the internet and repurposed for television.

Noam Chomsky explains in Manufacturing Consent, that he believes that fewer broadcasters, means shorter messages, ones the general public understands and agrees with (page 305 Chomsky 1988). He also points out it also means dissenting voices, complex messages and stories that run counter to public opinion and require lengthy backgrounds do not receive airplay.

### 5.3.3 Symptoms of Consolidation

Some of the symptoms of a consolidated medium, as listed by Chomsky in Manufacturing Consent are as follows.

1. Shorter stories in terms of time
2. Decreased content within presented stories
3. Manufactured consent type stories, with broadcaster/viewer pre-agreed upon perspectives and stereotypes
4. Fewer stories with countervailing, complex content
5. Reduction in the breadth of coverage

During the interviews, all the interviewees commented on the five symptoms listed above on the consolidations of the television industry and its affects on the quality of science stories on newscasts.

It was noted that science stories require lengthy backgrounds to set up the story and this need to explain the science content slows the story. The scientists and broadcasters groups interviewed both pointed out many times that science on television has suffered due to the time constraints of current network newscasts and the general lack of understanding and priority of science in newscasts. They both stated that clips with scientists are too short, often misrepresenting scientists and science content.

Newscasts are a staple of the networks and rarely appear on specialty channels, Discovery Channel being the notable exception. As has been previously noted in the literature review, a paper by Gardiner and Young (Gardiner&Young 1981) stated that newscasts are an important source of science information for the viewer. It has also been listed repeatedly in the literature review and the interviews, neither the reporters nor the

audience have the necessary science backgrounds to delve into the science content of the science stories presented on television. Both the scientists and broadcasters felt that science stories which did appear in newscasts relied on spectacle or on anthropogenic relevance (self interest) in order to hold viewer interest and not science content. It was noted by one broadcast executive, inferring that networks no longer had the capacity nor the interest to produce short science stories, that changes in the marketplace, led to a diminished science voice.

*"I think there is tremendous science programming on television. Uh, not generally, though, in the mainstream media. By mainstream, obviously our own channel, Global, CTV, even CBC. I don't think, just from what I see, I don't think we are particularly strong in presenting good science, and good scientific evidence and good scientific fact, and good scientific information, perhaps is the best word I should use."*

His comments about the inferior quality of science on television news also led him and others to say that network television was not where one could find good quality science presentation, because journalists had little science knowledge or understanding themselves.

*"Just the misinformation out there. And clearly news media is partly to blame. I won't argue that. I mean we just love to run with that stuff. And I think that perhaps that's our ignorance of science. We're not scientists, and I'd be the first one to admit that. I think that 95, perhaps even a higher percentage of journalists are hardly scientists at all..."*

A federal fisheries scientist noted that science stories were getting shorter and shorter, and the need for capturing public attention due to decreased attention spans indicated that viewer's understanding of science were limited.

*"Well you have to recognize that there is only so much that you can do in such short hits. You want the public to be captured enough by that short hit that they are going to go elsewhere to learn on their own. Whether it be a book or the internet..... Because people's attention spans are fairly short. I mean if people have to wait while their computer boots up. They are sitting their twiddling their fingers. Its amazing...I mean everybody has ADHD...its crazy."*

One of the television scientists explained in great detail the attraction of the medium of television to viewers from a biological standpoint. He detailed how science stories require lengthy interviews and detailed explanations, and as a result are static when they deal with science content. It is this "slowness" which deals with content that makes science stories uninteresting. We lose interest in television science newscasts in the network television environment. He said that because science and scientific method require a long time to explain, it becomes very difficult for science reporters to rationalize to producers of mainstream daily television network news the necessity of allocating the necessary time and resources for substantial science productions and still maintain viewer interest. Television newscasts today rely on short stories, stories that their audiences can understand in a presentation that rarely last two minutes and can be understood by the viewer without the need for an education in the subject matter. Their highly consolidated broadcast environment requires stories to hold viewer interest and in the opinion of most broadcast producers, science unless it has a strong spectacle or anthropogenic characteristic does not fit well in those requirements. The viewer has also come to expect the newscast stories to be short and without detailed content, stories the viewer expects to understand without a detailed background. Stories that do not fit this mandate and are too long, or intellectually over the heads of the viewers and contain too

much content do not make it to air. This is part of what Noam Chomsky calls manufactured consent, where the viewer is presented with stories that enhance what the viewer already knows, where the facts of the viewer are enhanced and not challenged. It becomes a positive feedback mechanism where the viewer expects the stories to enhance and strengthen what they already know, and not challenge their understanding. This is a symptom of a consolidated medium where the diversity and breadth have been narrowed.

Almost every interviewee commented on how short news stories when they did make it to air contained serious shortcomings. They also noted that in spite of the dissatisfaction expressed by scientists over the quality of science stories in television newscasts the trend to low quality science broadcasts has continued on the networks and the priority of science in the newscasts has fallen. Evidence of this is that in late 2008 due to apparent fiscal constraints, the entire news science department of CNN was axed (The Observatory Dec 4, 2008). Though this action was bemoaned by scientists at the time, there was surprisingly little response from CNN viewers.

### 5.3.4 The Daily Planet and a Diversified Television Environment

As would be expected, if the consolidation of a medium leads to a manufactured consent, restricted number of voices, a dearth of science stories on newscasts, a narrowing of opinion of the importance of science in society and education, and a general diminishing of science and its societal importance, one would expect in a diversified market the opposite would be true.

During the interviews this was commented upon repeatedly, that in a broadcast market with a great diversity, such as the cable environment, where the viewer has a great choice, it is possible to create and maintain an interest in science, even with long interviews and "talking heads" and science content within a news format, completely opposed to what is and has been the television network practice and what has been outlined by Chomsky in Manufacturing Consent. An example of this is the success of "Daily Planet" the sole science news show in Canada produced by Discovery Channel of Canada.

*"...you have 5 or 6 interviews where you actually, they'll be edited by as little as possible. So sometimes we run the entire interview. We are not taking 20 second clips. You do get to see the person and you do get to hear them and in that sense you are brought a little bit closer to what they are like and if they are a great communicators you'll see that."*

This perspective is noteworthy because the specialty channels like Discovery Canada, who have to compete with other content driven specialty channels, are commonly deemed to be of interest to viewers with higher educations, especially in the sciences. (Broadcaster packages at the web sites of History, Discovery, VisionTV and National geographic). The cable specialty channel environment is a varied and highly competitive environment with none of the channels having a majority of the viewers. Furthermore, specialty channels like Discovery Canada, are further broken down with related specialty channels, such as Discovery Civilization, Animal Planet and Discovery HD. Currently there are almost 50 (Rogers and Eastlink cable package Information)specialty channels on cable that broadcast some form of science content, offering a highly diversified and eclectic programming. In the past 16 years since Discovery Channel first began broadcasting in Canada, the number of broadcasters on cable that can be deemed science broadcasters, from a broadcaster perspective, has increased from one to fifty. In this environment, even science news has benefitted, the most criticized of the television science broadcast forums, in terms of science content and accuracy.

The general consensus during the interviews was that the specialty channels provided the best science on television because of the diversity that still exists within the specialty channels venue. There are many specialty channels that broadcast science productions. A local news director noted that among the networks, it was now hard to find any good science, or any science programming for that matter.

*"I don't think, just from what I see, I don't think we (networks) are particularly strong in presenting good science, and good scientific evidence and good scientific fact, and good scientific information, perhaps is the best word I should use. If I think science, you ask me, "Where would you go for science?" I'd certainly go to Discovery, PBS, History Channel, things like that."*

A Chemistry Professor noted that the trend in newspapers, as they have struggled to survive, is to consolidate, and incorporate science within the news and no longer treat science separately. The message becomes shorter and simpler and the depth of the science decreases.

*"it depends on the medium. In the television domain, because its all so short, its difficult to reconcile. Radio is a little bit better because if you could have a longer interview and get into more detail. And of course in print media I think there is lots of scope for good in depth articles. Most of the newspapers don't have a science page anymore. Even the globe decided to integrate it this past year and they're not putting as much science into it as they were before. I think that they're not getting the depth that they did have."*

As network television struggles with a general decrease in viewership, it seems to be following the route taken by the newspapers as they faced declining readership. Television companies are becoming larger, with fewer competitors and central markets servicing smaller, what were once independent, markets. Generalized, short stories, with little science depth or content are streamed from the central markets and are rebroadcast in the smaller markets. This diversity of the independent is lost as the same science stories are repeated across the country, because of the consolidation of the television markets.

A Discovery Channel in Canada executive pointed out that in the areas of greatest consolidation, network television news, children's programming and network programming, the diversity also seems to be the least, or at least, less than in the still diversified cable channel sectors specializing in science programming.

