



Probable Impossibilities:
Using Science Fiction to Communicate Science

by **Brian Macken BSc.**

Supervisor: Dr. Paschal Preston
Department of Communications
Dublin City University
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Abstract

This dissertation examines the different kinds of science fiction, and how they can be used to communicate both the mechanics of science and the issues surrounding it. A survey was also carried out of Irish science fiction fans, to determine if there is any relationship between having an interest in science fiction and expressing an interest in science. Another survey was carried out on crime fiction fans to serve as a benchmark.

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Chapter 1

Introduction

“The poet should prefer probable impossibilities to improbable possibilities.”

- Aristotle, *The Poetics*

From the early days of Jules Verne’s *20,000 Leagues Under The Sea*, with the enigmatic Captain Nemo and his ruminations on power and technology, science fiction has always been a mirror on which science has been reflected. But this mirror is, by dramatic necessity, a funhouse mirror, which exaggerates and distorts as science is stretched in potentially ridiculous ways. It is this distortion which has led to science fiction’s bad reputation amongst scientists and led them to dismiss it, as one scientist famously put it, as “just that Buck Rogers stuff”. Many believe that science fiction is therefore not only useless, but actually an inhibition to communicating science. The fact that the actual science in science fiction is sometimes stretched, “fudged” or just plain wrong, leads many to think that audiences and readers are believing incorrect “facts” because they are being presented them as scientific truth (Bradley 2001).

And there might be a lot of truth in that. For many people, their only encounter - certainly their most dramatic encounter - with science is through science fiction, be it in novels, movies or television. Can anyone be blamed for believing the big lies that science fiction tells, if all the little details are correct (for example, the books of Alastair Reynolds, which take into account the time dilation effects predicted by relativity but allow faster than light travel)?

However, as much as it can be said that ‘science’ is in science fiction’s brief (as evidenced by the name) it must also be pointed out that so is fiction. As Crichton (1999) argues, many of the scientific inaccuracies apparent in science fiction are there purely as a means to tell a story. “Hard” science

fiction tries to minimise this ‘cheating’, but even the masters of this sub-genre admit that it is sometimes necessary in order to tell the story which they want to tell. Even H.G. Wells stated that he allowed himself “only” one impossibility per story.

This dissertation argues that if scientific principles are fudged in order for there to be faster than light travel, sentient computers, teleportation, holodecks, black-hole weapons or peril-sensitive sunglasses it does not detract from science fiction’s ability to be useful in communicating science to the public. It is in fact *because* of the willingness to distort certain scientific facts that science fiction is of use.

To do this, chapter 2 attempts to define what science fiction is, and then reviews published literature which investigates the various aspects of the relationship between science and science fiction, and how the latter can shed light on the former.

If science fiction has no value to learning science, then there should be no above-average interest in science within the science fiction fans. However, if it can be shown that there is a link between having an interest in science and an interest in science fiction, then this would be an indication that there is some common thread between the two which effective science communication could be built upon. In order to show whether an interest in science and an interest in science fiction are mutually exclusive, a questionnaire was developed and distributed at a science fiction convention which took place in Dublin. In order to provide a comparison for the results from this questionnaire, a similar questionnaire was distributed to the attendees at a crime fiction convention which took place in Bristol in England. Chapters 3 and 4 detail the methods and results of this study.

Chapter 5 discusses the results of the study and literature review to arrive at a conclusion, and chapter 6 describes the limitations of the study and further work which could be done on the topic.

Science fiction has a very bad reputation, but this dissertation sets out to demonstrate that “Buck Rogers stuff” helps far more than it hinders the goal of a public understanding of science.

Chapter 2

Literature Review

“We hope it will not be long before we may have other works of Science-Fiction [like Richard Henry Horne’s “The Poor Artist”], as we believe such books likely to fulfill a good purpose, and create an interest, where, unhappily, science alone might fail.

[Thomas] Campbell says, that “Fiction in Poetry is not the reverse of truth, but her soft and enchanting resemblance”. Now this applies especially to Science-Fiction, in which the revealed truths of Science may be given, interwoven with a pleasing story which may itself be poetical and true – thus circulating a knowledge of the Poetry of Science, clothed in a garb of the Poetry of Life.”

- William Wilson, *A Little Earnest Book upon a Great Old Subject* (1851) [First use of the term “science fiction”]

2.1 Defining Science Fiction

To discuss science fiction, we have to first be clear on what it is we are referring to. It’s origins are hazy, and veer wildly depending on how you define it. Certainly the earliest writer to popularise it as a genre was Jules Verne, who became the first (and indeed last) science fiction writer to be blessed by the pope for doing so. Verne excelled at the fantastic voyage (“voyages extraordinaires”) style of novels, writing over a hundred of this type. His novels always showed an awe at the natural world along with a deep admiration for engineering. This dual interest in the fantastic and the scientific often led Verne to go one step beyond any of his contemporaries and strive for as much accuracy as possible in his fantastic voyages, “[Verne] invented the expansive sense in fantastic literature, but he did it by dreaming exactly”

(Benford 2005). It is true that there were novels published before Verne which could be considered science fiction (Mary Shelley's *Frankenstein: The Modern Prometheus* was published in 1818, forty-five years before Verne's first) but Verne was the first to make the form of science fiction internationally popular, becoming the second most translated novelist after Agatha Christie (UNESCO 2006). His interest in science came to characterise the genre.

Science fiction in its modern form was born out of the pulp magazines which originated in the 1920s. The first of these, *Amazing Stories*, appeared in 1926 and its first issues contained stories from Verne, Wells and Poe. These were the stories which Hugo Gernsback, the editor, held up as examples of the type of fiction which he wanted to publish - tales of the fantastic where science and engineering play an important part, or as he put it, "charming romance intermingled with scientific fact and prophetic vision" (Gernsback 1926). The next of what were eventually termed "science fiction magazines" to follow *Amazing Stories* had a title which explicitly stated this editorial aspiration: *Astounding Tales of Super-Science*. Harry Bates, the editor of *Super-Science*, here mentions the troubles which they had in deciding upon a name

My preference [for the title] was 'Science Fiction', which was generic and like the other magazine ['Tomorrow'] had dignity, but I killed this one with arguments that as a phrase hardly anyone had ever seen or heard it...and that as a name it would promise only mild and orthodox stories concerned with today's science...the magazine could easily die of lack of readers. (Rogers 1964)

We can see from this quote that extrapolating *away* from current science was always important, but the titles suggest an equal importance on making sure that it was *current* science which was used as a starting point.

It is not until the late thirties and early forties that the term "science fiction" regularly begins to appear with titles such as *Astounding Science Fiction*, *Future Combined with Science Fiction* and *Science Fiction Quarterly*.

Ever since then, people have been struggling to formulate a universally satisfactory definition for science fiction. Some claim that science fiction is a sub-genre of fantasy (Aldiss 1975), while others argue that the majority of science fiction is "realistic" and therefore the complete opposite of fantasy (Heinlein 1969). The closest definition that the majority of people seem to agree upon is by Suvin (1979), where he defines science fiction as "a literary genre whose necessary and sufficient conditions are the presence and

interaction of estrangement and cognition, and whose main formal device is an imaginative framework alternative to the author's empirical environment".

What this means is that a science fiction writer creates a world ("imaginative framework") which differs from ours in some way to create a sense of estrangement in the reader. A sense of estrangement means creating something separate from what the reader is familiar with. Estrangement is vital in a text as "it creates that disruption which forces the reader temporarily out of an involvement in the text (during which she or he is not able to reflect on what is being read) and forces him or her to grapple actively with the material in order to evaluate it" (Spencer 1983). But estrangement is not something which is unique to science fiction, as all writers use it to some extent. It is, however, the way in which the estrangement is achieved that is unique to science fiction.

