

3 October 2011

**The Influence of Popular Culture and Science Fiction on the Public  
Perception of Emerging Technologies – Focus: Nanotechnology**

**Name:** Stefan Vargolici

**First Semester University:** University of Maastricht, Netherlands

**Second Semester University:** Universite Catholique de Louvain la Neuve, Belgium

**MA Program:** European Studies on Society, Science and Technology

**Specialization:** Nanotechnologies and Society

**Professor Coordinator:** Bernard Feltz

**Key Words:** nanotechnology, popular culture, science fiction, literature, film

**Word Count:** 20.305

## Contents

<b>Introduction</b> .....	3
1. <i>General Facts about Nanotechnology</i> .....	5
2. <i>Status of Research, Debates and Impact</i> .....	8
3. <i>Research Question, Aims and Objectives</i> .....	11
4. <i>Methodology</i> .....	13
5. <i>Structure and anticipated results</i> .....	14
<b>I. Popular Culture</b> .....	16
1. <i>Towards a mass culture - The rise of the mass society</i> .....	16
2. <i>Terminological confrontations</i> .....	20
3. <i>Ideological confrontations - conveyor belt culture vs. a creative and refined culture</i> .....	21
4. <i>Political power, cultural power and globalization</i> .....	24
5. <i>Americanization and pop-culture</i> .....	26
<b>II. A timeline of relations between Popular Culture and Emerging Technologies</b> .....	28
1. <i>Electricity and the Industrial Revolution</i> .....	28
2. <i>Before and After the Atomic Age</i> .....	30
3. <i>Robots and Robotics</i> .....	31
4. <i>From Computers to Cyberspace and Cyberpunk</i> .....	33
5. <i>Biotechnology and Bioengineering</i> .....	36
6. <i>Nanotechnology and Nanopunk</i> .....	39
<b>III. Science Fiction Literature and Emerging Technologies</b> .....	41
1. <i>Mary Shelley's Frankenstein, or, The Modern Prometheus (1818)</i> .....	43
2. <i>Isaac Asimov's I, Robot (1950)</i> .....	45
3. <i>Michael Crichton's Prey (2002)</i> .....	47
<b>IV. Nanotechnology in Literature</b> .....	50
<b>V. Nanotechnology in Film</b> .....	56
<b>VI. Discussion and Main Points</b> .....	61
<b>Conclusions and Further Research</b> .....	68
<b>References</b> .....	71

## **Abstract**

*Nanotechnology is the term which refers to the study and to the technological applications of the nanometric level, respectively to the manipulation of matter at an atomic and molecular scale. Because of the speculation surrounding the potential applications of nanotechnology a significant number of issues arose connected to the effects that these applications may have on our society if they would be developed and the measures that need to be taken to tackle these risks. It is thus necessary to look at the ways in which nanotechnology is imagined and portrayed in literary works and in motion pictures, as well as to assess the role that such imaginaries play in innovation processes and the influence that they may have on the public perception of this new technology.*

## **Introduction**

17 June, 2011, a famous Soviet monument in Bulgaria's capital city, Sofia, is transformed over night into a pop culture stage for some of the world's most well known icons. The soldiers presented in the statue have been painted to resemble The Mask, Batman's nemesis, The Joker, Wolverine from the X-Men, Superman, Captain America as well as Santa Claus and Ronald McDonald. What is interesting about this fact is that the hundreds of people passing by the statue every morning most likely did not have a clue about who the soldiers were, but when the statue was painted most of them could identify the characters envisioned. Even more interesting is the fact that the statue did not receive any attention from the media in its many decades of existence but after the over-night makeover, its picture and the story appeared on news websites all over the world, including on some of the most famous ones such as Yahoo! News. The event sparked up a very interesting debate, especially throughout the social media (namely Facebook), and it split the people of Sofia between the anti-communists and the anti-capitalists. Many wanted to keep the statue in the new form but the authorities decided to wash the paint off and now the statue is back to its old self.

Following the recent tragedy in Japan, in March, and the accident at the Fukushima nuclear power plant, various episodes from the well known animated comedy television show *The Simpsons* were banned in numerous EU countries. The German channel Pro 7 was the first one to ban the episodes which contain humorous references to nuclear crises and which allude to faulty safety regulations. The famous main character of the show, Homer Simpson, works in a nuclear power plant and is known for his carelessness which often leads to accidents. The event

was related by news stations worldwide and again sparked an intense debate regarding the influence of pop culture on the population, the issue of censorship and of course the issue of nuclear energy at an international level.

Soon after this, on a more relaxed note, in June a team of German neurosurgeons underwent a thorough study and catalogued the number and the gravity of the brain injuries which appear in the French comic books *Asterix & Obelix*. The researchers at the Heinrich-Heine University in Dusseldorf have analyzed no less than 34 comic books. They have identified 704 cases of brain injuries, most of them suffered following attacks (98.8 %), and the victims were generally male. More than half of the lesions were catalogued as severe and most of the victims lost their consciousness following the attack. In spite of this, the final conclusion of the study was that none of the individuals were left with permanent damages. (BBC News, 16 June, 2011)

There are numerous other examples of the way in which popular culture is part of our day to day lives, it influences the way in which we perceive things, the way we dress, the way we speak, and many times the way we think and act. This form of culture is representative for the 21<sup>st</sup> century and for contemporary societies worldwide.

As we have seen in one of the examples above, pop culture can play a very important role in debates around serious problems with regard to politics, social issues and also science and technology. Throughout time we have seen how the world's greatest inventions and innovations have been presented in extraordinary ways in books, pictures, magazines and films, bringing them closer to our understanding and acceptance. We grew up learning a lot of what we know today from cartoons or comic books. They stimulated our imagination and fed us with metaphors about the world so that we may understand even the most delicate aspects of life. Later on in our

existence we still take up a large mass of information from literary works and films and we use that knowledge in our day to day activities.

The world is constantly changing and advancing at a faster and faster pace. The technologies that we use today were only fragments of dreams not even one hundred years ago. Because we have come such a long way it makes us wonder what the future will look like, it makes us think about the benefits of the new technologies that we create but it also makes us reflect upon the risks that may arise, upon issues of responsibility and fairness, ethics and morals.

One of these new technologies that we see emerging before our eyes and under the highly developed microscopes of the scientists today is none other than nanotechnology. The mere word leads our minds and imaginations to distant places where promises of immortality are made and threats of human extinction are lurking.

Being faced with this new emerging technology we need to look at the way it will change our lives, we need to understand the impact that it may have on our society, but also very importantly, we need to look at the way in which it is imagined, at the promises and threats that these imaginaries bring. For this purpose, it is essential that we explore the field of popular culture and science fiction imaginaries and understand the way in which they influence the public perception of nanotechnology.