*"And the reality is the conventional channels like CBC and Television do reach huge audiences. I am not sure they are giving as much...I don't see as much kids science programming at all. We have been over run by Disney and Nickleodeon and I think that's an area that a lot more could be done. In terms of...are there going to be protests on the streets by people campaigning for science, more science programming on their channels. Probably not. Where I think the big void is happening is in the news side. I still think science is sometimes treated as separate subject that is not integrated into society. It doesn't get its due. Its sometimes treated as the funny kicker story at the end of the newscast. I think that reporters and journalists in general who have grown up in the arts world tend not to put a lot of value or tend not to understand science content. I think that science programming and news programming are areas where probably the public deserves more attention. But certainly in the documentary are we are seeing more science documentaries than we ever have before."*

### 5.3.5 Consolidation vs Diversification Summary

Both scientists and broadcasters, during the interviews, related strongly to the symptoms of consolidation on the network television industry. Each shows how science decreased and how science stories have suffered, and how this led to a "dumbing down" of the science stories on newscasts. All also noted the reverse, how in a diversified environment, such as cable television, the opposite was true. Science news was resurrected and was successfully received by the audience.

In spite of the fact that scientists were highly introspective about the nature of what was science and what was not science programming on television, and critical about many aspects of science programming on television, most of the scientists interviewed did not consider the consolidation of the media markets in television as an issue, though they did comment extensively on the symptoms of the consolidation. The broadcasters on the other hand were deeply aware of the changes in the television market and how it impacted science programming on television. The broadcaster/producer group all commented on the changes within television programming because of the evolution of television.

In summary, it was noted that as the mainstream networks have contracted and decreased in number, the science news programming has decreased in both quality and in quantity. In the cable environment which has in recent years been expanding in the number of stations, with a large number of stations competing for a smaller audience, science programming has actually increased and become more diversified. In addition, the amount of quality science has increased, where even the newscasts of science news had in-depth content driven and scientist driven science stories.

### 5.4 The Language Difference Between Scientists and Science on Television

To say, that how we use language, plays a crucial role in our communications is an understatement. Within a given language, there are different language types or styles. For example, it is commonly understood that for most people their spoken language vocabulary is different than their written language vocabulary. And in the same way, there is a great deal of difference between how scientists use language to express their scientific researches and how language is used in the broadcast of science stories and documentaries. Language used by scientists in their researches, presentations and publications, both written and spoken, is precise and highly defined, whereas language in everyday life, which is reflected in television, even in the most rigorous science productions is fluid, variable and multifaceted. The definitions are much less precise and broader in meaning.

For example, the word "energy" to a scientist has a clear mathematical definition. It is kilogramme metres squared per second squared ($kg \times m^2/sec^2$). To a physicist or a chemist energy is just that, no more, no less. Energy, in common parlance however, can be sugar, oil, a scientist's definition, hyperactive children and much, much more depending on the context of the topic being discussed. In television science productions language is colloquial, reflecting the common every day use, rather than how it is used by scientists.

### 5.4.1 George Lakoff

The purpose of this section of the analysis is to examine the disconnect between scientists and television science from the perspective of language differences between scientists and broadcast television productions. George Lakoff in his book, The Political Mind, *(Lakoff 2008)* illustrates how language can be very powerful in shaping ideas, conveying messages and how it can also be used to create a confusing atmosphere of conflicting terms and ideas. According to George Lakoff the use of language in television productions is a very powerful tool. This observation may seem to run counter to general wisdom given the popular perception that television is all about moving pictures. The words and sounds of TV productions tend to be thought of as taking a back seat to the visual presentation. However, according to Lakoff, the words are very important and the language and how it works, is often overlooked in television where images, graphics and animation, all part of the visual spectacle, can cause a perception that diminishes the importance of language in television science production.

Using Lakoff's work as a lens to view the differences in language usage between scientists and television science, another aspect in the disconnect between scientists and television science can be explored. Lakoff in his book "The Political Mind" states that our perceptions of the science programmes we watch are complicated amalgam of the images and words our brains receive and interpret. And even small differences in language can make large changes in the outcome of the message. Sometimes the words used in the creation science stories by journalists and producers, may on the surface

seem the same as that which the scientists use, but they are not. Add to that the biases of vested interests, poorly understood science by producers and the influence of video and graphics, and the potential for disconnect increases dramatically.

### 5.4.2 Differences In How Words Are Used By Scientists vs Science On Television

There are a number of issues to consider when comparing the language of scientists and that of television.

1. In simplest terms, television science stories are comprised of two components, video and audio. That contrasts with scientific research and scientific method which rely mainly on the written word.
2. There is also a difference between how scientists use their words in researching and describing science, and how television producers and broadcasters use words in describing television science to their viewers.
3. Scientists communicate mainly to other scientists and television communicates science to its viewers who are mostly non-scientists.
4. Television science stories work under a mandate of retaining viewership, making the science stories of interest to viewers, very often presenting the science from a perspective of spectacle and anthropogenic interest. Scientific publications rely heavily on scientific method and facts and discourage language that deviates from these two areas.

It is important to stress that television is a business and strives to create programming which will appeal to their audience and ratings. In addition, television is also a medium that is used by other businesses with vested business interests, who use language in science programmes to enhance their interests. Almost all broadcasters are funded by commercial advertising revenue and their science stories are often funded by vested interests, who benefit from a particular scientific stance. These vested interests can have influences on how the science is presented, how stories are worded and presented. Scientists, because of the nature of peer reviewed process, are not as vulnerable to vested interests, though it does occur.

Scientists, in communicating and publishing their scientific research, rely on words and are very specific in how they are used. Because scientists often appear in television science stories often the same words used in scientific research publications are also used in television science productions. But because the final broadcast science production is almost always determined by the journalist, producer or broadcaster, who are not scientists, the meanings of the words may be entirely different from the way the scientist intended them to be. Scientific language and colloquial language often clash in television stories and contribute substantially to the disconnect between scientists and television science productions.

There is also the general perception that the audience and producers of television science programmes are most interested in the video component of television and not the words or the content. This is evident in the budgets of television productions (PAL

Science Media 2009). The video budget is usually many times the cost of the audio, because most of the production effort is in the creation and editing of video, not the audio. The audio component, including the research and script writing, the words, which contain much of the information of a science story, are a small part of the process of television science programming.

In George Lakoff's discussions on the concepts of language, he posits that television stories have different components. He states that the narrative of words underpin the story in any television production. These themes can either work in concert with each other to tell a story or work against each other and create under currents that make the video part of the story different from the audio story. This complementary relationship is a very powerful part of the television message. It can also be exploited by vested interests who wish to either discredit the science in the television science stories or at the very least cast a doubt in the minds of the viewers as to the scientific consensus. This method is particularly prevalent in the Darwin vs Intelligent Design arguments raging in many parts of Canada and the United States. The Intelligent Design lobby, wishing to cast off its old Bible based image, trying to recast itself as a science, changed its name from Creationism to Intelligent Design to appeal to the viewer as a legitimate science. The term Climate Change was coined by the Bush administration in the United States, because Global Warming seemed too harsh and human caused. In Canada the term Climate Change was introduced because it was viewed that Global Warming was too appealing to Canadians who would welcome warmer winter weather!

Language is where most of the content is contained in the presentation of a television science story and the video is most often added to the story after the story has been verbalized and is traditionally used to bring in or enhance the emotional appeal of the story (PAL Science Media 2009). Because of this, the words and video, though they are intended to complement and enhance the science story, can often tell different or even conflicting stories. In the presentation of television science news stories, this can be especially the case. The scripts are written first, approved by the editors and programmers, then the reporter or field producer adds the video, which hopefully compliments and complements the story. The reporters who write, edit and present science news often have serious time constraints to meet and choosing suitable video to tell the story while meeting those constraints often adds to the mismatch of audio and video.

Scientists in explaining science use language differently than do reporters. A good example of this is in the use of probabilities, which are an important part of every scientific study. Most scientific studies have probabilities and error bounds and that are included to give other scientists a good idea of how well researched the science publication is. When that probability is translated to common language it can often be confusing. To a scientist, "very likely" is a standard labelling and sharply defined by statistical methods. To the scientist, it is a matter of professional integrity and a necessary bounding, to acknowledge that in every study, there is a possibility that there could be other outcomes in the study, no matter how small that probability may be and no matter how convincing the evidence is to support the published outcome. To the

viewer, a reporter's story that says an occurrence is "very likely" probably means there is some doubt in the science. To the reporter and the viewer, who have very little experience in scientific method or language, "very likely" means there is doubt, meaning, the science is incomplete.

Lakoff takes this concept even further. He states in chapter 12 of his book that the media, television in particular, often do stories where concepts play an important part of the story. When a topic is not understood in the context in which it is given, such as when reporters who have little understanding of science, there is an inherent bias that skews the content of the story. The concept of the science that a reporter has or doesn't have, comes into the language of story and changes the concept of story. For example, is Global Warming anthropogenic of not? A reporter may have the idea that anthropogenic Global Warming is a scientifically debated concept. In actual fact the statistics bear out that almost half the reporters and the general public think that human induced global warming is a scientific debate among climate scientists. The latest study (Doran 2009) however shows quite the opposite, that there is really no debate among scientists, that in fact 97% of scientists who study and research climate change agree the climate is being altered substantially by people. Even by doing a story about whether climate change is anthropogenic or not skews the science behind the studies, by giving climate skeptics a voice they should not have and by inferring that there is a scientific debate over whether global warming is human induce or not.