Science fiction's estrangement comes from what Suvin coined as the "novum" of the text. The novum is that element of the story which separates the fictional world from the real world. Usually this difference is an extrapolation away from our world in some imagined direction, i.e., Dick's *The Man in the High Castle* hypothesises that the Axis won World War Two; Huxley's *Brave New World* hypothesises that reproduction is only done through cloning and everyone is conditioned from birth for their roles in life; Scott Card's *Ender's Game* hypothesises there is an immanent alien invasion which prompts the military to train children from a young age to be generals.

Once this novum is established in a text, the science fiction writer then logically follows the implications of this novelty, be they social, ethical or physical, to create the new world in which the story takes place. This is where the cognition in Suvin's definition of science fiction becomes important, because as Spencer (1983) explains "in the first place, the world of the text must stand in some kind of cognitively discoverable relation to our own empirical situation. The writer should not present us with some mysterious self-contained world which simply exists somewhere without explanation". Or as Delany (1975) succinctly puts it, "not only does SF throw us worlds away, it specifies how we got there". Unlike in other genres, the estrangement in science fiction comes first from creating a novum, and then providing a scientific kind of explanation of how it came to be.

So, Spencer (1983) argues, the way in which science fiction introduces a novum is what makes it "unrealistic", as a novum by definition is something which is not present in our reality. It is, however, the way in which this imagined world is still governed by a set of natural laws that it is "realistic".

It is in this way that science fiction becomes scientific, and so of interest to those who communicate science.

2.2 Disassembling Science Fiction

According to Bainbridge & Dalziel (1978) there are three different kinds of science fiction novel:

- “Hard” science fiction (e.g., Asimov, Niven, Campbell and Heinlein)
- “New-Wave” science fiction (e.g., Delany, Zelazny, LeGuin and Ellison)
- “Science Fantasy” (e.g., Burroughs, Leiber and McCaffrey)

Each type has its own standards and norms which appeal to different types of readers and authors for different reasons. Each type is worth examining on its own merits.

2.2.1 Hard Science Fiction

Hard science fiction is defined by Bainbridge & Dalziel (1978) as “[referring] to stories built around certain facts or speculations concerning the ‘exact’ or ‘hard’ sciences, and is usually optimistic about the value of scientific and technological progress”. Isaac Asimov (one of the giants of this kind of science fiction) wrote, “by hard science fiction, I mean those stories in which the details of science play an important role and in which the author is accurate about those details, too, and takes the trouble to explain them” (Asimov 1973).

Authors of this kind of book try to minimise violations of physical laws in their fiction. According to Westfahl (1993), there are four different ways this can be achieved.

The first is simply to use jargon - the author invents a device which takes care of some scientific inconvenience. For example, to get around the problem of there being no gravity in a spaceship, the author simply invents a “gravity generator” and then the characters can walk freely and have adventures without any violation of natural law. “The mood is that of rationalisation; even if the reader observes an apparent change in the laws of the world - both the protagonist and the reader know that it is not a breach of the laws themselves, but the acquisition of a better knowledge about them” (Zgorzelski 1979).

However, most hard science fiction writers consider this “cheating” (Samuelson 1993), and one writer (Hal Clements) even goes as far as to say that “gobbledygook SF furnishes ammunition to intellectual snobs who can’t admit that science fiction is a legitimate branch of the storyteller’s art” (quoted in Westfahl, 1993). So despite its obvious advantages, this method of avoiding scientific errors is strongly frowned upon by those who consider themselves to be hard science fiction writers.

The second way is to speculate in areas where little research has been done, or little is known. As Hal Clements explained about his book *Mission of Gravity*, “I don’t have to describe the life processes [of the aliens] in rigorous detail. Anyone who wants me to will have to wait until someone can do the same with our own life form” (quoted in Westfahl, 1993). The advantage to this approach is that you cannot be corrected, as your speculations may very well be the truth.

The third way is to, as Westfahl puts it, “play it safe” and base the story in the near future with technology which is currently planned or plausible to be developed soon. Westfahl calls this “microcosmic hard science fiction” as it “[involves] small steps into the future to predict small advances”.

The final way to avoid making scientific errors is by creating the most spectacular environment possible while adhering to all known scientific facts. This is, obviously, the most challenging of the four paths open to the hard science fiction author. Westfahl calls this “world-building” or “macrocosmic hard science fiction”. A popular example of this kind is Niven’s *Ringworld* books. These take place on a huge, doughnut shaped artificial world which spins in order to create gravity. These books, and books like them, are meticulous in assuring that the invented worlds act as they would if they were real, “writers accumulate and absorb all scientific information and based on that data carefully develop a detailed picture of the imagined environment, using equations when possible or informed guesswork” (Westfahl 1993).

So while macrocosmic science fiction builds elaborate worlds from scratch, microcosmic science fiction just takes our world one small step into the future. However, according to Westfahl’s analysis, although macrocosmic hard science fiction is the most challenging and requires a more complete grasp of science, in order for a writer to be considered a hard science fiction writer they must be able to write *microcosmic* hard science fiction, “one shows membership to the tribe by writing realistic, near-future space adventures, or by including such projections as part of a more extravagant stories of constructed worlds” (Westfahl 1993).

Westfahl does make the further point that no matter which form is chosen, macro- or microcosmic, what unites the two is an obsession with complete accuracy. This standard is held by both the authors and the fans, and so a story which does not completely work out the scientific concepts, or relies too heavily on gobbledygook, will not be considered by critics or fans as hard science fiction.

Bridgstock (1983) considers exactly why hard science fiction appeals to those who are fans of the sub-genre. He suggests that most readers choose to read for relaxation, and so pick books which do not conflict with the way they see the world and the assumptions they make about it. So when someone

chooses to read science fiction, it is serving a “maintenance function” for the reader, that is it “does not instruct, but reinforces existing ideas and assumptions” (Bridgstock 1983).

Bridgstock uses Liam Hudson’s theory of human personality, where the way people deal with uncertainties in life can be described as a spectrum with “convergence” type people at one end, and “divergence” people at the other. Convergences are people who are very scientifically inclined, and who choose to deal with the uncertainties in life by trying to deal with them rationally and logically. Divergences generally specialise in the arts and humanities and are at ease with a world which is irrational. Neither way is a “better” way to deal with the world, each are just different methods.

Bridgstock argues that hard science fiction appeals to convergers because it serves a maintenance function for them, “[in hard science fiction] order may defeat disorder through use of reason. This not only reassures the converger of the ultimate triumph of order over chaos: it legitimises the thought-processes he regards as appropriate” (Bridgstock 1983).

A perfect example of this can be found in the John Wyndham (1981) short story *Invisible Monster*. In it, a shuttle is sent out to Venus, but never returns. When it crash lands on Earth months later, it is discovered (via the horrific deaths of many people) that the remains of the ship contain an invisible monster. The monster is plant-like in that it is immobile, but as it feeds it grows at an enormous rate. As the monster continues to grow out of the ship, one of the survivors of the original group who found it insists that biologists be called to try and understand the threat. By now the military have been convinced of its existence, and opt instead to blow it up. When the monster is tricked into eating explosives, the resulting explosion only serves to spread tiny chunks of the monster around the forest, each part alive and able to eat and grow. As our protagonist tries to escape the forest he discovers that he is being slowly surrounded as smaller parts grow and aggregate into a larger circle around him. It is then that science *literally* saunters on screen to save the day. A biologist walks casually through the forest, killing each monster by making it ingest a dye at the end of a stick. The dye then allows the biologist to see each monster’s “heart”, which he then simply pierces with a sharpened pointer and saves our protagonist.

While not strictly hard science fiction, this kind of story reaffirms what the converger already believes - the superiority of rational thought and science. If we recall Bainbridge’s definition of hard science fiction as “[referring] to stories built around certain facts or speculations concerning the ‘exact’ or ‘hard’ sciences, and *is usually optimistic about the value of scientific and technological progress*” (Bainbridge & Dalziel 1978) (emphasis added) we can see how hard science fiction also reaffirms these same beliefs, and so

serves the all-important maintenance function for the converger. This is, according to Bridgstock, one of the most appealing aspects to the readers of hard science fiction (Bridgstock 1983).