### *1. General Facts about Nanotechnology*

Nanotechnology is the term which refers to the study and to the technological applications of the nanometric level, respectively to the manipulation of matter at an atomic and molecular scale. This technology uses structures with dimensions between 1 and 10 nanometers

and involves the development of materials and mechanisms of the same size. (Allhof, Lin & Moore, 2010, p. 5) In order to better understand the nano-level we can give a few examples: the relationship between a nanometer and a meter is the same relationship as between a 1 Euro coin and the entire Earth, our hair grows about one nanometer in less than a second, and DNA has a width of approximately two nanometers.

The prefix “nano” is derived from the greek word “nannos” which means very short man, or dwarf. It refers to a scalar size in the metric system and it is used to describe a billionth of the base unit. For example, in a second there are one billion nano-seconds and in a meter there are one billion nano-meters etc. Thus we can say that the nano-scale is the scale at which nanotechnology operates and generally refers to dimensions between 1 and 100 nanometers.

As many other successful technologies, nanotechnology has many founders. From a certain point of view we can say that chemistry has dealt with nanotechnology since the beginning. Hence, the nano level is not completely new, but studies recently made at the nano level, as well as the possibility to manipulate atoms directly are revolutionary.

The term “nanotechnology” first appeared in 1974 and was used by Norio Taniguchi in a paper called “Study on the basic concepts of Nano-technology”. Here, Taniguchi describes this new technology as allowing the manipulation of materials at a nanometric level. Still, the history of nanotechnology goes further back, to a speech presented by Richard Feynman at the California Institute of Technology in December 1959, called “There’s Plenty of Room at the Bottom”. In this speech, Feynman talks about the principles of miniaturization, about the precision at the atomic level as well as about the fact that these concepts do not break any known laws of physics.

Later on, in 1987, K. Eric Drexler publishes his book *Engines of Creation: The Coming Era of Nanotechnology*, written for a non-technical audience, but which attracts the attention of scientists alike. Drexler's book describes a new form of technology based on "molecular assemblers" which are capable of arranging atoms in nearly any possible way, allowing the creation of anything allowed by the laws of nature. This idea sounded exaggerate and unreal to some, but as Drexler noticed, it was a process already achieved by nature, without the implication of man, through the existing biological mechanisms. The topic of this book started a very heated debate about the possibilities, promises and problems of these "molecular assemblers". Even the potential existence of these machines is heavily debated, but it is clear to say that it marks the starting point of nanotechnology as we know it today and of the scientific study associated with it.

"The discovery of novel materials on the nanoscale notably began with the Buckminsterfullerene (also called the buckyball). The buckyball was so named because of the resemblance to the geodesic domes that the architect Richard Buckminster Fuller popularized" (Allhof, Lin & Moore, 2010, p. 7) It was discovered in 1985 at the Rice University and it is built up from an arrangement of 60 atoms of carbon. Six years later, in 1991, Sumio Iijima, a Japanese physicist working for NEC Corporation, a Japanese multinational IT company with headquarters in Tokyo, discovered carbon nanotubes, an event which brought a huge focus of intense research on nanoscale materials. Since then, nanoscale materials have been developed at a very fast pace and "nanotechnology is now recognized as the future of technological development". (Allhof, Lin & Moore, 2010, p. 8)

In 2000 a very important step for nanotechnology was taken with the development of the National Nanotechnology Initiative (the NNI) by the US government. "The NNI today consists

of the individual and cooperative nanotechnology-related activities of 25 Federal agencies with a range of research and regulatory roles and responsibilities [...] With the support of the NNI, nanotechnology R&D is taking place in academic, government, and industry laboratories across the United States. (NNI Website, 2011)

## 2. *Status of Research, Debates and Impact*

Nowadays materials are the essence of technology at the nano-scale. Because of the extremely reduced dimensions, atomic species and structures define not only the properties of the material but also the functions of the mechanisms in which they are used. Moreover, numerous materials interact differently with their environment at the nano scale. When they are found in their natural state, as bulk materials, they interact with their surroundings in a certain way, because most of the atoms are inside the material and not on the surface. Atoms respond to their surroundings differently when they are surrounded by other atoms than when they are on a surface without other atoms surrounding them, and the relative number of surface atoms can influence the properties of the whole material. Thus, gold is a material which in a natural state has no negative effects when it comes into contact with biological materials, but at the nano scale, gold particles have a high level of toxicity.

Nanomaterials today are used either individually or in conjunction with other materials in order to enhance their properties. Thus we can find nanomaterials in the field of mainstream materials for quite some time. Carbon particles of nano-sizes have been used, for example, in the reinforcement of tires for a very long time. “Another, more common example is precipitation hardening of materials. Precipitation hardening is a heat treatment technique that is used to

strengthen materials, particularly some metals. It relies on producing fine, impure nanoscale particles, which then impede the moving of defects within the material.” (Allhof, Lin & Moore, 2010, p. 9) Through this process the material is hardened.

Because of the speculation surrounding the potential applications of nanotechnology a significant number of issues arose connected to the effects that these applications may have on our society if they would be developed and the measures that need to be taken to tackle these risks. There are some main areas in which nanotechnology controversies generally appear.

First of all in relation to the environment, nanotechnology is seen by many as extremely dangerous. The small sizes of nanomaterials raise numerous issues connected to containment, clean-up and toxicity. “Because, historically, materials have had such a high profile impact on the environment or health, the study of the environmental/health impacts associated with nanotechnology and nanoscale materials is attracting a large degree of interest” (Allhoff, Lin & Moore, 2010, p. 159)

Secondly, the issue of military use and weapons development is highly debated and raises many public concerns. The creation of nano-based weapons would, in the view of some, lead to the greatest threat that humanity has ever faced. These weapons would have a stealth and destruction capacity never before seen and thus, by falling into the wrong hands they would take the issue of terrorism to a whole new level, and would greatly lower the level of global security.

Also there are many concerns linked to the issue of privacy and surveillance. The small sizes of nano-scale surveillance mechanisms would make them invisible and undetectable, thus allowing for a constant monitoring of society and of individuals. This debate generally sparks techno-totalitarian future scenarios in which society is enslaved by an oppressive government which controls every aspect of personal life. The debate on privacy is also connected to the

development of RFID (Radio Frequency Identification Devices), which we nowadays see are being developed and introduced in numerous areas of industry and public life.