A television executive noted that television reporters, in their efforts to make stories have an impact, often resort to language that enhances the sensational parts of the story. Scientists, who provide qualifiers, such as worst, middle and best case scenarios, in order to make the science in their work accessible to those who have little understanding of science, often find the their language choices used in ways that they had not intended. Even worse, the quest for sensationalist stories can often lead to more frequent quotes from scientists who are more extreme in their outlooks.

*"The media tends to focus on the numbers and the worst case scenarios. The moderate people in the middle get left out in those arguments. Because we always go with the people on the extremes. One extreme is its a pandemic and millions of people are going to die. And on the other extreme, this is just another virus and flu outbreak and it is no big deal. We do tend to polarize issues."*

This difference of language use and understanding between scientists and non-scientists can also lead to deliberate exploitation by groups with vested interests, where non-scientist producers and reporters repeat pseudo science as science and create stories that appear to have scientific credence.

This opens the conceptual door for the exploitation of any scientific study and through the relabelling of old concepts and the mislabelling of issues, vested interests create a doubt in the viewers mind, to make it seem as though there is controversy in the sciences and that scientists are divided. This leads to the creation of controversy in science reporting. When controversy does not inherently exist in a science story, vested interests, a poor understanding of science and deliberate distortion create public interest.

A fishery scientist's comments about the lack of understanding of science and the language of science by reporters and its importance underscores how science can be skewed by reports on television.

*"People have their agenda, and they're pushing it. Climate change is an example, the deniers. For instance, if a study comes out a study were to come out in "Science", about the change in the Labrador Sea, that shows that climate change is not happening, when that's not the case, suddenly tit will be in the news, they blow it up, way out of proportion. They don't understand its one little study. They're ignoring the way science works and the complexity of the environment and sometimes tune in on a single issue and blow it out of proportion. They're pushing an issue. Other times, I think it maybe just lack of understanding of the methods that by the people reporting it. They're not scientists, they have very little training. Many times you get the junior reporter."*

The language of vested interests is of particular interest and was commented on by the scientists and television scientists as a ploy to extend the discussion around science concepts and to make certain arguments seem scientific when they were not, or by focussing on a single study to the exclusion of all the others. This exploitation of reporters' lack of science language and lack of scientific method understanding was a key issue to all the scientists interviewed.

The scientists, who felt the medium of television had a very hard time differentiating real sciences from pseudo science, expressed that understanding the language of science was very important, especially when differentiating science from pseudo science. The relabelling of creationism as intelligent design, calling astrologers and psychics paranormal experts, pseudo medical practices, naturopaths and holistic methods, etc. all contributed to legitimizing highly questionable pseudo sciences as real science. In doing

this, television science news creates doubt through the fact that the pseudo sciences get air time right along side the real science in their stories. The viewer has a hard time discerning what is legitimate from what is pseudo science. The new labels refresh old concepts without adding any new content. The new language used in describing these old concepts also give them credence, because it appears that new arguments were continuing a debate with new information, when the arguments had already been satisfied and refuted in most cases.

The scientists felt it was important to at least educate reporters as to what scientific method and scientific language was, in news and the longer format documentaries. It was felt that without an understanding of scientific language and method, the likelihood of erroneous science reports would not decline, especially in the case of shorter format science news reporting.

### 5.4.3 Language Summary

It was recognized by all interviewed that the language of scientists and of television science productions often use language differently. That gap in itself was viewed as a substantial part of the disconnect between science and television. It was also noted that the words used in television often take a back seat to the images and the images often tell an entirely different story than do the words. What was also noted was the use of language in television by vested interests and those who did not understand scientific method and how language is used in scientific method. Vested interests played on the

difference in language and difference in understanding of scientific concepts to deliberately create doubt and cloud the science. Reporters who had a weak scientific understanding often added to the doubt by inherently giving these vested interests a platform, when there was often no sound science behind them.

# Chapter 6: Discussion and Conclusions

## 6.1 Introduction

The intent of this study is to examine the disconnect between scientists and science, as it is presented by television, examine the underlying reasons for the disconnect and then formulate, from a conceptual lens provided by the works of Lakoff, McLuhan and Chomsky, a consistent theory that provides some insight as to how the disconnect might be bridged. This study also recognizes that this topic is very large and diverse and that there are many areas in need of more research and study.

In trying to understand the underlying reasons for the disconnect, this study considered the works of Marshall McLuhan to be the main lens through which the information collected was examined. Two additional contributing lenses that were also used to examine the data and considered to be subsets of McLuhan's works as they related to this study, were the language studies of Lakoff and the importance of a diversified television media as represented by Chomsky.

The main area of concern in how television represents science and in the disconnect that is created by the difference in representation of science by television and by scientists comes from an educational and informational perspective. It is widely recognized that television is perhaps the most influential medium in our lives and as has been shown,

most viewers rely on television to provide them with their daily information, news and education about science and science related issues. Because of this, how television represents science in turn has a large potential to influence viewers in making their decisions about science and science related issues based on what they see on television. The communication technology of television stretches into all areas of our social fabric and links viewers, science, scientists, business and government in a very complicated tapestry. That in turn even affects how our elected government officials choose to look at science related issues, basing their decisions on viewer perspectives, their constituents, in the funding of science related projects, educational science mandates, the types of education their children will receive in science and how they will respond to the many science related issues facing our society today.

### 6.2 Conclusion One - Twin Solitudes

It has been stated throughout this study, and confirmed by the evidence in the literature reviews and the interviews, that television science and science as represented by scientists, are at a disconnect. This disconnect is supported and enhanced by a number of serious divides, based on a mutual lack of understanding between the two groups. On one hand this is not surprising, since scientists and science broadcast/producers are two independent groups that currently exist with little formal contact or consultation between each other and in fact have grown apart over the years. On the other hand that this should be so, is a surprising conclusion since, on the whole, both scientists and broadcasters/producers of science programming have the same basic vested interests in a

making the viewer, a science literate viewer. It points to a deep disconnect that could be said to border on arrogance from both sides. Each side is a solitude that appears to dim the perspective each side has on the other.

It is important to consider and study the disconnect because of a number of reasons.

1. Our society is a technical society based in and supported by science.
2. The threats to our society are significant and the potential solutions to these global concerns will only come from science.
3. The general public receives much of its science information from television science programming.
4. Solutions to science issues and funding of science studies come, by and large, from the public purse, which, in turn, is influenced and supported by the public understanding of science.
5. Political solutions to our great societal problems will come from the public.

Scientists and television science programming are two solitudes, nurturing a deep disconnect with many causes. What follows is this study's conclusions on some of the probable causes of the disconnect and what is hoped are some of the solutions to the disconnect.

### 6.2.1 Scientific Method vs Television Science

One of the conclusions of this study is that a lack of scientific method in television science programming is one of the main reasons behind this disconnect between scientists and television science programming. The scientists interviewed felt this was the case, many of whom stated, that in their opinions, there was little or no science on television, even though broadcasters and producers held entirely the opposite opinion. This disconnect between scientists and television science was clear. The scientists without television experience felt that almost all of what is currently presented as science programming by producers and broadcasters is not science because it lacks scientific method or an understanding of what constituted science as practiced by scientists. Broadcasters and producers, on the other hand felt that scientific method was an anathema to their science programming. They felt it would undermine the science programming to the large degree, that audience ratings would suffer significant losses as viewers sought other more interesting and entertaining programming.

Examining the concept of scientific method illustrated clearly the lack of understanding between scientists and the science television broadcasters and producers, as to what the other did on even a basic level. To add to the disconnect there was quite some confusion as to what was even considered to be science. The broadcaster/producers had a very broad definition of what constituted science, whereas the scientists, in some cases, defined most of what appeared on television as devoid of science. Most of the scientists defined science as what came out of the process of scientific method. If scientific method was not present then it was not science but a collection of facts, that perhaps pertained to science, but was not really science.

To understand the scientists' perspective, it is important to understand that scientific method is the bedrock of scientific research. Every scientist understands the importance of scientific method, and studies that do not adhere to those principles do not get published in peer reviewed papers, nor are they considered to be scientific studies. However, as important as scientific method is to scientists and the furthering of science research, the viewers, broadcasters and producers have little understanding of scientific method.

Many if not most of the producers and broadcasters who do science programming have little formal education in the sciences and scientific method. In their view scientific method not only is not necessary when producing science programmes, but actually would make the science production unwatchable to modern audiences. They stated that they see their science programmes and stories as furthering the understanding, education pursuits and interests in science within the business constraints of the medium of television. And they use all the production methods available to them within the television medium, to further garner viewer interest in their science programming.

As a result, scientific method rarely appears in any television science, newscasts or documentaries. Broadcasters and producers point out that their objective is to inform and educate an audience about what is happening in science in an exciting, interesting and entertaining manner that is competitive with other, non-science programming. They make the point that today's viewer has many programming choices and if scientific

method is introduced into television science productions, the viewer would soon be bored and switch to other programming, or even other entertainment activities such as computer games. It is their opinion that in the current broadcast environment scientific method is not something that can be used by broadcasters and producers in the production of television science programming.