2.2.2 New-Wave Science Fiction

“New-wave” science fiction is no longer “new”, but the phrase is still used descriptively when referring to the next type of science fiction. Bainbridge & Dalziel (1978) point out that a strict definition for new-wave is hard to find, but they sketch its boundaries as “avant-garde fiction which experiments with new styles, fiction concerned with harmful effects of scientific progress, utopian political novels and essays, and fiction which deeply probes personal relationships and feelings”. In this type of science fiction, adherence with the known laws of science is not seen as important as in hard science fiction.

One of the most famous of the new-wave authors, Ursula K. LeGuin, spoke about how she viewed science fiction in the introduction to her novel *The Left Hand of Darkness* (LeGuin 1976). LeGuin makes the case that science fiction is not merely an extrapolative exercise, but is used to investigate and probe how the world is *today*, or as she says, “Science fiction is not predictive; it is descriptive” (LeGuin 1976).

LeGuin describes how novelists work by first of all, “telling lies”. LeGuin’s argument is that since these “elaborately circumstantial lies”, or fiction novels, never actually happened they are actually just metaphors for examining who we are and the issues which we face.

Yes, indeed the people [in *The Left Hand of Darkness*] are androgynous, but that doesn’t mean that I’m predicting that in a millennium or so we will all be androgynous, or announcing that I think we damned well ought to be androgynous. I’m merely observing, in the peculiar, devious, and thought-experimental manner proper to science fiction, that if you look at us at certain odd times of the day in certain weathers, we already are. (LeGuin 1976)

Science fiction is unique, she says, because the metaphors which are used are drawn from elements in our contemporary world, such as science and technology, “Space travel is one of these metaphors; so is an alternative society, an alternative biology; the future is another. The future, in fiction, is a metaphor” (LeGuin 1976).

So it is not important, in this style of science fiction, that a convincing prediction about the future is made, or even that the science in the text be totally correct. What matters is what the story, acting as a metaphor,

is telling us about our lives as they are today. The fact that this is done by lying to us about imagined people and places is immaterial, “I am an artist and therefore a liar. Distrust everything I say. I am telling the truth” (LeGuin 1976).

This investigation into the ‘inner-space’ of who we are is a strong draw to new-wave science fiction. Bridgstock (1983) tentatively suggests that new-wave provides a maintenance function for the “diverger” type of person, “Divergers...may be drawn to a literature that explores inner space and makes sense of it. In contrast to the converger, who disregards, defeats, or explains away the inner world, the diverger is fascinated by it, and seeks to explore it symbolically” (Bridgstock 1983).

2.2.3 Science Fantasy

Science fantasy is a difficult sub-genre to define. It is described by Gary Wolfe (quoted in Malmgren, 1988) as a genre “in which devices of fantasy are employed in a ‘science-fictional’ context”. By “fantasy”, what is being referred to is the literary genre typified by the likes of *The Lord of the Rings*, where the stories take place in a world where magic and myth are part of everyday existence. Another definition by David Allen (again quoted in Malmgren, 1988) is, “Under [the science fantasy] heading would go those stories which, assuming an orderly universe with regular and discoverable natural laws, propose that the natural laws are different from those we derive from our current sciences”. Science fantasy is seen to be a middle-ground between science fiction and fantasy, using elements of both.

One of the most important and defining aspects of science fiction is a scientific epistemology. Most science fiction believes in science as the basis for knowledge, whereas in fantasy any kind of magical character or event can happen without any kind of scientific rationale. The science fantasy novel sits astride these two differing value-systems. A typical science fantasy novel (if there is such a thing) is based in a science-fictional world - one in which science is the basis for knowledge. However there may be one or more fantastic elements which contradict the laws of science. For example, in the *Dragonriders of Pern* series of novels, the author, Anne McCaffrey, has populated a feudal world with dragons which fly and breathe fire. However, these dragons are given a scientific rationale as their fire-breathing and flight are not magical events, but biological and physical ones. The dragons in the *Pern* series do have psychic abilities which allow them to communicate to their “riders”, and this is never rationalised, lending weight to the fantasy element in the story.

Malmgren (1988) suggests that “the scientific discourse of science fan-

tasy serves to validate the counter-scientific element, convincing us of its validity”, so the psychic abilities of the dragons in *Pern* are made more convincing, and more real, by the fact that the world is based on a scientific rationale, despite the fact that in real life ‘psychics’ of any sort have never been proven genuine, or even possible.

Malmgren also describes the ideas of science fantasy as a furtherance of Suvin’s idea of a novum. He suggests that the science fiction ‘landscape’ of far-off planets and spaceships are no longer novum in and of themselves, as these aspects have now been relegated to background and serve only as tools to introduce the “foreground” novum of the text. For example when a spaceship is used to visit a strange alien race, the ship that can go faster than the speed of light, which in other novels would be the novum, is used only as a device to investigate the primary novum, the aliens. Science fantasy, Malmgren asserts, is that kind of fiction where the background novum are all science fictional, but the foreground one is fantastical “a science fantasy...must have as its dominant novum an entity or motif which explicitly violates standards of scientific possibility or empirical fact” (Malmgren 1988).

This tension between the rational and fantastic elements in a science fantasy story can also be used to interrogate the tension between the two, or to put it another way, examine the tension between the converger and diverger points of views.

Malmgren cites the perfect example of this in Fritz Leiber’s *The Conjure Wife*. The protagonist is a professor of ethnology, and expert in feminine psychology in relation to magic, and he firmly believes in science and the scientific method. When he discovers that his wife has been practising “magic” in order to help him in his career he convinces her to stop. Then, of course, his career suffers a number of serious setbacks, and even his private life begins to suffer terribly. But, although the thought occurs to him that it his sudden turnabout in fortunes is due to his wife ceasing her magic, he dismisses the idea. However, he then discovers that a trio of women are actively using magic to try and destroy him and his wife. He initially refuses to believe he is dealing with actual witchcraft, instead believing the three women to be merely hysterical and suggestible. But the situation escalates until he is fighting the women to save his wife’s soul, eventually admitting that it is all, in fact, real and he goes on to use science with a magic spell to create a “super-spell” with which he defeats the three women. After the encounter, he determines to master this new (to him) art of magic, and put it on a scientific footing. By the end, magic has been “naturalised...into a ‘soft’ science (like psychology)...and the scientific paradigm is modified so as to make room for magic” (Malmgren 1988).

Throughout *The Conjure Wife*, Leiber asks questions about how we know

what we know, and how we define what “valid” knowledge is, and so raises questions of epistemology, and even the scientific method and point of view.

2.3 Science Fiction as Cautionary Tales

Science fiction has a long history of telling cautionary tales about science. It is, in fact, the perfect vehicle for it, as today’s concerns can be converted into a novum and the boundaries of the problem investigated.

2.3.1 Early Science Fiction

Back (1995) discusses two of the most pervasive cautionary tales in science fiction - Mary Shelley’s *Frankenstein* and Aldous Huxley’s *Brave New World*.

In *Frankenstein*, Shelley uses the image of the monster to investigate the boundaries of science. The story is so famous that it hardly needs recounting here, and thus also proves its value as a myth worth investigating. When Victor Frankenstein creates his monster he goes outside the limitations which society has put on science, by researching how to become God-like and create life. However, in Frankenstein’s unrelenting attempt to expand the boundaries of science he ignores his social obligation to his creation, “the creation of a new kind of organism puts the burden on its creator to design also a new kind of community or at least satisfactory relationships for his creation” (Back 1995).

In failing to take into account the social effects of the creation of a new kind of life, and only caring about the pursuit of knowledge, Frankenstein brings about his own destruction. This serves as a caution to us to examine whether science should have no limitations, and to ensure that the potential effects on society are always considered. Frankenstein’s monster so becomes the embodiment of the fear of technology experienced by a world going through the industrial revolution, “Frankenstein’s failure is the payment for stepping beyond the human boundary and extending human ingenuity beyond its natural limits. This represents the dilemma at the beginning of the industrial revolution” (Back 1995).