Last but not least, the field of nano-medicine and human enhancement is highly debated and sparks numerous ethical and social concerns. The development of nano-based treatments or drugs has a huge future potential and promises the elimination of numerous diseases or weaknesses with which we are faced today. Nonetheless, these medical advancements, just as almost all other advancements in the field of nanotechnology, are currently very uncertain and risky. Nano-based treatments could target more specifically the diseased cells and eliminate them, while protecting the healthy ones and not damaging the body as many actual treatments do, but the long term effects of nanoparticles on the body are unknown and may be toxic.

From the point of view of human enhancement, nanotechnology promises a longer life, enhanced strength, speed, intelligence and many others, even though up to now only in theory. All of these, though, will come at a cost, and thus the main ethical issues are concerned with the social cleavages that these developments will bring, with the so called nano-divide which will separate the enhanced people, who can afford these improvements, and the normal people who will become inferior and obsolete.

Thus we observe that there are numerous potential dangers that arise with the development of nanotechnology, such as: unidentifiable weapons of mass destruction, invisible surveillance networks used by governments, rapid military developments and world-wide imbalances, which need to be taken into consideration very thoroughly.

Numerous groups consider that nanotechnology should be specifically regulated by governments and supra-national organizations because of these reasons, but there are also many

who consider that over-regulation would slow down scientific research and innovation and would block the great benefits that could be brought to humanity.

### *3. Research Question, Aims and Objectives*

Throughout all the debate surrounding the issue of nanotechnology, Phil Macnaghten, Matthew Kearnes and Brian Wynne ask in their article from 2005, what is the role of social sciences? There, the authors argue that nanotechnology represents an extraordinary opportunity to build in a robust role for the social sciences in a technology that remains at an early and hence undetermined stage of development. They set out a prospective agenda for the social sciences and its potential in the future shaping of nanotechnology research and innovation processes. Through this agenda they show that the ambition is to develop interdisciplinary approaches that seek to embrace the complexities of nanotechnologies, and their emergent, materializing and condensing social relationships.

Thus, they discuss five potentially rich veins of social science research activity: imaginaries, public engagement, governance, globalization and emergence.

Our paper aims to tackle the first “rich vein”, respectively to look at the ways in which nanotechnology is imagined and to assess the role that such imaginaries play in innovation processes. Hence, our arguments are in line with the author’s when they refer to the fact that:

“Imaginaries are materially powerful, they do shape practices, relationships and commitments (which are often rendered irreversible) and as such, they demand reflective, accountable attention and debate. As well as shaping the expectations of individuals and institutions, imaginaries are mobilized through ongoing public discourse and enacted in everyday practices [...] Emerging technologies, surrounded

by ambivalence and conflicting narratives of utopia and dystopia, provide fertile ground in which the moral dilemmas of modernity are rehearsed .” (Macnaghten, Kearnes, Wynne, 2005, p. 279)

Furthermore, from the point of view of nanotechnology, on which our paper will focus, the authors state:

“Nanotechnologies are framed by scientific and engineering imaginaries that have longstanding antecedents [...] Such imaginaries render nanotechnologies visualizable and to some extent already familiar (for ex. The macrolevel machines expressed at the nano-level) [...] For the empirical invisibility of nanotechnology, beneath the threshold of the human senses, makes it almost impossible to verify whether it is in fact under human control – thus providing fertile ground for voices of opposition; for instance dystopias that build upon Drexler’s imaginary of self replicating “grey goo” as a central motif” (Macnaghten, Kearnes, Wynne, 2005, p. 280)

Daniel Dinello, in his 2005 book emphasizes that “while the nano-revolution, like all 21’st century technologies promises heaven on earth for post-humans, it also brings threats and risks.” (p. 15) Because of this, in this paper we aim to look at the way in which these risks are presented by popular culture, more specifically by science fiction and what are the possible impacts that these representations may have on the public perception of nanotechnology.

Nanotechnology offers science fiction the greatest opportunity to play out unforeseen consequences in time for us to ask serious questions about its direction and value (Dinello, 2005, p. 15)

Even though some, especially scientists, are generally skeptical about the impacts and importance of science fiction and pop culture on society, we see numerous arguments and

evidence which confirm that there is a strong connection between the two. “Not only is no language, including mathematics, ever free of troping; not only is facticity always saturated by metaphoricity; but also, any sustained account of the world is dense with storytelling. ‘Reality’ is not compromised by the pervasiveness of narrative; one gives up nothing except the illusion of epistemological transcendence, by attending closely to stories.” (Haraway, 1997 as cited in Lopez, 2004, p. 131)

Furthermore, discourses that extrapolate techno-scientific developments into the future, through science fiction narrative elements “contain assumptions about, amongst other things, the nature of being, the dynamics of historical change, the aspirations of citizens, and the relationship between society, culture and techno-science.” (Lopez, 2004, p. 132)

#### 4. *Methodology*

The methodology which we will use is based on text analysis of the relevant literature which tackles the issues of: nanotechnology, popular culture, science fiction and imaginaries. We will look at the field of popular culture and focus on the power and importance that it has on the modern and post-modern civilization and at the way it reacts to emerging technologies and we will follow a timeline in which we analyze the main points in history where these two fields meet. For this purpose we will discuss three main pieces of literature, namely Mary Shelley’s *Frankenstein* (1818), Isaac Asimov’s *I, Robot* (1950) and Michael Crichton’s *Prey* (2002) and look at their common elements but also at their main differences. Following this we shall go deeper in the science fiction literature that deals with nanotechnology and analyze the way in which it might influence society. We will also look at the way in which nanotechnology is

portrayed and imagined in movies and try to understand what impact this has on the general public. For this purpose we will select several motion pictures which have been cinematic successes (from the point of view of number of audience, meaning box office rating, and not critical reaction) and we will analyze the way in which they approach the field of nanotechnology, the way it is imagined and the messages that it sends to the public.

##### *5. Structure and anticipated results*

In the second chapter we shall take a deep look into popular culture and we will try to understand its historical background and the way it evolved relying on the most well known theories of social sciences in this field.

Following this, in the third chapter we will analyze the relationship between emerging technologies and popular culture throughout time and we will highlight the main moments when these have met and what implications those encounters have had.

In chapter four we will look at the field of science fiction, as a major exponent of popular culture, we shall examine its general features and take three key literary case studies which we shall analyze in view of our central topic.

Chapter five will focus on the topic of nanotechnology in literature and we shall see the way in which this emerging technology is portrayed in some of the most influential works of our recent times. We shall make note of the most important science fiction novels focusing on nanotechnology and we shall see the messages they send and how these may impact the views and opinions of the public.