In contrast, scientists speak primarily to other scientists about their researches and use what is the common scientific language of scientific method and peer review to further their research communications. Scientists study the world through scientific method and spend almost all of their time researching science and rarely consider that communication to and with those who are not scientists has historically been part of the process of science. Their lack of interest and their lack of skills in popularizing, educating and informing the public of science must be considered to be a major shortcoming in science research and of most scientists themselves, and is a major concern in the disconnect between scientists and television science.

This study concludes that scientists need educate themselves in a number of areas to close the disconnect. Here are a number of suggestions about how scientists might be able to make a positive influence in television science programming and contribute substantially to reducing the disconnect.

1. It could be argued that the burden of getting quality science programming to air on television rests with the reporters, broadcasters and producers of science

programming, but in practice journalists and producers have on the whole not been able to do that. The reality is that in order to increase the quality of science programming on television, scientists have to become involved in the television process.

2. Scientists should include in their education, courses that specialize in the understanding of the media, particularly television science production, and how it differs from peer review, scientist to scientist communication.
3. Scientists need to understand that scientific method is not an obvious process to most non scientists, nor perhaps necessary for the production of a good science news story or documentary. As such it is as important understand the role of science journalists and how to facilitate their productions without the presence of explicit scientific method.
4. Scientists should make the study of the TV medium part of their researches where the understanding of the science to the viewer is as important as the clarity of their researches and methods are to other scientists. The institution of dual papers, one for their peers and one for non scientists should be considered.
5. Though there are some journalists who do become versed in the sciences and scientific method, in the current climate of television broadcasting, especially in the impoverished science programming of network newscasts, the burden of quality science information falls to the scientists, since so few non scientists read or understand the peer reviewed science papers in peer reviewed publications and science is progressing faster than at any other time in history.

6. Scientists should have an understanding of the different genres of television science and how each genre has its own needs and requirements. Scientists should also be critically active where science has been poorly represented and reported in television science programming.
7. Scientists should look at ways in which they could become more active and participatory in the science programming that appears on television.

In my view, when science is not in the news (anthropomorphic or a spectacle), not in conflict with big business interests or with religious or political concerns, it rarely appears in the news or is the subject of documentaries. Most researches in physics, chemistry, biology, medicine and the humanities rarely receive air time because they are deemed too science oriented and uninteresting to the viewer. There is no "story" or hook to entice the viewer. Attempting to do a science story that does not satisfy these two issues is met with comments like "who cares" factor and "why is it relevant". Only when science is highly anthropomorphic and spectacle driven, does it rise to be of interest to television programmers. This is true, especially in science news, skewing to the viewer how science is practised, what its process is and ultimately what scientific method consists of. Though we live in the most technological and scientific of times, the vast majority of science researches never appear in television, even though we know that time and time again unrestricted science researches have enormous intrinsic value and interest.

Producers and broadcasters of science programming and news rarely have primary backgrounds in the sciences. And while science is the basis of our society and the technology that drives the planet's economy, science itself, as far as the media is concerned, is a low priority. In the news many, if not most reporters are science illiterate, as are the news directors of the television newsrooms and science has a very low priority.

### 6.2.2 Different Medium - Different Method

The differences in media are a key point in this study. Each medium handles information differently and in the case of television vs peer reviewed print publications, the differences in how science is handled is profound. Scientific method works well in print and between scientists where information is the currency. In television entertainment is the primary concern and information takes a back seat, as does scientific method. Science programming on television is not peer to peer and in general, both the viewer and the producers of science programming have little backgrounds in formal scientific research.

Translating science found in peer reviewed publications into television programming is fraught with pitfalls and in many senses alienates the viewer. In television programming new presentation techniques based on entertainment are necessary for a variety of reason outlined in the analyses of this study. However, science programming produced without

adherence to scientific principles runs the risk of producing inaccurate science programmes.

This study finds that the best science television programming, e.g. Daily Planet, Nova makes allowances for the following.

1. Adequate time for scientists to express themselves and represent the science fully and within context.
2. Studies into how peer science as found in scientific journals might be translated into television programming .
3. Consultation with scientists on more than a just “talking head” level.
4. Refraining from the use of journalistic method where the reporter or the producer looks for a pro and a con in a story. This method often skews the weighting of a science story to make it seem as though this perspective is a point and counterpoint to science when in fact there rarely is.
5. Journalists should have at least a background in science. A degree in science as well as journalism would be preferable.
6. Resisting the urge to anthropomorphize or sensationalize every science story.

The conclusion of the scientists was that television is prone to hyperbole and with its emphasis on ratings and the numbers of viewers, is often at odds with what television producers and broadcasters say their goals are and what is produced as science. But it wasn’t just the scientists. The television producers and broadcasters also stated there was a great variation as to what passes as science. Scientists in general dismiss science on

television and while they recognize television's influence and ability to mould the viewer's perception of science and what it represents are generally ambivalent to what appears as science on television.

### 6.2.3 Business Interests vs Scientific Interests

Often, because journalists and producer/broadcasters have little background or understanding of science they are vulnerable to the business interests of broadcasting, where because the bottom line is often the bottom line, what is deemed the least important facet is often not the least important, just the least understood. As a result, when television businesses scale back they begin with what they deem to be the least important parts of their broadcasts. In the case of CNN this past year, it was deemed to be the entire science department. This is potentially devastating for science understanding and education, since television provides a large fraction of the viewer's science information. Science is important in all levels of our society, but because it is not seen as a ratings grabber, it becomes vulnerable.

A possible solution would be to have a science standards council set up for television broadcasters which is administered by an arms length council of scientists and journalists and supported by public funds.

## 6.3 Consolidation vs Diversification in Television

Science programming is hit particularly hard when there is consolidation and broadcasters produce newscasts from a central source. Diversity is a core to the promotion of good science production and the evidence shows that in a diverse environment science programming becomes better with increased diversity and the viewer has a greater choice of science programming. The government agency in Canada, the CRTC is responsible for the current phase of consolidation of the television industry. This study would recommend that any consolidation of the television industry take into account the adverse effects that science reporting has experienced in the past because of consolidation. A diverse broadcast environment is a healthy broadcast environment from the perspective of quality science programming. CNN recently cut its entire science reporting staff as it reallocated funds and priorities in its news reporting. Discovery Canada, owned and operated by CTV BellGlobe Media has had a hold on new production that has affected producers of science production across Canada, even though the ratings at Discovery have grown. The financial duress the network parent company like CTV feel due to decreased ratings and the current financial downturn, has been passed on to its successful specialty sibling and its science production funding has been cut as the network struggles.

### 6.3.1 News Vs Documentaries

There is a great deal of difference between the production of a science documentary and that of a 60 second science news story. However, the need for good, unbiased science is the same for both. Science newscasts have suffered on the major networks and it is the

prevailing wisdom among journalistic circles that science is not important. However, what runs counter to that concept is the success of science newscasts such as the Daily Planet by Discovery Canada. In the diversified and competitive broadcast environment of Cable Television, ratings have increased and viewer interest in science is sustained in spite of the fact that stories about science are longer, more detailed and interviews with scientists are sustained and a significant part of each story.

It was generally accepted that documentary productions were of a higher overall quality than news and it exhibited the same trends as news did. On network television where consolidation has led to a diminishment of both the number and quality of science documentary programming, the opposite was true in the cable environment for science documentaries. National Geographic, Discovery Channel, the History Channel, VisionTV all air science documentaries and are in a very competitive environment and their programming in science is generally recognized to be of a higher quality than the networks'.

### 6.3.2 Dumbing Down and Science Generalizations

In a consolidated broadcast environment the science becomes generalized and "dumbed down" because of the brevity of the science stories. This is especially the case in the newscasts, but also plays a role in documentaries. Viewer science literacy has been shown to be linked to television programming and if the programming lowers the bar, the viewer science understanding is also lowered. Documentaries in consolidated

environments often become reduced to glorified reality shows where any topic can be labeled as science and offered as science programming, in spite of the fact that the show revolves around the actions of the cast of characters who have little to do with science or understand little science themselves.

### 6.4 When Language Becomes a Barrier to Communication

In the consolidated environment of network broadcasting, with less emphasis and importance given to science, especially in the newscasts, where time restrictions are a major factor, a short science story might contain only 150 words to explain to a basically illiterate science viewer the complexities of science. This is, for all intents and purposes, an impossible task. The language barrier is set so high that cognition of the science concepts is not possible. What is construed to be science is distorted and actual science is missed.

#### 6.4.1 Vested Interests and Deliberately Creating Confusion

The most striking part of this research is that as science issues continue to play a larger and larger part in the well being of television viewers and their planet, (issues like climate change, the H1N1 virus, intrusion of the pseudo science “Intelligent Design” into the science education system, vaccinations and autism, alternate energy sources, manned vs unmanned space research, undirected scientific research vs applied science, alternate medicine, etc.), the understanding of what constitutes science, based on what is

presented on television, becomes more and more confusing to the viewer. Debates are created by television, in the guise of serving the best interests of the public, when no such debates exist in the scientific community.