In *Brave New World*, Huxley presents us with a possible future where reproduction is done through artificial means on a production line, and each person’s personality is pre-chosen and conditioned from birth to fit a particular social role. Personal ambitions and privacy are a thing of the past, with each person conditioned to find their life and society perfect. “The terror of the story does not rely on the transgression of one man. On the contrary, it

arises from the fact that nobody in the story is particularly upset about any of the discoveries and inventions” (Back 1995).

This highlights the fear that the march of science, if unchecked, could lead to us losing our privacy, sense of self, and autonomy. In *Brave New World* this fear becomes the novum of the text, thus allowing the extent of the fear to be examined and experienced.

These early examples construct cautionary tales about scientific progress and it is perhaps the universal nature of the fears and issues brought up by these texts, the Promethean fear of the cost of knowledge and the fear of losing our identity, that gives these texts the longevity which they have enjoyed. The allegories may have changed focus, so Frankenstein’s monster may no longer be a fear of industrial technology but a fear of genetic manipulation, but the worry is still the same, making these texts as relevant today as they were when first published.

2.3.2 Nuclear-Era Science Fiction

Dowling (1986) examines how the atomic scientist is portrayed in science fiction in the years before and after the Hiroshima explosion in 1945. Much science fiction in this era, understandably, focused on the potential effects of nuclear power and weapons.

With its scientific allegiance, much of the science fiction “with its traditional narrative focus on the solitary scientist (rather than the research team), generally presents the atomic scientist as a beneficent Prometheus” (Dowling 1986). Dowling presents the example of the story *Deadline* by Cleve Cartmill (published in 1944), where the hero steals a nuclear bomb from the enemy and then disassembles and throws the bomb from an airplane, in order that even his own government do not get access to the technology (this particular story is also famous for earning the offices of *Astounding Science Fiction* a raid by the American military, because of the closeness of the description of nuclear fission in the story to reality). Thus, we were saved from the dangers inherent in the creation of a nuclear bomb.

Similarly, in Theodore Sturgeon’s 1946 story *Memorial*, an American scientist discovers a method to completely annihilate atomic mass, rather than partial annihilation in the fission of uranium. He believes that by setting off this vastly more powerful weapon, the resulting radioactive pit from the test detonation will serve as an eternal warning to world governments about nuclear arms. However, there is a betrayal and the bomb is accidentally detonated. The explosion convinces the United States that it is under attack and the ensuing retaliatory strikes wipes out all life on earth. The scientist’s good intentions in preventing a nuclear war leads to one; the cost of trying to

discover that-which-man-was-not-meant-to-know. This is clearly reminiscent of the boundaries of science theme seen in *Frankenstein*.

Another example used by Dowling worth mentioning is F.H. Rose's 1948 novel *The Maniac's Dream*. In it, a Kurtzian madman uses slave labour in the African jungle to create the ultimate nuclear weapon so that he can terrorise the world. The book satirises both the 'mad-scientist' image and the idea held by the post-war scientific community that knowledge about how to build nuclear weapons could be contained, "by dramatising the dangers of terrorism, it therefore looks both inward, at the faulty machine of the scientist, and outward, at the faulty morality of the world at large" (Dowling 1986).

Dowling asserts that "stories such as these posed the problems of the nuclear age in a simple, direct way, exonerating the atomic scientist at the same time as they implicated him in the global responsibility of nuclear management". But while science fiction was sympathetic to the scientist, it was largely suspicious of politicians and politics as a process, as Berger (1976) explains.

After Hiroshima, very few science fiction writers thought that a nuclear war was avoidable. Much of the fiction revolved on how to defend against attacks or how the inevitable end would happen, "they had seen the situation primarily as an insoluble technical one, how to defend against an irresistible weapon, rather than as the essentially political problem faced by Congress and the atomic scientists, the maintenance of peace" (Berger 1976).

This distrust in the political process could be seen in stories like Poul Anderson's 1950 story *The Perfect Weapon* which posited a weapon which would only destroy paper, assuming that a society with fewer laws would be more free, and so would need less paperwork. Or in George O. Smith's 1947 *The Answer* where an evil regime was constructing military nuclear facilities. In the story, the slow democratic process of the UN will not work fast enough to stop the would-be aggressor. The Secretary-General in the story eventually stops the regime by a massive world-wide letter writing campaign. The bureaucracy of the regime only pays enough attention to the letters to file them, until the plutonium which the letters have been laced with reaches critical mass and explodes. The dislike of the political process and bureaucracy which inevitably accompanies it is evident in stories such as these.

Many of the science fiction stories told tales where the politicians were corrupt, or at least incompetent, and someone else had to take individual action to 'save the day'. However, often in these stories the hero's solution is far from democratic and the "quasi-military organisations of scientists" (Berger 1976) were often held up as examples of superior government, for ex-

ample E.E. 'Doc' Smith's 'Galactic Patrol'. "The naivete about politics and preoccupation with technological solutions was the obverse of the prevailing SF distaste for politics" (Berger 1976).

This kind of fiction was a direct reaction to "the appalling scientific ignorance and prejudice displayed by Congress after Hiroshima, and its general unwillingness to be educated" (Berger 1976). So after seeing the tremendous power of nuclear weapons, and then their governments reaction to it, it left the door open for science fiction writers to depict the kind of peril they believed the world to be in, and the consequences of what would happen if it all went wrong.

2.4 Science Fiction in the Classroom

Science fiction can be used in education in many different ways, from teaching 'hard' science, to the social implications of science, to the realities of how science is performed in society.

2.4.1 Teaching Science

Rose (2003), an American teacher, argues that science as depicted on screen doesn't need to be accurate, just plausible. He defines "accuracy" as "detailed information about scientific devices, techniques, and concepts that is likely to be known only to scientists with the relevant specialisation". He defines "plausible" as "concepts or techniques that may appear valid or feasible to a general audience on the basis of the information presented in the film and the public's understanding of related scientific knowledge" (Rose 2003). Rose argues that scientific plausibility has far greater potential for communicating science than merely scientific accuracy, and a greater usefulness to teaching science in the classroom.

Scientific plausibility allows greater freedom to ask students questions like "what is the additional science necessary to achieve the film's goals?; what are the theoretical flaws or technical limitations that might make them impossible?; are there any real science analogies to the fictional science?; how do the goals and implications of the real science compare with the fictional treatment?" (Rose 2003). The fact that the science in a piece is plausible (but not 100% accurate) provides a window for explaining real science in a way which the student can readily connect with something they are familiar with.

Rose also examines four science fiction movies (*Frankenstein*, *Jurassic Park*, *The Boys from Brazil* and *The Sixth Day*) and shows how they each

can be used as starting point on various topics in biology. For example, in *The Boys from Brazil*, blood samples from Hitler are used to clone numerous new copies of the dictator. The movie gives a reasonably thorough explanation of how the cloning process is achieved, at least as accurate as science was about the process in 1978. By watching it now, it can then be used to point out how the understanding of cloning has changed, and how the process works. It also raises questions of nature versus nurture, as eventually the film's protagonist burns the list of Hitler clones, confident in the strength of environmental influences to prevent a new dictator.

Rose finishes on the point that it is unreasonable to demand Hollywood to maintain levels of scientific accuracy as “unless all members of the movie-going public suddenly opt to undergo regular scientific training, the need to enforce scientific accuracy in movies will remain secondary to the need for story lines that exploit science in exciting, innovative, but not necessarily real, ways” (Rose 2003). Where scientific accuracy can frequently stand in the way of good storytelling (Crichton 1999), the scientific plausibility seen in many of the good science fiction films can be usefully used as a door to learning science.

Others have used science fiction extensively in teaching science courses. Firooznia (2006) sets out his biology course which uses science fiction as a basis for teaching a class of non-science majors.