The last chapter before our concluding remarks shall contain discussions and main points regarding the influence of pop culture and science fiction on the public perception of nanotechnology. We shall analyze the essential reasons why popular culture and science fiction are important when discussing nanotechnology and we will underline the main points of focus for social science research.

In the end we aim to have a good overview on the way in which emerging technologies, especially nanotechnology, are portrayed in science fiction works and pop culture. Due to the methodological difficulties and challenges that such research poses in order to understand the origins, the nature and the effects of imaginaries, and also due to the fact that our research does not focus on developing interactions with nanoscientists or social actors, we shall limit our conclusions to underlining the main influences and impacts that these imaginaries may have on the general public but we shall refrain from making generalizing remarks and categorical affirmations.

We anticipate that in the end of the study we shall find that there is a strong link between science fiction and science and that the way in which popular culture takes on and presents a certain emerging technology has a clear influence on the public's perception of it. Furthermore, due to the abundance of worst case scenario portrayals and dystopian future based science fiction works, we anticipate that influence to be mostly negative towards the public's perception.

## **I. Popular Culture**

In this chapter we shall approach the concept of mass culture, or the culture of mass society. We shall start with an exposition of the modifications that the modern age and technological developments have produced on society and on the individual, enumerating some of the characteristics of mass communication, as presented by John B. Thompson. We shall continue with the terminological difficulties regarding the definition of mass culture, comparing the concepts used by Hannah Arendt, Theodor Adorno and Douglas Kellner. In the next section, in order to see a few of the pro and against opinions on mass culture, we will analyze the opinions of the critics, regarding the culture industry (Adorno), the concept of McDonaldization (Ritzer) and the amalgam culture (Berger), while on the other side we have the creative industries represented by Kellner and Negus. The last subchapter will regard two main themes. The first refers to the growth in importance and influence of cultural power in comparison to economic, political and coercive power. This will lead us to our second theme, which is the domination of the USA on globalization as a cultural phenomenon.

### *1. Towards a mass culture - The rise of the mass society*

The standard story of modernity starts with the industrial revolution, which meant the change of the means of production, the change of the individual's lifestyle and the way in which he perceived the world. The time allocated to labor dropped, the quantity of physical work spent was drastically reduced, products became cheaper and more accessible to a wider mass of people and the learning institutions also became more open and accessible.

Because of these transformations, common people could have more free time on their hands. Until the 18<sup>th</sup> century only the elites had “free time, meaning time which they could dedicate to culture”. (Arendt, 1993, p. 206) Thus, the mass of the population could allocate time to culture, incorporating it deeper into society. This can be considered the moment when the mass society appeared. The access of the mass society to culture, along with the technological developments and the improvement of the means of communication lead to the shaping of a specific culture, namely the mass culture.

The cultural forms which preceded this period of social change were based on tradition, they were born out of myths and religion and had a regional character. The new paradigm changed radically the means of production, diffusion and perception of information and of cultural objects. This tendency would later receive the name of mass communication. Sociologist John B. Thompson uses this concept in his book “*The Media and Modernity: A Social Theory of the Media*”, in order to designate the “institutionalized production and generalized diffusion of symbolic goods through fixing and transmitting information or symbolic content” (Thompson, 1995, p. 26)

But mass communication could not take place without the appropriate technological means. The first step in this sense was the rise of the printing press in the 15<sup>th</sup> century which lead to the invasion of societies in the 17<sup>th</sup> century with newspapers and other written press. Afterwards, the scientific and technological discoveries allowed the transmission of sounds and images to a great distance, but also the stocking of this type of information. The radio dominated the first decades of the 20<sup>th</sup> century, being replaced by the television in the post-war period. The last twenty years represented the rise of the electronic means of mass communication, a true revolution in this sense, the most important element of these being the internet.

Thompson identifies four characteristics of the technical means of mass communication. The first attribute is that these means have the capacity to store information, either on a magnetic support or on paper, allowing the reviewing/recollecting of the specific information. The second characteristic of technical means is the possibility of reproducing symbolic objects, allowing their distribution on a wide scale. Also, the mass reproduction of symbolic objects meant their transformation in goods, they become commercial items, sold and bought with a price. (Thompson, 1995, p. 24)

The space-time distancing is the third attribute of the technical means of communication. “A message [...] can be listened to or read by individuals who are set in different contexts, which can be far away, in time and space, from the context in which it was originally produced.” (Thompson, 1995, p. 26) Finally, the technical means presume that the individual knows the procedures of codifying the information and also that he knows the set of rules and procedures to use the respective mean.

In the next parts of his work, Thompson presents the five characteristics of mass communication: involving certain technical and institutional means of production and diffusion, meaning the mass media; transforming the symbolic objects in goods; the discrepancy between the context of their production and their reception; the space-time distancing and, finally, the public circulation of symbolic objects. (Thompson, 1995, p. 31-34)

Being an engine for the propagation of mass culture, mass media can offer great power, they educate us, seduce us and thus fulfill important social functions. As researchers Lazarsfeld and Merton observe, they can attribute certain statute to problems of public interest, persons, social organizations and movements (Lazarsfeld, Merton, 1999, p. 20) but also they can give accentuated importance to debates on new technologies, their risks and their ethical and social

implications. Thus, what appears in the mass-media is separated by the great anonymous mass and its actions and implications are of public interest. Also mass-media are an important element of socialization and of imposing certain social norms. They can initiate organized social action through exposing conditions which are in contradiction to the public morals. (Lazarsfeld, Merton, 1999, p. 21) One important social consequence identified by the two authors is that of the narcotizing dysfunction. This refers to the fact that the enormous influx of information to which the individual is subjected results in an increase in his interest to read, watch or listen to it, but also in a decrease in his will to act upon it. (Lazarsfeld, Merton, 1999, p. 22)

Mass media have also determined a change in the way in which people interact. The individual is confronted with a new type of visibility in the public space. Traditionally, the primary form of social interaction is the face to face one. Individuals communicate in the context of co-presence, meaning sharing the same space-time framework. This communication has a dialogical character and gestures, facial expressions and intonation are complementary to the words used. (Thompson, 2005, p. 32)

The rise of the printing press, the radio, the television, cinema, the internet and social media, meant the birth of a new type of social interaction, one which Thompson names mediated quasi-interaction. This form of communication implies the production of symbolic forms for an indefinite number of receptors. Its character is predominantly a monologue and the degree of reciprocity and interpersonal specificities are reduced. (Thompson, 2005, p. 33)