Another area of concern is the propensity of broadcasters to create misconceptions in order to gain viewer credibility at the expense of science. This is especially obvious in local, regional and network weathercasts in local regional and national broadcasts rarely feature trained meteorologists with science degrees. Though they have no science credentials the stations they represent label them as such. For example, in the past 20 years of broadcasting in Halifax, there have only been two weathercasters reporting television weather who are accredited meteorologists. None on the local private stations, CTV and Global, currently have weather reporters on staff who are accredited meteorologists. CBC's Trevor Adams is the only accredited meteorologist who is working in the Maritime television market who has a post secondary education at a university level in meteorology. The others, whose stations call them meteorologists and label them as such, at most are technicians who have worked in various capacities in the weather outside of broadcasting, from meteorological instrumentation to weather technicians with Environment Canada. This skewing of credentials misleads the viewing audience and also points to how the television medium fudges the facts when it suits them, which gives an indication of the priority of science and their perspective of the importance of science in their broadcasts.

However, with the proliferation of cable television, channels such as the Weather Channel have filled the credibility void and off set the short broadcast time allocated for weather, which is often the only science within the nightly news broadcast. The Weather Channel provides 24 hour round the clock weather programming, with weather content provided by their own staff of accredited meteorologists. Their model is to make the meteorology content the material they build their productions around. Their weather presenters are not meteorologists, but television presenters who are continually briefed and updated by the Weather Channel's own scientific staff. In addition to weather, the Weather Channel also provided short weather and climate based stories and productions, again with the extended consultation and content from their own scientific staff. The Weather Channel's ratings have been among the highest of all the cable broadcasters right from its inception some two decades ago, providing it with a loyal and consistent viewership.

### 6.5 Education and its Relationship with Television Science

The second part of this study is the medium of television itself and its predisposition to sacrifice credibility for ratings. Nearly all reporters and producers have no backgrounds in the sciences and rarely consult with scientists about what constitutes a good science story for television. Scientists are used in a stereotypical fashion and only used to represent the interest of the reporter or producer as spokespeople to provide backing for one side or another of an artificial argument. There is nothing that requires a broadcaster or producer to adhere to credible science from a scientific perspective or to have

credentials that are backed up by the scientific community. At this juncture in our society, we have so many pressing problems that need to be solved and it appears the media, especially television, is a hindrance to the public's understanding of the true nature of these problems. Science journalism and science production on television is a special, influential and critical component in the linkage between the scientific community and the public. A viewer without a strong educational back ground in the sciences cannot trust the science information in television news and science documentaries, cannot separate the truth from pseudo science and the vested interests from pure science.

The combination of low education levels in the sciences by both the producers and the viewers makes for highly suspect science on television, with no surety that the science that is portrayed is in fact the best science that can be presented on television. The combination of consolidation, ratings and quest for profits by television broadcasts make any efforts for self directed voluntary enforcement of a set credible science ethics and guidelines unlikely and makes most television science subject to distortion from vested interests.

The most credible and successful television science programming consult with scientists who have a strong formal background in journalism and television arts and communications. This coupled with broadcasters whose mandate is to allow for television science programming that has a strong science content and who adhere to a formal set of guidelines culminating in the certification of credible science producers

would result in a more educated, informed and science literate viewer. That coupled with a review process of the programming would allow the viewer to understand what is good and what is not as far as television science programming is concerned.

Many organizations have bodies that self govern and regulate certification and credentials. It appears that perhaps it is time for such a body to be created for science television. Because of the crucial bond between the viewer and the scientist and the fact that so much rests on the understanding of science, television is in a very powerful position to influence how the public sees very crucial scientific issues that will have a profound impact on what will happen to our world.

Chris Hedges, a Pulitzer prize winning author, in his most recent book, Empire of Illusion, (page 44-45) has the following statistics and comments, which should provide some food for thought.

*"Functional illiteracy in North America is epidemic. There are 7 million illiterate Americans. Another 27 million are unable to read well enough to complete a job application, and 30 million can't read a simple sentence. There are some 50 million who read at a fourth or fifth grade level. Nearly a third of the nation's population is illiterate or barely literate - a figure that is growing by more than 2 million a year. A third of high school graduates never read another book for the rest of their lives, and neither do 42 per cent of college graduates. In 2007, 80 per cent of the families in the United States did not buy or read a book. Canada has an illiterate and semiliterate population estimated at 42 per cent of the whole, a proportion that mirrors the United States.*

*Television, a medium built around the skilful manipulation of images, ones that can overpower reality, is our primary form of mass communication. A television is turned on for six hours and forty-seven minutes a day in the average household. The average American daily watches more than four hours of television. This amounts to more than twenty-eight hours a week or two months of uninterrupted television-watching a year. That same person will have*

*spent nine years in front of a television by the time he or she is sixty-five. Television speaks in the language of familiar, comforting cliche's and exciting images. Its format, from reality shows to sit-coms, is predictable. It provides a mass, virtual experience that colours the way many people speak and interact with one another. It creates a false sense of intimacy with our elite - celebrity actors, newspeople, politicians, business tycoons and sports stars. And everything and everyone that television transmits is validated and enhanced by the medium. If a person is not seen on television, on some level he or she is not important. Television confers power and authority. It is the final arbitrator for what matters in life."*

Science and scientific method are the product of education and utterly dependent upon literacy and require years of study and work. Television requires nothing more that the pressing of a button on a remote and the flow of rewarding images, sound and opinions cascade endlessly and effortlessly in any format or language desired, hour after hour after hour. The contrast between the two is palpable, visceral and comes at a time when we need an educated, literate and intelligent population more than ever. Television has become an anathema to literacy and learning, its rise to prominence has mirrored the equally precipitous decline in literacy, especially science literacy, in our North American culture.

Without an educated, literate public, one that is cognizant of and literate in the sciences, and scientific method, societal decisions will be based on whatever images and impressions television sends to them, from all the vested self interested priorities, parties and businesses who determine what the viewer will see. It is a vast solipsistic, positive feedback mechanism, that every year, further divorces us from reality and entrenches illiteracy, science illiteracy and shallow opinion, masquerading as information and fact.

### 6.5.1 Positive and Negative Feedback

When scientists or science specialists who have been trained in the media, specifically television, make a substantial effort to get involved in television programming and are made part of the programming, they produce some surprising results. Scientist producers such as Jay Ingram, host of the Daily Planet, aired by the Discovery Channel, find their programming elicits enormous viewer interest, especially among school age children, yet does not exclude Discovery's adult target audience. In depth non spectacle driven and anthropogenic programming appears to have an inherent interest to the viewers, in spite the emphasis on science. On the Daily Planet, scientists are given a chance to speak for extended periods and stories about science can come from any branch of science, and are not restricted to the more typical fare of science news production with its emphasis on spectacle and anthropogenic issues. Though the Daily Planet makes use of journalistic methods by having a story line, a start, middle and conclusion for each story, implicit in its production values is an understanding of scientific method. Though scientific method is not explicitly spelled out in each story, viewers get an understanding that science is not solely about spectacle and immediate discovery. The process of science and a truer picture of the scientist and the work they do, comes out to the viewer. This emphasis of science tailored for television and not repeating a print peer reviewed scientific magazine method makes use of the perspective that television has something to offer to science and allows science stories to be created with television in mind. The television medium and its particular strengths are brought to the forefront, when introducing the science. The production, of what the Daily Planet portrays as science on

television, is flexible and differs markedly from what is defined as science in the scientific community. The importance of having a science articulate host in news production, dedicated to science news cannot be overstated. It means that interest can be maintained throughout the interview. It allows the individual science stories to be longer and more in depth and less simplistic. This also means that the token and virtually meaningless traditional 10 second clip from the scientist usually seen in other newscasts, can be dispensed with. This has made the Daily Planet almost unique in broadcasting.

In addition, the Daily Planet has time slots with actual scientists who are skilled at television presentation, who have a relatively free hand to bring in other perspectives from the scientific community. Because the viewer is able to hear and see extended conversations with scientists hosted by a science literate host, they are able to get a better perspective of what a scientist is, receive exposure to the language of science, how it fits within society and realize that there is science that is interesting and can be presented on television without pandering to sensationalism. The ratings of the Daily Planet have over the years (its been on air for 15 years) consistently been among the highest of all the offerings on the Discovery Channel, which reflects well as far as viewer interest is concerned and the business concern of private broadcasting.

### 6.5.2 Implications

If we deem science literacy of the general population to be important, then we can also assume that an education in science is important. And because many of the studies

reviewed in this thesis show a significant fraction of the lay population get their science information from television, and make their decisions about science and science education from how television represents science, this issue of science literacy becomes important, from an educational standpoint. There is a positive link between what television presents as science and what the lay person deems to be science and thinks about science from an educational perspective. That opinion about science, generated by television, influences educational decisions as they relate to science, on a number of levels.