The course uses a science fiction movie to introduce a topic, and then the movie is discussed at length in class. The basic biology is explained, and news articles which mirror science fiction predictions are also examined, especially those which have ethical concerns in today's world, “literature and film help students, especially non-majors, visualise the more abstract science concepts and their applications” (Firooznia 2006). For example, to introduce the topic of “DNA and the Gene”, students watch *Gattaca* (a film where discrimination is done to the genetic level, making it impossible, or almost so, for anyone without the correct gene to get high-paying jobs) and news articles on Watson and Crick's discovery of DNA and more recent articles on decoding genes are also examined. This way, the topic of genetics is introduced in an immediately engaging way, which also examines not only the science, but the potential effects of it as well.

Firooznia's course emphasises scientific literacy and “science fiction's ability to imagine the future is another advantage of using it to engage students in learning about biology and to provide them with the scientific literacy they will need to be effective citizens” (Firooznia 2006). And his course, which he ran three times, was a success as well, as two thirds of students who took the class said that their interest in biology increased, and slightly less than one third said they would consider taking another biology course.

Literary science fiction can be used as much as film, and for more than biology, as evidenced by Liberko (2004).

Liberko uses Kurt Vonnegut Jr's novel *Cat's Cradle* in order to help teach thermodynamics. In the novel, a type of solid water which is stable at room temperature is discovered called "ice-nine". When a seed-crystal of ice nine is accidentally introduced to the ocean, it immediately turns the entire ocean into ice-nine and eventually destroys all life on earth, as even humans have enough water in them to be "frozen" on contact.

The class can then apply various calculations to the description of ice-nine to determine how it would act if it were real, "Even if a situation is fictitious, concepts such as thermodynamics can still be applied" (Liberko 2004). For example, the students can readily work out that the conversion of water to ice-nine has negative entropy (as entropy is a measure of disorderedness, and solids are more ordered than liquids) and from there go on to determine that the conversion would be exothermic (i.e. give off heat). The melting point of ice-nine is mentioned in *Cat's Cradle*, and this information can be used, along with the Gibbs function and the equation for specific heat capacity, to determine that the change of one mole (eighteen grams) of water to ice-nine would be accompanied by a temperature increase of 79.8 degrees Celsius, and so on. By doing this, it "strengthens students' understanding of specific concepts by applying their knowledge to new situations" (Liberko 2004). It also makes the topic much more memorable, as dry equations are applied to an interesting and exciting novel.

2.4.2 Teaching Ethics

Nanotechnology, the investigation and manipulation of material at the nanometer scale, is one of the most exciting new branches of science, and Berne & Schummer (2005) believe that science fiction could be invaluable in teaching ethics to students of this young science.

The full implications of nanotechnology on our lives and our culture is an unanswered question at the moment. The students who are studying it now are the ones who will define what direction it goes in the future, and because of the potential of this technology it is important that they get a sound ethical education. However, according to Berne & Schummer (2005), there are four major issues which ethics boards are faced with: Firstly, whether ethics should be taught as a separate course or integrated into the general engineering curriculum, and who should teach it?; Secondly, should the emphasis be on teaching moral issues and societal implications or professional and general responsibilities?; Thirdly, should a 'top-down' (i.e. starting off with general ethical principles and then supporting them with examples) or

‘bottom-up’ (i.e. starting off with specific examples and building up to general principles) approach be used?; And finally, how to get the individual student intellectually or emotionally engaged with the subject matter?

Berne and Schummer propose that an examination of an appropriate science fiction text could be a valuable addition to an ethics education, and is flexible enough to handle many of the issues listed above - the study of a novel is easily integrated into a curriculum; no matter which emphasis (either professional or societal) that is chosen, a suitable text exists; and in terms of student engagement, it “is actually one of the strengths as we replace conventional ethics text with intellectually provocative, entertaining science fiction stories to be discussed in the classroom” (Berne & Schummer 2005). Berne and Schummer do favour a bottom-up approach, however.

Berne and Schummer also examine two examples of novels which could be used in teaching ethics, Michael Flynn’s *The Nanotech Chronicles* and Neal Stephenson’s *The Diamond Age*.

For example, in *The Diamond Age*, Stephenson has created a world with a global government that allows each area to govern itself how it wishes. Wars are fought for land, resources and power and the world has reverted into an almost feudal, medieval society, albeit with highly developed technology. This world has also mastered nanotechnology and “matter compilers” can be used to build any object imaginable, although not every country has access to them. We see this world through the eyes of Nell, an impoverished, neglected and abused young girl who has managed to get hold of a “book” called the Primer. The Primer is not actually a book in the traditional sense, as books are forbidden, but rather it is a super-intelligent computer which responds in real-time to the “fantasies and desires, fears, and imaginings” of its reader, “it is omniscient and perfectly empathising, prudent, foresighted and benevolent - a device that meets various human desires through advanced information technology” (Berne & Schummer 2005). The Primer is Nell’s advisor throughout the book, and ultimately her deliverer from her hellish life.

There are three different aspects of *The Diamond Age* that Berne and Schummer emphasise as particularly relevant to an engineering ethics course. The first is in the social realities of new technologies. Many consider that material wants and needs are the basis for struggle in our lives, and so nanotechnology’s ability to manipulate atoms will mean less material wants and needs, and so less struggle. However, Stephenson’s novel reconsiders this idea as matter compilers are capable of fulfilling these needs, but conflict remains, “human struggle is depicted...not simply as an outgrowth of material want, but from more complex elements of the human psyche and social structure” (Berne & Schummer 2005).

Another thread in the book important to nanotechnology students is that of the loss of privacy. In *The Diamond Age*, nanotechnology has completely removed any kind of privacy and made undetectable surveillance available to private businesses and individuals. Since one of the stated objectives of nanotechnology research is to provide exactly this kind of technology, it is important that students consider the possible social effects when designing these devices in the future.

Another potential thread which could be picked up on in a class is that of technology and nature. Since trees only real ‘use’ is to provide oxygen, and matter compilers can produce oxygen, in *The Diamond Age* all forested areas have been bulldozed to provide more land for development. This raises obvious issues about our desire to “master nature”, and the extent and values of this drive.

Berne and Schummer suggest that science fiction is the perfect vehicle with which to examine the potential future ethical decisions that may be faced by developers of a powerful technology that is only at its beginnings. “Students of nano-engineering can learn from classical nano-fiction novels something about the visionary roots of their field, the public image of nanotechnology, and the great hopes and fears that they as professionals will be faced with” (Berne & Schummer 2005).

2.4.3 The Scientist in Society

Nunan & Homer (1981) consider how the use of new-wave science fiction can be used in a ‘radical’ science education.

Nunan and Homer believe that the science which is taught in schools is a “myth of science”, where “science educators still imagine a rear-view mirror picture of science, a composite of 19th-century gifted amateurism and 20th-century professionalism...[it] offers the fantasy of the independent scientist following his individual whim or interest and free to gather data, theorise about it, and reach objective conclusions” (Nunan & Homer 1981). However, school-science, Nunan and Homer assert, does nothing to address issues such as the scientists place in society or the social effects which science can have. They argue that science is also partially a social construct, and so has the values of the society which produced it inherent in it, and this is something which should be brought up in class.

Science fiction, and particularly new-wave science fiction, has “moved towards the ‘soft’ (social) sciences and towards speculative extensions of theory rather than the technological ‘filling-in’ of a theory” (Nunan & Homer 1981). This places science fiction in the unique position of being able to fill in the gaps in school-science, as “at its most significant, [new wave science fiction]

locates science within specific value-systems, demonstrates the limitations of both, and examines alternatives...it can serve to call attention to the value-emphases inherent in different types of science and for placing science in a socio-cultural context” (Nunan & Homer 1981).

Nunan and Homer examine five different science fiction novels (Lem’s *The Invincible* and *Solaris*, Fisk’s *Trillions*, Hoyle’s *The Black Cloud* and LeGuin’s *The Dispossessed*), and use them as examples of how they might be read so as to communicate the issues which they feel should be examined.

For instance, their use of *Solaris*. *Solaris* takes place on a space-station studying a planet of the same name. The planet is covered by an ocean of a “colloidal substance” which is capable of assuming various shapes based on the memories of anyone who comes in contact with it. These shapes are capable of fully taking on the qualities of what is remembered, to the point where Kelvin, the book’s protagonist, has a futile relationship with the ocean’s “reincarnation” of his dead wife.