The means of mediated communication allow the recording and later transmitting of the information in a different context, eliminating the situation of co-presence. Developing mediated communication meant a “liberation of visibility of the space and time properties, from the here and the now” (Thompson, 2005, p. 35)

## 2. *Terminological confrontations*

The culture of mass society is defined from different perspectives. Thus, ideological conflicts arose between those who have tried to find the right concept. First of all it is necessary to define the term “culture”. James Lull strengthens the definition given by Raymond Williams, which is that “culture is a particular way of life built on values, traditions, convictions, material objects and territory” (Lull, 2000, p. 75) Developing on this, culture is determined by “people, objects, visions on the world, activities and ambiances” (Lull, 2000, p. 75) The social communication and interaction make these elements live on and change among themselves constantly. “Culture is the way in which we live out our own nature (including our biological one) and the meanings that we meet in our day to day lives” (Storey, 2003, p. 2)

Three concepts have tried to give meaning to, and explain, the culture of mass society: mass culture, popular culture and media culture. The term of mass culture has been discussed above, in the perspective of Hannah Arendt, as being merely the culture attributed to the mass society. Critics of this concept have considered that this is only an attempt to intellectualize the kitsch. This gave rise to the opposition between the high, intellectual culture and the common one, the culture of the kitsch. The members of the Birmingham school of thought have rejected the term of mass culture exactly because of this elitist tendency. (Kellner, 1995, p. 46)

In Adorno’s conception, the term popular culture, which is often mistaken with that of mass culture, defines the cultural production oriented intentionally towards the creation and control of a cultural objects market (Adorno, 2005, p. 160) The evolution of society in the context of a popular culture which is continually expanding meant a change at the level of the

receiving public, this was the disappearance of the cultural elite, which was partly replaced nowadays by the modern intellectuals (Adorno, 2005, p. 161)

James Lull and Douglas Kellner criticized the use of the concept of popular culture to define mass media commercial products of the culture industries (Kellner, 1995, p. 47) because the term “popular” names a culture which belongs to the people. This concept would thus designate another culture, opposed to that of the mass society. (2000, 1999, p. 81-82) Kellner proposes a different concept, that of media culture, which would mean the nature and form of artifacts from the culture industry, as well as their means of production and distribution. Media culture is the industrial culture organized after the model of series production and which is targeted to a wider audience (Kellner, 1995, p. 13), it is a commercial culture, its products being merchandises and the wider public being the target.

Due to the nowadays mainstream use of the term and because of the appropriateness which it has in connection to the central topic of our research, throughout the rest of the paper we shall use Adorno’s term of popular culture when making reference to this type of culture in society.

### *3. Ideological confrontations - conveyor belt culture vs. a creative and refined culture*

Mass society and popular culture, in which cultural objects are mass produced by specialized institutions and then sold as goods also attracted opposite opinions. One of the most critical voices against mass culture was Theodor Adorno. Even from the first sentence of one of his studies he accuses the commercial character of culture which leads to a filling of the gap between practical life and culture. (Adorno, 2005, p. 61) The author brings numerous arguments

against mass culture. He condemns the fact that the majority of cultural creations are adaptations. Also, the individual consumer of culture is rewarded for being mediocre, his cultural and intellectual needs align with the material needs, his cultural experience is reduced to a simple evaluation and his curiosity is always fueled by the attractiveness of cultural objects. (Adorno, 2005, p. 67) Adorno also criticizes publicity materials, which have a purely informative role, the promoted products being similar and everything reducing itself to acknowledging and selecting brands, the consumer thus being forced to submit if he wants to survive. (Adorno, 2005, p. 85)

Adorno's critique of a culture which mass produces prime symbols and which identifies itself by the sound of speakers turned to the max (Adorno, 2005, p. 67, 93) becomes more concrete in the article "Culture Industry Reconsidered" in which he introduces the concept of culture industry. The term will substitute that of mass culture because the latter may be interpreted as the culture which stems from the masses, so a contemporary form of popular culture. The culture industry produces tailor-made cultural objects for the masses. Individuals are just part of the machine which only produces for profit. (Adorno, 2005, p. 98-99) The total effect of the culture industry, he states, is one of anti-enlightenment, in which the enlightenment, meaning the progressive technical dominion over nature, becomes a mass deception and is turned into a way to chain the conscience (Adorno, 2005, p. 106)

The level of standardization which has been reached within popular culture is criticized also by sociologist George Ritzer. He thus introduces the concept of McDonaldization, stemming from the name of the well-known chain of fast-food restaurants. The concept is defined as the process through which the principles of the fast-food restaurant are starting to dominate more and more sectors in the American society, as well as in the rest of the world (Ritzer, 2004)

The characteristics which ensured the success of McDonald's were noticed by Ritzer, these also becoming the central characteristics in his McDonaldization process. Thus he talks about four attributes: efficiency, calculability, predictability and control. The fact that one receives the ordered products within less than five minutes from placing the order represents efficiency. The calculability is found in the exact cost of the products but also within the precise quantity of each ingredient which goes into its composition. The fact that the products, services and the environment are almost identical in every corner of the world represents the predictable characteristic. From the point of view of control, this is reflected in the conformity of the employees, as well as of the customers. (Ritzer, 2004, p. 26-28) Still, there is one more characteristic of McDonaldization and that is the irrationality of the rationality. Ritzer gives examples through the impact that this type of organization has on the population and on the environment and also through the inhuman work environment, similar to that of an assembly line. (Ritzer, 2004, p. 29-30)

The influence of the McDonaldization process is felt also throughout culture. Because of standardization "the products of a certain culture are much more easily diffused than those of another" (Ritzer, 2004, p. 29) At the same time, it may become more and more difficult to distinguish what is local and what is global. The inability to differentiate between the culture specific to a certain area and the imported culture is also underlined by Rene Berger, who calls this phenomenon amalgam culture. (Berger, 1972)

Still, there are also authors who support popular culture, accentuating its socializing function, its creativity and the similarity between itself and refined culture. Kellner criticizes the idea of culture industry, proposing a different perspective. The so-called media culture and communication represents the center of entertainment production, thus being an important

socializing agent, a mediator of the political reality, which has to be seen as a major institution of the contemporary societies, having numerous economic, political, cultural and social effects. (Kellner, 1995, p. 41)

The concept of culture industry is also criticized by Keith Negus. Adorno observes how cultural institutions were forced to adopt certain formulas and standards in order to get the attention of the public, thus creating standardized cultural objects, meant to only be appealing to the population. (Negus, 2006, p. 198-199) Negus proposes a rethinking of the concept of culture industry. The accent will be moved to the creative process and to the artist. By renaming Adorno's concept into creative industry he overlaps the esthetic value with the capitalist industries. Popular culture creations, as well as standard products imply a high degree of creativity in their development, thus the artistic value of the market grows. (Negus, 2006, p. 201)