We can see evidence of this already playing out. Many educational jurisdictions have been affected by what is deemed to be science as represented by television. A very powerful example is the resurgence of religious fundamentalist groups pushing for Creationism relabelled as Intelligent Design to be taught in public schools as an alternative to Darwinian Evolution. Television plays a large role in making Creationism attractive, merely by presenting it, incorrectly, as a viable theory and an alternative to the actual science of evolution. Other examples include the proliferation of alternative medical practices and confusion over the importance of inoculations, the programming of pseudo science shows and stories about the paranormal, UFOs and the myriad of conspiracy theories that currently abound on TV as science fact and also find their way onto newscasts as science.

The feedback loop as to what constitutes science for the layperson with little science understanding, becomes very distorted, and has the potential to supplant legitimate

science in the minds of the public. This has the potential for serious consequences for education and educational levels and can even determine what scientific research is funded.

Another implication is as follows. As adult education becomes more prevalent, what career changes or educational augmentations a person might choose is influenced by what he or she might see represented by TV science programming. What is represented as exciting or lucrative to a lay person might be seen as an attractive career option. Conversely, science careers, presented in a less than favourable light, might be avoided.

In turn, these impressions about science, based on what is seen on television, are also passed on to children, who also form their own opinions about the importance of science in their own education, both from their parents and other adults, and what they see represented in television programming.

As a society, our basic science understanding and education in science is reflected in the media. If the science understanding thresholds become lower, the general levels of science and science education can also be adversely affected. That, in turn can affect the decisions about science education and its role in society.

**6.6 Responsibilities**

Where television represents science well according to both the scientists and broadcaster/producers is when scientists are trained in journalism and the broadcaster has a mandate to provide science. Almost all the interviewees agreed that doing television production as an extension of the peer review process that science consists of in print would make for uninteresting and boring productions. Scientific method, though essential for the process of science to work does not make for compelling television. An understanding and experience with scientific method however appears to be essential in the good production of television science programming.

It appears also to be the case that training journalists in science does not seem to make the same positive impact. There are journalists who have been trained in the sciences and who are successful in print and who can do credible science stories, but it appears that an innate interest in how science works AND interest in television production are necessary. This means at least an undergraduate degree in one of the sciences as well as study in television arts or journalism. Peer review and scientific method appear to be the threshold someone must pass in order to understand the workings of science and this occurs in undergraduate degree science programme level. In order to understand the difference between what is real science and pseudo science, (especially in issues like Climate Change, alternative medicine, intelligent design vs Darwinism, the language of scientists vs the colloquial use) the ability to understand and participate in the scientific peer review process and an understanding of what constitutes scientific method as opposed to directed argument and endless debate is needed.

The representation of science by television is not homogeneous. Television is a vast medium of many different facets and varies enormously from region to region and in quality. It also changes as technology changes and with the advent of computers and the internet is likely to change even more in the coming years. There is science programming that all would agree is good, programming that represents science well and that is respected by scientists and broadcasters. However, "good" science reporting and productions are not in the majority of science programming. News reporting of science from local stations to network news appears to be recognized as the area where science and science issues fare the worst and provide the viewer with a mixed and confusing message at best. The stories are too short, the scientists are stereotyped, with overly short clips and the employment of journalistic "pro" and "con" perspectives skew the science by adding sensationalism and focusing on the scientists rather than the science.

### 6.7 Shortcomings of the Study and Areas for Further Study

The responses to the questions of this study were indicative of my personal experiences in the thirty years I have been in television news, weather, documentary, series and children's production. From language to method of presenting science, to what constitutes scientific method and how science should be portrayed, not only are there many and differing opinions, but the opinions vary not only between groups, but within groups, from individual to individual. Science and how television represents science are two solitudes with a vast chasm between. There is no consensus on what constitutes

science on television. Even among the broadcasters and the producers of science on television, from newscasts to documentaries to series production, the concept of what is science on television and how it should be presented depended on who was producing it and what the needs of the broadcaster were. What is called science on television was a loose concept that was passed on to the viewer and was very much more different than what a scientist would term science. If it suits the needs of the broadcaster, almost any topic can be labelled as science. And in times of financial crisis, as in the current network ratings crisis, science journalism is the first to fall to the axe.

The representation of science by television is not homogeneous. Television is a vast medium of many different facets and varies enormously from region to region and in quality. It also changes as technology changes and with the advent of computers and the internet is likely to change even more in the coming years. There is science programming that all would agree is good, programming that represents science well and that is respected by scientists and broadcasters. However, "good" science reporting and productions are not in the majority of science programming. News reporting of science from local stations to network news appears to be recognized as the area where science and science issues fare the worst and provide the viewer with a mixed and confusing message at best. The stories are too short, the scientists are stereotyped, with overly short clips and the employment of journalistic "pro" and "con" perspectives skew the science by adding sensationalism and focusing on the scientists rather than the science.

More studies are needed given the seriousness of the threats we face as a society and the importance the media has in mitigating the potential fallout.

# Appendix A - Letter of Consent for Interviews


***Faculty of Education***

**Letter of Consent**
**How Does TV Represent Science?**

I agree to participate in the research study entitled *How Does TV Represent Science?* carried out by Richard Zurawski, a Thesis Masters of Education Student at Mount Saint Vincent University, Halifax, under the auspices of Mount Saint Vincent University, for his Master of Education Thesis.

I understand that I will be interviewed and will be asked questions about how I think TV represents science. I understand that this study is seeking to explore how science is represented by TV and the relationship between science and TV.

I agree to allow the researcher to tape record my interview. I understand that I may refuse to answer any questions in the interview and that I may terminate my participation in the interview at any time without penalty. I may do this by indicating orally that I no longer wish to participate.

I have been informed that the researcher will transcribe and verify the content of the audio recordings. These recordings and the transcripts of them will be stored in a secure location for five years.

I understand that this study has been deemed to be of “minimal risk” in that "potential subjects can reasonably be expected to regard the probability and magnitude of possible harms implied by participation to be no greater than those encountered in everyday life." However, because some of the information I may give may be of a somewhat delicate or confidential nature, there is still the potential for emotional and social risk arising from confidential disclosure of personal conflicts, business failures, competition and the like. I understand that at the end of the interview, I will be asked by the researcher if there is anything which I’ve said that I would prefer not be included in the research results, and that if I wish I may also review the interview transcript prior to it being coded in order to remove information which I am not comfortable with at that time.

Halifax Nova Scotia B3M 2J6 Canada
Tel 902 457 6350 • Fax 902 457 2174
www.msvu.ca

I have been informed that the researchers will not report any information that will identify me or that will disclose my participation in any aspect of this study. All information I provide, such as written documents, photographs, web page printouts etc., will be stored in a secure location.

I understand that the data that researchers obtained from my participation in this study may also be reported in professional and scientific publications or conferences related to.

I understand that the interview process will be approximately thirty minutes in length. I understand that there may be a follow up phone call if the interviewer needs further information or clarification on points made during the initial interview. I understand that these subsequent discussions will not be taped, but will still be conducted according to the rules covering the conditions of confidentiality set out above.

If you have any questions about the study, please contact Richard Zurawski at (902) 233-4291 or his supervisor, Professor Andrew Manning at Mount Saint Vincent University at 902-457-6148. If you have questions about how this study is being conducted and wish to speak with someone who is not directly involved in the study, you may contact the Chair of the University Research Ethics Board (UREB) c/o MSVU Research and International Office, at 457-6350 or via e-mail at research@msvu.ca.

Signature of Study Participant: _____

Date: _____

Signature of Interviewer: _____

Date: _____

I agree to allow my interview to be recorded for audio in order that it may be transcribed for research purposes, i.e., coding.

Signature of Study Participant: _____

Date: _____

Halifax Nova Scotia B3M 2J6 Canada
Tel 902 457 6350 • Fax 902 457 2174
www.msvu.ca

# Appendix B - FAQs - Frequently Asked Questions


**Some Frequently Asked Questions About**
**How Does TV Represent Science?**

**1. What is the purpose of this research?**

The purpose of this research is to explore the relationship between TV and science, by asking how TV represents science and looking at the ramifications of that relationship on education, perceptions and science.

**2. Who is conducting this research?**

This study is being conducted by Richard Zurawski, a Thesis Masters of Education student at Mount Saint Vincent University, Halifax Nova Scotia for his Master of Education Thesis. Richard's undergraduate education is in mathematics and physics, he works as a meteorologist for Rogers Radio and is also an independent producer of science programming and writer of science based books on weather, climate change and science.

**3. This is an academic research project…what benefit will it be to me and my organization?**

This study seeks to clarify and understand some of the very complicated relationship between TV with science. TV is arguably our most ubiquitous and powerful medium and science has been responsible for the greatest accumulation of knowledge in human history. Understanding even a small part of the relationship between the two will have benefits to education, communications, science perception and the media. Both scientists and TV producers of science based programming can benefit from understanding how this relationship works.