The planet has been studied for so long that a branch of science, Solaristics, has been coined, and the book covers some of the theories and controversies in the history of Solaristics. However, science has gotten no closer to providing any kind of explanation for Solaris, as “any attempt to understand the motivation of the occurrences is blocked by the anthropomorphism of the ‘owners’ ” (Nunan & Homer 1981). As the book progresses and Kelvin learns more about the history of Solaristics, he becomes more convinced of science’s inability to explain the phenomena, as it stagnates and becomes little more than gathering data, “in Kuhnian terms, Solaristics requires a new paradigm” (Nunan & Homer 1981).

As Kelvin begins to believe mystic and deistic reasons for Solaris’ existence and behaviour, it is another scientist, Snow, who has to point out to Kelvin why science was failing at providing an answer: because of “the prevailing geocentricism of science. As [Snow] says, ‘We don’t want to conquer the cosmos, we simply want to extend the boundaries of Earth to the frontiers of the cosmos’ ” (Nunan & Homer 1981). It is impossible for Solaristics to explain Solaris, because Solaris is not something which we can put into terms which we are familiar with. *Solaris* “demonstrates the limitations of science as both a methodology and a faith and suggests the origin of these limitations” (Nunan & Homer 1981).

Nunan and Homer suggest that by studying the likes of *Solaris*, it can be shown that science is not a free-entity, able to go wherever it pleases, but something which has limitations both of philosophy and of society, and this is something which would be valuable as part of a school-science course.

Chapter 3

Questionnaire: Methods

“Plainly it was one thing to read a mind and another to understand it.”

- Philip K. Dick and Ray Nelson, *The Ganymede Takeover*

The question which this thesis sets out to answer is whether science fiction fans, on average, are interested in science, and what effect this interest (if it exists) has on their enjoyment of science fiction. If a link can be shown to exist between an interest in science and reading science fiction, it could be an indication of how important science is to science fiction readers.

Thus, a questionnaire was developed to try and determine if science fiction fans are interested in science, and how important it is that the science they read in science fiction novels is correct. This questionnaire can be found in appendix A.

In order to tell if the results obtained from the science fiction questionnaire were above average or below, it was necessary to have a control group to compare them with. A crime fiction convention was chosen, as its attendees would be broadly comparable to science fiction fans - varying ages, well read and interested in their genre enough to attend a convention. The questionnaire had to be slightly adapted for the crime fiction convention (i.e., taking out specific reference to science fiction in the questions), and can be found in appendix B.

3.1 Questionnaire Layout

The first two questions ask about the educational qualifications of the respondent. Both the area of study and level obtained are listed, operating under the assumption that a particular interest in science will lead to a de-

sire for further study of science (although it should be noted that many do not discover an interest in science until later years).

The area of occupation is asked, again operating under the assumption that an interest in science might lead to the pursuit of a job within it. The number of people who have scientific qualifications and the number of people who work in the sciences will be related, as people who study science are more likely to be employed in it.

Questions four through eight ask about the various media through which someone could be exposed to popularised accounts of science; magazines, the internet, books, television and radio. By finding out how often the respondent consults these media for science information, a further link to the level of interest in science could be drawn. These questions would also indicate if someone who doesn't have a science qualification or work within science has an interest in the subject, as these are the avenues with which to find out more about science.

On the fifth to the ninth of September, 2005 the BA Festival of Science took place in Dublin. Public lectures and workshops on every aspect of science took place, and the event was widely advertised. Attendance at public events such as this is an indication of science-interest, so they were asked whether they attended any BA festival events. However, people's attendance would also be dependant on their availability at the time of the festival, so the science fiction convention attendees were asked about whether they would be interested in attending if a similar event was run in the future, and if not, why not.

For the crime fiction convention attendees, the English science week was used as the science-event to compare with the BA festival. This is a week of science events from the tenth to the nineteenth of March, 2006. Since science week was taking place at the same time as Left coast Crime, this was used as the 'future event' which the respondents were asked to state their interest in attending.

The respondent was also asked to grade how important it was to them that the science in a science fiction piece was correct; "Very important", "Nice, but not essential" or "Not important".

A final question was to ask if the respondent would be interested in reading science-fact articles in science fiction magazines. Some people have an only very casual interest in science, so seeing if they would read science-fact articles in magazines which they might be reading anyway might indicate this interest.

A space was also left for the respondents comments on any aspect of the questionnaire.

3.2 P-con

Science fiction conventions are usually annual affairs, where authors are invited as guests to speak on panels on a variety of subjects. Fans will come from all over the country to meet their favourite authors and other fans. This is the perfect venue with which to do research on science fiction fans, as those who attend would define themselves as science fiction fans, rather than just casual readers.

“Phoenix Convention”, or “P-con”, is one of three science fiction conventions which take place in Ireland, and was chosen as the site of the study because it took place on the eleventh and twelfth of March, 2006, and so gave sufficient time to analyse the data. P-con regularly draws up to a hundred people, and this year had one hundred and fifty attendees.

Questionnaires were left at the front desk of the convention, where every attendee must go to collect their badges which identify them as fully paid-up. They were also distributed by hand throughout the convention. Completed forms could either be handed into the front desk, or given to the researcher, who was identified with a name badge.

Forty-two completed forms were received, meaning a return rate of 28%. A list of the occupations of the respondents can be seen in table 3.1.

Of these, five are directly involved with science (biomedical scientist, energy conservation, neuroscience, mechanical engineering and science medical journalism); eleven are involved with computers and IT (computers, data analysis and design, networking/ISP, translation/IT, video graphics, video games and web development); ten are easily identified as working in the humanities (arts, author, education, education/administration, humanities, librarian and publishing); four were students, two of which identified themselves in the ‘education’ question as secondary school students, while the

administration	arts	author (4)
biomedical scientist	civil service	computers (5)
data analysis and design	education/administration	education
energy conservation	humanities	insurance
international politics	law	librarian
management consultancy	networking/ISP	neuroscience
pensions	mechanical engineering/therapy	publishing
retail (3)	science medical journalism	student (4)
translation/IT	video graphics	video games
web development	none given (2)	

Table 3.1: Occupations of P-con Respondents

other two were post-bachelors science students; the remaining ten which gave answers defy easy categorisation, and so can only be coded as “other”.

The only other form of personal information collected was the maximum education level currently obtained by the subject, and what field it was in. Table 3.2 lists the subject areas given by those who had completed post-secondary education.

accountancy	aeronautical engineering
applied histochemistry and electron microscopy	art in commerce and industry
biology, brain and behaviour	celtic studies
classics	communications
communication studies/computer science	computer science (3)
history	engineering (2)
general humanities	geography and philosophy
geography/climatology	history
information science	insurance
languages	law
mathematics and philosophy	neuroscience (2)
physics with space science	physics with computer science
social science	teaching (history and geography)
tech interpreting	

Table 3.2: Subject areas of post-secondary education at P-con

These are easier to categorise, as they come from obvious faculties. Six are computer science qualifications (communication studies/computer science, computer science, information science, tech interpreting); thirteen are humanities (accountancy, art in commerce and industry, celtic studies, classics, communications, general humanities, history, insurance, languages, law, social science, teaching); twelve are science (aeronautical engineering, applied histochemistry and electron microscopy, biology brain and behaviour, engineering, geography and philosophy, geography/climatology, mathematics and philosophy, neuroscience, physics with space science, physics with computer science) and eleven didn't have any post-secondary qualification.

The actual level obtained in these are as follows; nineteen were bachelor degrees (aeronautical engineering, celtic studies, classics, communication studies/ computer science, communications, computer science, engineering, general humanities, geography and philosophy, history, languages, law, mathematics and philosophy, physics with computer science, physics with space science, social science, teaching and tech interpreting); five were diplomas (accountancy, art in commerce and industry, biology brain and behaviour,

information science and insurance); three were master degrees (applied histo-chemistry and electron microscopy, computer science and engineering); four were Phds (history, geography/climatology and neuroscience); and eleven had no formal post-secondary education.