#### *4. Political power, cultural power and globalization*

The influence of popular culture on the post-industrial society has led to changes also with regard to the impact of power on the individual, and the new visibility has made politics into a spectacle. Generally we can distinguish four types of power: political, economic, coercive and symbolic (also named "cultural" by some authors). The shift towards the modern age meant a change in the framework of each of the four. Economically, society passed from feudalism to capitalism, and the coercive forces manifested themselves mostly within the state. The individual is forced to process very large quantities of varied images and ideas; disorganized capitalism is installed, in which environmental problems arise and the discrepancy between the rich and the

poor becomes more obvious. (Kellner, 1995, p. 30) Though we are satisfied in our rush for comfort and material welfare, our collective purpose in life is less clear (Lull, 2000, p. 158)

From a political point of view, absolutism made way for the nation state, and the way in which the politician is presented today in front of the people has suffered major changes. (Thompson, 1995, p. 47-48) Because of the visibility offered by the technological means of mass communication, a person does not depend on the context of co-presence and he/she can build a personal image which can be sent in other places. The possibility of individuals to create an image through the mass-media has also brought with itself certain fragility. The control that people have over the means of communication is highly reduced and the new media is even harder to control. (Thompson, 2005, p. 38-42) Thus image conflicts between politicians, political parties, institutions, mass media and other public figures arise. Everything becomes, in a way, a spectacle.

Thompson defines symbolic power as the capacity to intervene in the course of events and to influence the actions of others through the production and diffusion of symbolic objects (Thompson, 2005, p. 50) James Lull speaks of another type of power, the cultural power, defining it as the capacity of individuals and of groups to produce meanings and to build ways of life which appeal to senses, emotions and thoughts about one's self and of others (Lull, 2000, p. 80) Even though symbolic power refers to the institutions which create symbolic forms, and cultural power to the individuals that assimilate them, Lull considers that these two are assimilated because, today, culture engulfs also the symbolic resources formulated by the mass-media, not only traditional values. Also, the two powers are more accessible and usable than any of the other three forms because they occupy a central spot in our day to day lives, helping us to create, to accept, to adapt and to transform the environments structured by the economical,

political and military authorities. (Lull, 2000, 80-81) Thus, who holds the symbolic power also has control over the other three spheres of authority.

##### *5. Americanization and pop-culture*

Because of the rise of the media conglomerates and the growth of their influence outside their origin country, contemporary society is faced with a large scale phenomenon in culture and communication: globalization. This concept describes the process through which cultural goods circulate in an international arena. (Thompson, 1995, p. 154-156) Such a sphere of influence implies the strengthening of certain standardization values and practices. Still, these influences do not penetrate in a uniform way but also interact with the local conditions. (Lull, 2000, p. 160)

The phenomenon of globalization from a cultural point of view, though, is somewhat asymmetrical. There are only a few countries which dominate the cultural and informational flow. Out of these main exporters we isolate the United States, which is by far the largest. In the beginning of the 21<sup>st</sup> century “American movies held 85% of the box office revenues in Europe and 80% worldwide [...] out of 220 movies, 191 were produced in the US” (Dobrescu, 2003, p. 261)

This process of Americanization was, and still is supported by the American government, beginning in the 1920's when Herbert Hoover, as President of the Chamber of Commerce, observed the potential of Hollywood productions as a form of publicity which can be exported to promote the American products and lifestyle. (Morley, 2006, p. 32) The dominion of the US from this point of view is strengthened by the misconception that the whole world dreams of being American, because it accentuates comfort and convenience and offers satisfaction to the

masses, being the first true culture of the people. Even the army is involved in the process of Americanization, its purpose also being to ensure the circulation of American products and to open the path for the cultural assault. (Morley, 2006, p. 34)

The fact that the USA is a cultural world-power is demonstrated by its capacity and know-how in communication, the dominion of electronic mass communication means and the publicity assault for the American products and lifestyle. The result is an electronic invasion which, in a way, threatens to destroy local traditions and to sink the cultural inheritance of less developed countries, under a torrent of TV programs, movies and other media products which come from a few powers in the West (Thompson, 1995, p. 159)

Thus, having went through all of the above, we can clearly state that popular culture, as an exponent of modern and post-modern civilization, generates images about organizations, persons, groups, products, services, and, most importantly for our topic, about technologies, influencing a greater and greater part of the world's population and transforming the individual in irreversible ways, while also demonstrating extreme power and importance.

## **II. A timeline of relations between Popular Culture and Emerging Technologies**

Throughout history we have witnessed the rise of new technologies which have changed our world, scientific advancements which shifted the way in which society perceived itself and the environment surrounding it. Also, at the same time we have seen that with each new stage in technological advancement, with each new scientific “era”, starting with the Industrial Revolution, the field of popular culture has reacted to it in a certain way, by developing narratives and imaginaries which explore the limits, the ethical and philosophical issues, and the dark parts of these new technological advancements. This reaction of pop culture has served as a social tool, as a mechanism of information, of alarming, of stage-setting for thorough debate, and of facilitating the public understanding of science by the general public.

In this chapter we shall look at a timeline of emerging technologies, starting with electricity in the Industrial Revolution and ending with nanotechnology today, and we shall observe the reaction of popular culture and its influence on the respective technology, and the publics’ understanding of it.

### *1. Electricity and the Industrial Revolution*

Electricity is a general term to describe the phenomenon caused by the movement of electrons and the charges they carry. These manifestations are easily recognizable and can be seen all around in the natural world in forms such as: lightning, static electricity and the flow of current in an electrical wire. The word is derived from the New Latin word, “electricus” which in direct translation means “amber-like”. It was coined in the 1600’s from the Greek “electron”

which means “amber”, because static electricity effects were produced originally by rubbing amber.

“Popular culture depicts electricity less as a natural phenomenon than as the lifeblood of modern civilization. Electricity, like radiation, is accorded powers more supernatural than natural: it can strike down the living, animate the dead, or contravene the laws of nature.” (Van Riper, 2002, p. 69) These views were gathered and used by Mary Shelley to create her novel “*Frankenstein, Or the Modern Prometheus*”, which will be more thoroughly discussed and analyzed in a following chapter.