**4. What will be done with the results of this research? Will I be able to see them?**

The final report of this research will be made available to those who indicate a desire for a copy of the thesis. I will also be posting the final thesis and results on my web site at www.richardzurawski.ca. As well, it is hoped that conference and journal papers will also be generated from the research process and findings. These can be acquired by contacting me at (902) 233-4291.

**5. If I agree to be interviewed, what will the process be?**

If you indicate by e-mail that you are willing to participate, I will contact you to set up a time and place for the interview. Both time and location will be completely at your convenience. The very first thing I will ask you to do when we meet will be to read and sign a *Participant Consent Form*. This form lays out exactly what will happen during the interview, any risks attached, how long the interview will take, the process for it and so on. It also explains what will happen to the information you give me during the interview, as well as how your confidentiality will be ensured. You will be asked to sign two (2) copies of the form, one for your records, and one for mine.

**6. If I sign this form, does that mean I am waiving any rights to control of the interview or the information I give you?**

No. Your signature on the consent form in no way constitutes a waiver of your rights. It simply shows that you were informed about what the research and the interview process will entail, and have agreed to participate on that basis.

**7. If I am uncomfortable with the interview, can I stop?**

Absolutely. If at any point in the interview process, or in fact during the entire research study, you are uncomfortable with what is being asked or how you are being treated, you may either refuse to answer the question(s) or bring a halt to the proceedings. It is up to you to decide whether to allow me to use any information you've given up to that point. If you decide you don't want me to use it, I will shred any written notes, and erase anything on audiotape.

**8. If I have a complaint about the process, who can I speak to?**

The first person to speak to is myself, either in person, or by phone at (902) 233-4291. If I am unable to resolve your concerns to your satisfaction, you may take them to Mount Saint Vincent University's Ethics Review Committee. Although this research has been reviewed and received ethics clearance through this body, they are not directly involved in it, and in fact, are there to ensure that all research done by individuals affiliated in any way with Mount Saint Vincent University is ethical and conducted without harm to the participants. You may reach the Chair of the University Research Ethics Board (UREB) c/o MSVU Research and International Office, at 457-6350 or via e-mail at research@msvu.ca.

**9. How long will the interview take?**

Each interview will be approximately one (1/2) half an hour in duration.

**10. What kinds of questions will you ask me?**

I will be asking you
What are your thoughts about science and TV?
What do you think of the amount of science on TV?
What do you think of the quality of the science on TV?
As TV evolves from being primarily network broadcast to internet on line broadcast, do you think this affects how TV programmes about science are made for TV? Is it different?

Does TV have an effect on educational choices? If so how?
How are scientists portrayed? Positively? Negatively?
Does science, as portrayed on TV, affect how we see science issues such as climate change?
Do you think climate change is anthropogenic, human caused?
Does science on TV represent science the ways scientists represent science? Do you think it should?

**11. How will you record the information I give you during the interview?**

The interview will be taped on analogue audio tape so that I can have it transcribed. If you are uncomfortable with the idea of being taped, then I will just take hand written notes during the course of the interview.

**12. What happens to all of the information after the interview is over?**

Following the interview, the audio tape(s) will be transcribed either by me, or by a professional transcription service. The individual who will be doing the transcribing is a professional transcriptionist, and is bound by the same rules of confidentiality as I am.

**13. How do I know it will be kept confidential?**

Once you have signed the consent form and agreed to do the interview, every precaution will be made to maintain confidentiality and your anonymity (should you wish to be anonymous). To this end, starting with the transcription process and continuing through the data analysis phase, right up to the end of the research process all individuals will only be identified by participant number. The coding key, as well as all transcriptions and tapes will be held in a locked cabinet in my office where the data analysis will be conducted. No individual other than me will have access to the cabinet.

**14. How long will you keep this information?**

The tapes and transcripts will be held for five years following the end of the study, at which point they will either be placed into long-term storage in my office, or if you prefer, they will be destroyed, in the case of paper documents, by shredding, in the case of the tapes, by bulk erasing.

**15. You say that this research is of minimal risk. Are there any risks attached to it that I should be concerned about?**

This is a minimal-risk research project because it deals with a community development organization in which the majority of the information being gathered is to some extent already in the public domain (i.e., matters of historical record). It is fair to say that "potential subjects can reasonably be expected to regard the probability and magnitude of possible harms implied by participation to be no greater than those encountered in everyday life." At the end of the interview, you will be asked if there is anything that you said which you would prefer not be included in the research results. If you like, you may also review the transcript of your interview prior to it being coded in order to remove information which you are not comfortable with. As I mentioned above, every effort will be made to maintain that confidentiality. If there are things you are particularly concerned about, please make sure you identify them to me.

**16. Once the interview is finished, is my part in this research over?**

In general, there will only be one interview for each participant. However, there may be cases when, after looking at the transcripts or other information you have given me, I have further questions. In this instance, I will phone you with any questions I may have. These subsequent discussions will not be taped, but will still be conducted according to the rules covering the conditions of confidentiality I've set out above.

# Bibliography and References


ABC News (2008). *Living in the Shadows: Illiteracy in America*.

Banks, J., & Tankel, D. T. (1990). Science as Fiction: Technology in Prime Time Television. *Critical Studies in Mass Communication, 7*, 24-36.

Bellon, J. (1990). The Strange Discourse of the X-Files: What it is, What it Does and What is at Stake. *Critical Studies in Mass Communication, 16*, 136-154.

Bienvenido, L. (2007). *Science on Television: The Narrative of Scientific Documentary*. Barcelona, Spain: The Pantaneto Press.

Barsky, R. F. (2006). Anarchism, the Chomsky Effect and the Descent from the Ivory Tower. *Critical Studies in Media Communication, 23*(5), 446-452.

Bauder, D. (2009). *Thrilling Giants-Patriots game makes Super Bowl the second most-watched TV show ever*. http://en-us.nielsen.com/

Bouse', D. (1998). Are Wildlife Films Really "Nature Documentaries". *Critical Studies in Mass Communication, 15*, 116-140.

Brahm, G. N. J. (2006). Understanding Noam Chomsky: A Reconsideration. *Critical Studies in Media Communication, 23*(5), 453-461.

Briggs, C. L. (1986). *Learning How to Ask*. Cambridge: Cambridge University Press.

Carragee, K. M. (1990). Interpretive Media Study and Interpretive Social Science. *CSMC (Critical Studies in Media Communication), 7*, 81-96.

CBC. (2006). Canada's Shame. On *The National*.

Charmaz, K. (2006). *Constructing Grounded Theory*. London, U.K.: Sage.

Chomsky, N. (1968). *Language and Mind*. New York: Harcourt Brace Jovanovich.

Chomsky, N. (1988). *Language Politics*. Montreal: Black Rose Books.

Chomsky, N. (2002). *Understanding Power*. New York: The New Press.

Chomsky, N., Herman, E.S. (1988). *Manufacturing Consent, The Political Economy of the Mass Media*. New York: Random House.

Collins, H. M. (1987). Certainty and the Public Understanding of Science: Science on Television. *Social Studies of Science, 17*, 689-713.

Cook, J. (2009). The List of Questions and Pseudo Facts Used by the Anti Climate Change Lobby to Show There is no Human Induced Climate Change. from http://www.skepticalscience.com/argument.php

Dahlmann, G. (2005). Mediarology - The Roles of Citizens, Journalists, and Scientists in Debunking Climate Change Myths - Journalism and Environmental Reporting. On *The Environment Show*. Los Angeles.

Denscombe, M. (1998). *The Good Research Guide*. Buckingham: Open University Press.

Depoe, S. (1997). Environmental Studies in Mass Communication. *CSMC*, 368-372.

Derrida, J. (1972). *Plato's Pharmacy in Dissemination*. London: Athalone Press.

Dillon, J. F., Crifasi, S.C. . (1993). A Multi-Disciplinary Approach to Cultural Learning Through Cable Television. *JACA, 1*, 50-58.

Doran, P., University of Illinois at Chicago. (2009). Scientists Agree Human-induced Global Warming Is Real, Survey Says. *ScienceDaily*.

Dornan, C. (1990). Some Problems In Conceptualizing the Issue of "Science and the Media". *Critical Studies in Mass Communication, 7*, 48-71.

Drew, D. G., & Reese, S. D. (1980). Childrens' Learning from a Television Newscast. *Journalism Quarterly*, 83-88.

Durham, F. (2006). Exposed by Katrina: The Gulf between the President and the Press. *CSMC, 23*(1), 81-84.

Elliott, W. R., & Rosenberg, W. L. (1987). Media exposure and beliefs about science and technology. *Communication Research, 14*, 164-188.

Eveland, W.P. & Mihye Seo Krisztina, Marton School of Journalism & Communication Ohio State University (2002). *Learning From the News in Campaign 2000: An Experimental Comparison of TV News, Newspapers, and Online News*. Mediapsychology 4, 355–380.

Furisch, E., & EP, L. (1996). Science Journalism Under Scrutiny: A textual Analysis of "Science Times". *Critical Studies in Mass Communication, 13*, 24-43.

Gardner, C. (1978), 'Blinding with Science', *Time Out*, 20-26 October 1978.