3.3 Left Coast Crime

A crime fiction convention has the same format as a science fiction one, where fans come to hear their authors speak on a number of different panels. Ireland does not have many crime fiction conventions, and certainly none which would leave time for the interpretation of results, so the “Left Coast Crime” convention was approached. The convention is held in Bristol in England on the sixteenth to the nineteenth of March, 2006, and regularly attracts over two hundred people, with a little over four-hundred attending this year. Questionnaires were posted over to the organisers of the convention, and they were left out at the registration desk.

Thirty-two forms were completed, meaning an 8% return. A list of the occupations can be seen in table 3.3.

attorney-at-law	author (7)	civil service
customer service/accounting	education	education and publishing
film production	finance	graphic production
homemaker	law	law/accountancy
librarian (4)	public service	publishing (2)
rehabilitation	retired teacher	retired traffic engineer
science writer	social work	student

Table 3.3: Occupations of Left Coast Crime Respondents

These are a sharp contrast to the results from the science fiction convention, as only two of the occupations could be classified as science related (retired traffic engineer and science writer). There are twenty-one people working in the humanities (author, education, education and publishing, film production, graphic production, librarian, publishing, retired teacher). The remaining nine are grouped together in the “other” category.

The subject areas of post-secondary education show the same leaning towards the humanities, with only one computer science qualification (computer science); four science-related (civil engineering, mathematics, physics with English literature and psychology); twenty-four were from humanities faculties (creative writing and criminology, drama, English, English education, English literature, finance, history, history and political science, theatre

civil engineering	computer science
creative writing and criminology	drama
English (3)	English education
English literature	finance
history (3)	history and political science
theatre arts	journalism
law (tax)	liberal arts
liberal studies	librarian science (3)
mathematics	occupational therapy
philosophical theology	physics and English literature
psychology	social work
writing	

Table 3.4: Subject areas of post-secondary education at Left Coast Crime

arts, journalism, law, liberal arts, liberal studies, librarian science, occupational therapy, philosophical theology, social work and writing); and three people had no post-secondary education. Physics with English literature was coded as ‘science’ rather than ‘humanities’ because that person listed their occupation as ‘science journalist’. As this is a science-related job, it was decided that this is how the qualification would be coded.

The actual level of the qualifications were as follows: fifteen were bachelor degrees (civil engineering, creative writing and criminology, drama, English (3), history (3), history and political science, journalism, liberal arts, liberal studies, mathematics, occupational therapy and physics with English literature); eleven were master degrees (English education, English literature, finance, theatre arts, law (tax), library science (3), psychology, social work, writing); three were Phds (computer science, history, philosophical theology) and three had no formal post-secondary education.

Chapter 4

Questionnaire: Results

“If you had high hopes, how would you know how high they were? And did you know that narrow escape routes come in all different widths? Would you travel the whole wide world without ever knowing how wide it was? And how could you do anything at long last,’ he concluded, waving his arms over this head, ‘without knowing how long the last was? Why, numbers are the most beautiful and valuable things in the world.’”

- Norton Juster, *The Phantom Tollbooth*

Both the P-con and Left Coast Crime (LCC) conventions provided interesting and useful data.

Table 4.1 shows the relative percentages of the occupations of P-con and Left Coast Crime respondents. Computer science and science are taken to be in the same category. Table 4.2 shows the relative percentages of the education categories of P-con and Left Coast Crime respondents.

It can be seen that the fans at P-con have a much stronger scientific background than those at Left Coast Crime, with 38.1% of P-con respondents working in the sciences, compared to 6.3% of Left Coast Crime respondents. Similarly, P-con has a higher proportion of scientific educational qualifications with 42.9% compared to Left Coast Crimes 15.6%. The levels of scientific employment and education are related, as people who study science are more likely to then go on and work in a science-related field, but

	Science	Humanities	Student	Other	None
P-Con	38.1	23.8	9.5	23.8	4.8
LCC	6.3	65.6	-	28.1	-

Table 4.1: Occupation (%)

	Science	Humanities	None
P-Con	42.9	31	26.1
LCC	15.6	75	9.4

Table 4.2: Formal Post-Secondary Education (%)

they still demonstrate that there is a significantly higher interest in studying and interacting with science.

There is a corresponding interest in the humanities in the Left Coast Crime respondents, with 65.6% working in the humanities and 75% having an education in them, compared to P-con’s 23.8% and 31% respectively.

Table 4.3 presents the results of the remainder of the questions on the questionnaire (Except for the question on the importance of correct science, which can be seen in table 4.4).

	Publications	Online	Books	TV	Radio
P-Con	57	50	66.7	85.7	16.7
LCC	31.2	31.2	34.4	81.3	46.9
	Festival	Other Festival	Fact Articles		
P-Con	4.8	31	74		
LCC	6.3	-	53.1		

Table 4.3: Results of Media Questions(%)

In the media questions, a higher proportion of P-con respondents read about science in books, magazines and online (with 66.7%, 57% and 50% respectively, compared to Left Coast Crime’s 34.4%, 31.2% and 31.2%). However, the number of those who watch science on television are almost the same, with 85.7% of P-con respondents and 81.3% of Left Coast Crime respondents watching science documentaries. This result might be due to the popularity of the medium or there are also a multitude of true-crime documentary series which could be classified as science documentaries, and which attendees of a crime fiction convention would have a particular interest in watching. Oddly, a far higher proportion of Left Coast Crime respondents listen to science programming on the radio, with 46.9%, than P-con respondents, with 16.7%. This may be because there is far more science programming on the various BBC radio stations than there are on the Irish stations.

It can be seen that the attendance in both BA Festival of Science and Science Week events was very low from both convention respondents. The comments from the “why not?” question for Left Coast Crime respondents revealed that some respondents were from overseas (six people), others did

not know that it was taking place (four people), some hadn't the time (four people) and the rest who gave a reason had no particular interest in attending science week events (five people). The remaining ten people who indicated that they were not attending Science Week events did not answer this question.

31% of P-con respondents indicated that they would attend a similar event to the BA festival if it were run again. Of those that said they wouldn't, the comments from the "why not?" question indicated that this was either because they were not based in Ireland (eight people), they hadn't sufficient time (three people) or sufficient interest (eleven people). The remaining person who indicated that they would not attend a similar event did not specify why.

The proportion of respondents who would be interested in reading science-fact articles in a science fiction/crime magazine for P-con and Left Coast Crime were 74% and 53.1% respectively. This is further evidence of a stronger interest in science among the science fiction fans, although the level of interest in reading science-fact articles in crime magazines is still quite strong. This could be because any science-fact article in a crime magazine would probably be about forensic science, and this is an area which is naturally interesting to a crime fiction fan.

Table 4.4 shows the results for the question regarding how important correct science is to the fiction of the respondent. More Left Coast Crime respondents indicated that correct science was "very important" (with 59.4% compared to P-con's 42.9%), and more P-con respondents indicated that it was "nice, but not essential" that the science be correct (45.2% compared to Left Coast Crime's 34.4%). Those that indicated that the science was "not important" (or didn't answer) only make up a small percentage of either convention respondents.

	Very	Nice	Not	No Answer
P-Con	42.9	45.2	4.8	7.1
LCC	59.4	34.4	3.1	3.1

Table 4.4: Importance of Correct Science (%)

4.1 Comments

Below are additional comments given by P-con respondents

- "The science is often overdone and extremely heavy in sci-fi books, eg Cryptonomicon [by Neal Stephenson], and can detract from story. A

nice mixture seems hard to obtain but works well if done correctly as atmospheric science”

- “SF [science fiction] and science have become too separated in my opinion. Perhaps more science articles in SF mags would help”
- “I think, ideally, what distinguishes SF from other genres, and arguably what adds value, is that SF does investigate science and its relation to society etc. Many scientists are NOT good at this”
- “The science does not need to be factual in fiction, but it should be logical, and if it’s proven science it should be factual”
- “Correct extrapolation of current science essential”
- “More important that science is correct in books – TV doesn’t have time”
- “If has a fantasy element, more inaccuracy is tolerable”
- “Science is very interesting in a sci-fi/ fantasy novel and adds to the story”
- “My personal interest in science came about as a direct result of my interest in sci-fi (Just thought I’d mention that!)”
- “I feel the online science sites are superior to the popular science periodicals due to possibility of immediate publishing and ease of cross referencing topics elsewhere on other sites”

Similarly, below are comments given by Left Coast Crime respondents.