This mystical attitude towards electricity began with the experiments of Luigi Galvani, in 1771, when he noticed that the legs of a dead frog twitch when electricity is applied. As the theme became better known and electricity was considered the lifeblood of the Second Industrial Revolution, its uses and the ones who manipulated it were shown in a better light, such as it is presented in Rudyard Kipling’s poem from 1907, “Sons of Martha” or in the novel written by Jules Verne. (Van Riper, 2002, p. 71)

During those times, and shortly afterwards, the “wizards” of electricity, as they were popularly named, Thomas Edison, Charles Steinmetz and Nikola Tesla, were perceived as having supernatural powers and access to a knowledge outside the human realm. (Van Riper, 2002, p. 71)

The most well know pop culture elements related to electricity which can be found even today, and which are now even considered classics, are the references made by Mary Shelley in her novel which allude to electricity as being the source of life. In fact, even though Galvani’s work may have inspired the author to write her well known novel, it is the lightning effects of the

Tesla coils and the high voltage knife switches, developed by Nikola Tesla, which have become archetypes in all Frankenstein movies or popular references made to it.

## 2. *Before and After the Atomic Age*

The background of the Atomic Age starts with the year 1903 when Ernest Rutherford, a British chemist and physicist, born in New Zealand, started discussing the possibility of atomic energy. Following this, the first pop culture reaction we see takes place in 1914, with the publishing of H.G. Wells' science fiction novel entitled "*The World Set Free*" in which he describes the finding of limitless energy locked inside atoms and presents a story of how atomic bombs are deployed around the world.

Starting with that moment, until 1945, when the first atomic bombs are tested and deployed on real targets, and even afterwards until today we see an evolution in the research within the field of nuclear energy and a parallel timeline to it, of pop culture references to the atomic bomb and to nuclear scenarios.

There is no distinction within popular culture between fission and fusion, and the weapons using these technologies are simply classified as "nuclear weapons" (Van Riper, 2002, p. 14) In spite of this, there is a clear distinction between two opposite imaginaries of atomic energy. Thus we are faced with "an optimistic view which portrays it as a powerful but pliant servant, and a pessimistic view as a barely controllable demon, always on the verge of a rampage" (Van Riper, 2002, p. 14).

The optimistic view on nuclear weapons portrays them as conventional weapons which have more firepower. Their effects are limited to a certain area and the damages are not

cataclysmic. “Terrorists and megalomaniacs threatening to set off nuclear weapons are standard plot devices in action movies from *Goldfinger* (1964) to *Broken Arrow* (1996) and *The Peacemaker* (1997), but the threat is always confined to a single city.” (Van Riper, 2002 p. 15)

On the other hand, the pessimistic view on nuclear weapons shows how the use of any sort of these weapons will target a full scale worldwide nuclear war which will lead to the extinction of humankind and the destruction of the Earth. “Some stories from this tradition, like Nevil Shute’s “*On the Beach*” (novel 1957, film 1959) and *The day After* (TV film, 1983) assume that existing nuclear weapons can obliterate human life. Others – films like 1964’s *Dr. Strangelove* and 1970’s *Beneath the Planet of the Apes* – invent a doomsday bomb [...] that can do the job in a single explosion” (Van Riper, 2002, p. 15)

The Atomic Age and the emergence of the technology for the atomic bomb, as well as for the widespread use of atomic energy have started one of the strongest pop culture waves in history. The reactions to these new scientific advancements by a huge number of scenarios and narrative imaginaries have the role of informing the public about the risks that these technologies pose, setting the stage for a debate on their use, raising awareness on the ethical and social implications that they have, as well as suggesting ideas for reflection and analysis.

### 3. *Robots and Robotics*

The general understanding of the word robot is that of an electromechanical machine which is guided by a computer program. The Encyclopedia Britannica defines the robot as "any automatically operated machine that replaces human effort, though it may not resemble human

beings in appearance or perform functions in a humanlike manner" (Encyclopedia Britannica Online, 2011)

The word "robot" was first used in Czech author's Karel Capek's play *R.U.R.* (1921), where it is used to describe automatic laborers of organic origin, what today we would be more likely to call "androids" (Roberts, 2000, p. 158) Within the period of the 1920's and 1930's there were numerous robot stories published which presented this potential new technology in various ways, generally in a negative light. The robots in those stories were presented as human-machines, in the style of the already famous *Frankenstein*, or as symbols to explore the boundaries and the relations between humans and machines. (Roberts, 2000, p. 158)

The most famous robot storyteller was undoubtedly Isaac Asimov, who generally wrote stories in which he explored the ethical, social and philosophical issues surrounding the relationships between humans and machines. One of his most famous works, the volume *I, Robot*, will be amply discussed in a further chapter.

"The sinister potential of the 'robot' has provided many SF texts with their organizing structure". (Roberts, 2000) The relationship between science and technology, and popular culture in the 30's and 40's from the point of view of robots was very closely connected. It was a self propagating relationship, with the public interest in robots pushing research and innovation, and those in return pushing the creation of narratives and imaginaries connected to the potential impacts that robots may have. The humanoid robot, for example, exhibited at the 1939 and 1940 World's Fairs, named Elektro, spurred the public interest but also the public fear with regard to robotics.

Even today, "the robot is that place in science fiction texts where technological and human are most directly blended. The robot is the dramatization of the alterity of the machine,

the paranoid sense of the inorganic come to life.” (Roberts, 2000, p. 159) Just as we have mentioned before, with regard to atomic energy, the issue of robotics has also stirred one of the strongest pop culture waves with regard to science and technology, the confrontation / cooperation between man and machine thus becoming an archetype which has been almost exhaustively explored.

#### *4. From Computers to Cyberspace and Cyberpunk*

Undoubtedly the greatest technological advancements of the recent times, and the core developments that most of us have witnessed throughout our lives are related to computer technology. The word computer is derived from the verb “to compute”, meaning to calculate, to process. A generally accepted definition of the word “computer” is “an electronic device that can store, retrieve and process data” (Merriam Webster Online Dictionary, 2011) Obviously this is a very raw definition but it is the basis from which all the many functions of a computer, that we see today, start.

The first electronic computers were created in the mid 20<sup>th</sup> century and were very large, usually the size of a whole room. They consumed great amounts of power and were capable of very simple operations, a very small fraction of what computers nowadays are capable.

The potential of computer technology was seen immediately and huge investments were made by private companies, industries and governments to develop this technology. Because of this, the speed at which computers advanced in the second half of the 20<sup>th</sup> century was never before seen and the breakthroughs came one after the other. They became smaller, faster,

smarter, and integrated themselves into almost every aspect of human life, opening the door to further scientific and technological progress.

Because of the benefits that they had, and still have, on communication, information storage, computing capacity, computers were socially accepted and became essential to the everyday life of a huge number of people in the world.