Gardner, C. (ed.) (1979), Media, Politics and Culture: A Socialist View, London: Macmillan.

Gardner, C., & Young, R. M. (1981). Science on Television: A Critique. *Popular Television and Film. BFI Publishing*, 171-193.

Gavin, N., University of Liverpool (2009). Climate Change Is Not Taken Seriously Because Media Is Not Highlighting Its Significance. *ScienceDaily*.

Gee, J. P. (2007). *What Video Games Have to Teach Us About Learning and Literacy*. New York: Palgrave MacMillan.

Gitlin, T. (2002). *Media Unlimited*. New York: Holt.

Glaser, B., & Strauss, A. (1967). *The Discovery of Grounded Theory*. Chicago: Aldine.

Hannaford, N. (2009, July 25). Why people are cool to global warming. *Calgary Herald*.

Hedges, C. (2009). *Empire of Illusion: The End of Literacy and the Triumph of Spectacle by Chris Hedges*. New York: Nation Books.

Hornig, S. (1990). Television's NOVA and the Construction of Scientifc Truth. *Critical Studies in Mass Communication, 7*, 11-23.

Hwang, Y., & Southwell, B., G., University of Minnesota. (2008). *Science TV News Exp [osure predicts Science Beliefs*. Paper presented at the International Communication Association.

Jarvie, I. C. (1990). Media Representations and Philosophical Representations of Science. *Critical Studies in mass Communications, 7*, 72-79.

Jones, G., Connell, I, Meadows, J. (1977), The Presentation of Science by the Media, University of Leicester Primary Communications Research Centre.

Koolstra, C. M., Bos, M. J. W., & Vermeulen, I. E. (2006). Through which medium should science information professionals communicate with the public: television or the internet? *Journal of Science Communication, 5*(3), 1-8.
Krugman, H., & Hartley, E. L. (1969). *Passive Learning from Television*. Paper presented at the World Association for Public Opinion Research.

Kunkel, D., The University of Arizona. (2008). Educationally/Insufficient? An Analysis of the Educational Quality & Availability of Children's E/I Programming. *ScienceDaily*

Lafollette, M. (2002). A Survey of Science Content in U.S. Television Broadcasting, 1940s through 1950s: The Exploratory Years. *Science Communication, 24*(1), 34-71.

Lakoff, G. (2008). *The Political Mind*. New York: Viking.

Lankshear, C., & Knobel, M. (1968). *Handbook for Teacher Research*. New York: Open Unoiversity Press.

Latour, B. and Woolgar, S. (1979), Laboratory Life: The Social Construction of Scientific Facts, New York: Russell Sage.

León, B. (2008). Science related information in European Television: a study of prime-time news. Public Understanding of Science(17), 443-460.

Lessl, T. M. (1985). Science and the Sacred Cosmos: The Ideologival Rhetoric of Carl Sagan. *Quarterly Journal of Speech, 71*, 175-187.

Lievrouw, L. A. (1990). Communication and the Social representation of Scientific Knowledge. *Critical Studies in Mass Communication, 7*(1), 1-10.

Logan, R. (2001). Science Communication. *Critical Studies in Mass Communication, 23* (2), 135-163.

London: Fontana. Dunn, R. G. (1979), Science, Technology and Bureaucratic Domination: Television and the Ideology of Scientism', *Media, Culture and Society,* no. 1.

Lule, J. (2005). AIDS and the News Media: 1980-2005. *Critical Studies in Media Communication, 22*(3), 256-257.

Mares, M. L., Cantor, J., Steinbach, J. . (1999). Using television to foster children's interest in science. *Science Communication, 20*, 283-297.

McLuhan, M. (1962). *The Gutenberg Galaxy: The Making of Typographic Man*. Toronto, Canada: University of Toronto Press.

McLuhan, M. (1964). *Understanding Media*. New York: McGraw-Hill.

Meehan, E. R. (2006). Hurricane katrina and Bush's Vacation: Contexts for Decoding. *CSMC, 23*(1), 85-90.

Miller, J. D., Michigan State University, Schulhof, J., ScienCentral, New York, , & Kimmel, L. G., (2006). Adult Science Learning from Local Television Newscasts. *Science Communication, 28 Number 2*, 216-242.

Miller, J. D., Northern Illinois University, (1998). The measurement of civic scientific literacy. *Public Understanding of Sciences Vol. 7, No. 3*,, 203-223.

Mooney, C. (2009). *Unscientific America*. Philadelphia: Basic Books.

Morrison, I. (2009). Friends of Science. from www.friends.ca/news-item/1312

Myerson, G., & Rydin, Y. (1997). The Future of Environmental Rhetoric. *CSMC*, 376-379.

National Institute for Literacy (2007). *Adult Literacy in the United States*: National Institute for Literacy, National Center for Adult Literacy, The Literacy Company, U.S. Census Bureau.

Newton, I. (1687). Philosophiae Naturalis Principia Mathematical Rules of Reasoning in Philosophy.

Nordcity Group Ltd. (2007). *Analysis of Corporate Consolidation in the Canadian Media Sector* Canadian Film and Television Production Association.

Olson, R. (2009). *Don't Be Such a Scientist*. Washington: Island Press.

Palfreman, J. (2002). Bringing Science to a Television Audience. *Science Journalism, Fall*, 32-34.

Pierce, C. (2009). *Idiot America*. New York: Doubleday

Perlmutter, D. D. (2006). Katrina: Too Close to Home. *CSMC, 23*(1), 78-80.

Ralling, C. (1980), 'What Is Television Doing to History?', *Listener,* 10 January 1980.

Realclimate.org. (2009). Heritage Foundation. from www.realclimate.org

Richards, L., & Morse, J. M. (2007). *User's Guide to Qualitative Interviewing*. Thousand Oaks: Sage.

Robinson, J. P., & Levy, M. R. (1986). *The Main Source: Learning from Television News*. Beverly Hills, CA: Sage.

Rubin, J. R., & Rubin, I. S. (2005). *Qualitative Interviewing*. Thousand Oaks: Sage.

Scott, K. D. (2001). Popularizing Science and Nature programming. *JPF&T Journal of Popular Film and Television*, 29-35.

Shermer, M. (2009). I Want to Believe. *Scientific American, July*.

Sokal, A. (1994-11-28, revised 1995-05-13, 1996). Transgressing the Boundaries: Towards a Transformative Hermeneutics of Quantum Gravity. *Duke University Press, . Social Text* (46/47), 217-252.

Southwell, B. G., Blake, S. H., & Torres, A. (2004). Lesson on Focus Group Methodology from a Science Television News project. *Tecnical Communication, 52*(2), 187-193.

Southwell, B. G., & Torres, A. (2006). Connecting Interpersonal and Mass Communication: Science News Exposure, Perceived Ability to Understand Science, and Conversation *Communication Monographs, 73*, 334-350.

Thorson, E. University of Missouri-Columbia (2009). Traditional Media Provide More Comprehensive News Than Citizen Media And Blogs. *ScienceDaily*

Unknown Author, Irish Saying. (17th Century).

Weaver, A. (2007). Intergovernmental Panel on Climate Change (IPCC). from http://www.ipcc.ch/

Weigold, M. F., University of Florida. (2001). Communicating Science - A Review of the Literature. *Science Communication, 23*(2), 164-193.

Weigold, M. F., Treise, Debbie. (2002). Advancing Science Communication - A Survey of Science Communicators - *University of Florida Science Communication, 23*, 310-322.

Wikipedia. (2009). Television Statistiocs. from www.wikipedia.org

Wikipedia. (2009). Scientific Method. from www.wikipedia.org

Wilcox, S. A. (2003). Cultural Context and the Conventions of Science Journalism: Drama and Contradiction in Media Coverage of Biological Ideas About Sexuality. *Critical Studies in Media Communication, 20*(3), 225-247.

Wilde, O. (1854-1900). Quotation.

Willems, J., & Goepfert, W. (2007). Science and the Power of TV. *Journal of Science Communication, 6*.

Wilson, K. (2008). Television Weathercasters as Potentially Prominent Science Communicators. *Public Understanding of Science DOI, 17*, 73-87.

Wolfe, M. (2007). *Proust and the Squid*. New York: HarperCollins.

Woolgar, S. (1988). *Science the Very Idea*. London: Ellis Horwood.

Young, R. (1979b), 'Science as Culture', *Quarto,* December 1979.

Zurawski, R. (2009). Interview with Scientist Richard Wassersug. Halifax.

Zurawski, R. (2009). Thesis Interviews. Halifax.

http://people-press.org/. (2004). Local Television News. from Local Television News

http://en-us.nielsen.com/. (2004-2009). from http://en-us.nielsen.com/

http://www.csun.edu/science/health/docs/tv&health.html. (2004-2009). Television Free America. from http://www.csun.edu/science/health/docs/tv&health.html

http://www.suite101.com/article.cfm/student_journalism/18661. (1999). from http://www.suite101.com/article.cfm/student_journalism/18661

http://www.cjr.org/the_observatory/. (2008).