- “I’m really glad someone is asking these questions”
- “Importance of accuracy depends on the fiction”
- “I read some science fiction – I don’t care if the science is inaccurate in a futuristic book – I can accept from the start that the world is imagined. But inaccurate forensic science makes me crazy! Crime fiction that ignores forensic science or abuses it irritates me. The exception – JD Robb books – again, it’s the future, this is an imagined earth, so I don’t need the rules to apply – just consistency within the story based on its own rules.”
- “Interested in reading science-fact articles in a fiction magazine if interesting and accessible.”

- “As a mystery writer I do read mystery magazines and like ‘true crime’ inserts. I also am fascinated by forensics and crime investigation techniques”
- “I wonder how many mystery fans read ‘true crime’ criminology articles. For me, I triple check any fact that goes into my books and this often means reading lots of police/crime detection articles.”
- “I’m really only interested in zoological science and environment – not big on chemistry, physics etc.”
- “I’m a crime writer who sets her work 40 years into the future – so I’m naturally interested in how it will develop”
- “I do find science fairly impenetrable – my husband, who is a scientist, and I can both answer many culture questions on University Challenge but I can’t even guess at the science answers (hard science I mean biology/nature answers I can guess at)”
- “Probably irrelevant, since I’m not a UK resident, but some of my work deals with forensics”
- “From the US, if that impacts the data...(Also, have no TV, which is why I don’t watch any science on it)”
- “Although I am here as a mystery fan, I am also a sci-fi reader, specifically short stories, and regularly read (and subscribe to) short story magazines in both genres.”
- “I love science fiction as well as crime fiction. I watch both types of programs and movies as well”
- “There are other educational qualifications (for example vocational) than those noted at question one”
- “Would it not be more to the point to ask us if we read, watch, or listen to communications about criminology? I am assuming you would want to know how much fans are informed about the facts underlying their particular fictional interests. If you had asked me about books, shows etc about law enforcement, our criminal justice system or crime scene investigation, the answers would be very different.”

Chapter 5

Discussion and Conclusions

“Almost all knowledge, after all, fell into the category. It was either perfectly simple once you understood it, or else it fell apart into fiction.”

- James Blish, *A Case of Conscience*

Looking at the data from the questionnaires, it is clear that science fiction fans (or, at least, science fiction fans who attended P-con) do have a particular interest in science. Over two-fifths of P-con respondents said they thought it was very important that the science in science fiction be correct. These fans are most likely hard science fiction readers, and by extension perhaps lean towards the convergent end of the spectrum. Comments such as “SF and science have become too separated in my opinion. Perhaps more science articles in SF mags would help” or “correct extrapolation of current science essential” add weight to this idea.

Compared to Left Coast Crime, there was a far higher indication from the P-con respondents of a desire to learn about science independent of the fiction, with more people almost across the board reading or watching popular science. Particularly when occupation and education are taken into account as, again, a far higher proportion of P-con respondents were interested in science enough to pursue it further in education or as a career.

But the results also indicate that to many science fiction fans, it is not *essential* that the science be completely correct. Over 45% indicated that it was “nice but not essential” that the science be correct in the fiction which they read. The higher proportion of “very important” answers from Left Coast Crime respondents indicate that there is less room for inaccuracies within crime fiction, as the fans want the science in the fiction (presumably forensic methods as well as basic science) to be as accurate as possible. Science fiction fans seem to be slightly more casual about it, as the amount of

people who think it's important and the amount of people who don't see it as essential are split almost 50-50. For example, this comment, "The science is often overdone and extremely heavy in sci-fi books, eg *Cryptonomicon* [by Neal Stephenson], and can detract from story. A nice mixture seems hard to obtain but works well if done correctly as atmospheric science" is the perfect example of the "nice, but not essential" attitude that many science fiction fans at P-con seem to have. Furthermore, comments such as "I think, ideally, what distinguishes SF from other genres, and arguably what adds value, is that SF does investigate science and its relation to society etc. Many scientists are NOT good at this" indicate that there is a further interest in science beyond just the hard facts. These results possibly account for the diverger point of view, and so new-wave science fiction fans. Even science fantasy fans seem to have been represented, with this comment, "if has a fantasy element, more inaccuracy is tolerable".

Section 2.3 and section 2.4 both investigated how science fiction can be used to communicate both science and the issues around it. The questionnaire showed that people who are interested in science fiction are also, on average, interested in science in general. Combining these two results, it can be seen that science fiction and science are not mutually exclusive. Science fiction can be used to explain scientific principles, investigate the interaction between science and society, and the role and responsibilities of the individual scientist. Therefore it has been demonstrated that the fact some of the science is "fudged" in order to investigate these issues does nothing to hinder an interest in science, nor does it detract from the educational value.

Rose (2003) makes a valuable comparison at the end of his paper. He points out that scientific accuracy in movies (and so, by extension, through all of science fiction) should be treated the way that accuracy in autobiographies is treated. Authenticity in autobiographies, he says, is usually measured in terms of the depicted chronology, settings, appearances etc, "however, authenticity can also be meaningfully evoked on other levels, including the personalities and sensibilities of the characters, and the political atmosphere, moral tone, and emotional setting of a story. Likewise [appreciating scientific accuracy] is more a matter of finding the connections and parallels (intended and otherwise) with real science than pointing out the inaccuracies and oversights" (Rose 2003).

Chapter 6

Limitations and Further Work

“The more time he spent away out in the Galaxy the more it seemed that the number of things he didn’t know anything about actually increased.”

- Douglas Adams, *Mostly Harmless*

While an attempt was made to make this study as complete as possible, it is, of course, subject to certain limitations. The return rate from P-con was average for a questionnaire, with 28%, but the return rate from Left Coast Crime was very low, with only 8%. This is to be expected, as there was no researcher there in person to collect and promote the questionnaire to the attendees and the study was primarily about science fiction, so crime fiction fans would have less motivation to participate than the science fiction fans.

Both conventions focus on the literary side of their subjects, i.e. books. This means that those who attend such conventions read regularly, and that segment of the population who don’t do any reading (sadly, the majority) is unrepresented in either sample. While trying not to fall into the trap of generalisations, an interest in reading usually corresponds with an interest in the world at large, so there is probably already a high level of scientific literacy amongst readers, and so amongst the attendees of both conventions.

The small size of this study means that it is not possible to confidently extrapolate to the wider Irish science fiction fan community, so further studies could be done at the other two science fiction conventions, and at the number of science fiction clubs and college societies which exist throughout the country. This would lead to a fuller picture, as it would cut across all ages and the entire country.

A further question which arose during this study was exemplified in this comment, “My personal interest in science came about as a direct result of my interest in sci-fi (Just thought I’d mention that!)”. For this person, their

interest in science came from their interest in science fiction but it raises the question of whether this is a common occurrence. Does it work the other way around too, and an interest in science lead to an interest in science fiction? A study within the scientific community would be necessary to find out what sparked their individual interest in science, and if science fiction was a common cause.

If the link between science fiction and science could be fully investigated, it might then lead to science fiction's acceptance as a useful tool in the pursuit of a public understanding of science.

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Appendix A

“P-Con” Questionnaire

You can find Appendix A at
<http://www.minds.nuim.ie/~underdog/thesis.html>

Appendix B

“Left Coast Crime” Questionnaire

You can find Appendix B at
<http://www.minds.nuim.ie/~underdog/thesis.html>