Parallel with the development of computer technology the term “cyberspace” arose to describe the global network of interrelated IT infrastructures, telecommunication networks and computer processing systems. This term became ubiquitous and entered the common vocabulary, being widely used even today. It was first used by science fiction author William Gibson, in his 1982 short story, “Burning Chrome”, which was published in the science fiction magazine OMNI. The term became widely popular with the publishing of Gibson’s award winning, 1984, debut novel *Neuromancer*, where he anticipates in a very original way the multi-networked techno-culture in which we live today.

The word “cyberspace” has revolutionized popular culture and popular science fiction, ushering in the power and the omnipresence of the information age. Since its introduction in the common vocabulary it has come to symbolize everything from computers and IT to the worldwide communication networks and the internet. “Imagined by Gibson as an alternative virtual world, cyberspace emerged as a techno-paradisiacal escape from the banality of everyday reality – an electronic realm that suspends the physical laws that constrain our bodies and turns us into disembodied spirits in a nonmaterial world.” (Dinello, 2005, p. 147)

Connected to what Daniel Dinello is describing above, the concept of cyberspace lead to the idea of a virtual reality, a world inside the computer where a person could transfer himself and exist without biological boundaries. “A recent cultural fantasy, the dream of immersion in

the digital heaven of cyberspace has superseded the enchantment of a space-flight ascent into heaven. Just as rockets provided the machinery by which humans might be freed from their earthbound existence, virtual reality (VR) technologically provides the scientific stairway to an electronic escape” (Dinello, 2005, p. 148) This idea has been thoroughly imagined by a great number of books, movies and even cartoons (for example *Johnny Quest*) and has sparked numerous ethical and philosophical debates related to morals and human identity. Virtual Reality (or VR for short in most pop culture references) became known throughout the late 80’s and the 90’s as a new final frontier, a limitless universe with endless possibilities where humans could be free from disease, aging and even death.

Computers, cybernetics, cyberspace and VR essentially lead to the rise of a postmodern science fiction genre named “cyberpunk”, which focuses on very developed technologies set in post-industrial dystopian societies and is centered on a conflict among hackers, powerful multinational corporations, artificial intelligence and mysterious characters. Cyberpunk generally describes a world of the future where IT and cybernetics have led to a breakdown in the social order and have radically altered humanity. The genre has a very distinct atmosphere, containing elements of modern science fiction mixed with detective fiction. The name of the genre is very representative and it symbolizes the essence of the movement. “The root ‘cyber’ is also related to ‘cyborg’, describing new syntheses of humans and machines and generally signifies cutting-edge high-tech artifacts and experience. The ‘punk’ root derives from the punk rock movement, signifying the edge and attitude of tough urban life, sex, drugs, violence, and antiauthoritarian rebellion in lifestyle, pop culture and fashion” (Kellner, 1995, p. 301)

Famous cyberpunk literary examples include William Gibson’s “Sprawl Trilogy” with *Neuromancer* (1984), *Count Zero* (1986) and *Mona Lisa Overdrive* (1988); Rudy Rucker’s “The

Ware Tetralogy” with *Software* (1982), *Wetware* (1988), *Freeware* (1997) and *Realware* (2000); Bruce Sterling’s *Schismatrix* (1985), Neal Stephenson’s *The Diamond Age* (1996) etc. Also there are numerous well known films which fall under the cyberpunk genre, such as: *Blade Runner* (1982), *Tron* (1982), *Videodrome* (1983), *RoboCop* (1987), *Hackers* (1995), *Johnny Mnemonic* (1995), *Judge Dredd* (1995), *The Fifth Element* (1997), *The Matrix* (1999), *Equilibrium* (2002), *Repo Men* (2010) etc.

Very importantly, cyberpunk has also influenced other artistic and non-artistic fields such as architecture, the Sony Center in Japan and the Potsdamer Platz public square in Berlin, Germany being described as cyberpunk, numerous literary subgenres, such as “biopunk” or “nanopunk”, and also music, with bands such as Front Line Assembly, Psydoll and Sigue Sigue Sputnik being classified as cyberpunk.

Needless to say, the interaction between computers and pop culture has been very strong and it has had a great impact on society worldwide. It is a valid example of the influence that pop culture may have on the public perception of a certain technology and, as Douglas Kellner states “we should probably not forget cyberpunk as we create new theories and politics, for the future may yet have some new surprises and revelations and postmodern theory and cyberpunk are only part of the story that remains to be told” (1995, p. 327)

##### 5. *Biotechnology and Bioengineering*

Biotechnology is the fusion between biology and technology. It is the application of biological techniques to product research and development. In particular, biotechnology involves the use by industry of recombinant DNA, cell fusion, and new bio-processing techniques

(Merriam Webster's Medical Dictionary, 2011) Along with computer technology, biotechnology has been one of the most important fields in which research has been conducted in the second half of the 20<sup>th</sup> century. Scientists have made numerous breakthroughs and very important large scale projects have been developed so that we could learn more about the nature of things and be able to better manipulate the world around us. The Human Genome Project, for example, is an international scientific research project which has the objective of identifying the sequence of chemical base pairs which form DNA, and also of mapping the nearly 25 thousand genes of the human genome from a physical and functional point of view.

Naturally there are numerous controversies surrounding the field of biotechnology and many public concerns related to issues such as "playing god", tampering with the building blocks of life, the Frankenstein myth etc. Specific actions which have been seen as highly controversial and which have separated the world population on different positions are the issues of cloning, stem cell research and manipulating DNA. "Less than fifty years after Watson and Crick's discovery of DNA's fundamental message bearing structure, biotechnology promises to transform humanity more profoundly in the near future than has occurred in human history. We are confronted with new and unique bioethical dilemmas as well as critical questions about the nature of life, intelligence and humanity." (Dinello, 2005, p. 180) There are numerous critics of biotechnology, such as Bill Joy, Francis Fukuyama and Jeremy Rifkin, as well as numerous international organizations and NGO's, such as Greenpeace, who criticize the current regulatory frameworks and ask for better regulation and policies related to biotechnology.

This debate has always been seen as a very serious one with drastic social, moral and religious implications and the popular culture reaction to this emerging technology, or technological field, has not had the same amplitude as the one related to computers and IT.

However, there are several science fiction works which allude to biotechnology and there has been a very interesting recent trend to underline the importance of the regulatory and political implications that biotech (as it is better known in pop culture) has.

Related to the cyberpunk movement that we have discussed above, there is also a sub-genre which deals with the issue of biotechnology, named “biopunk”. Although not as popular or widespread as cyberpunk, the biopunk movement is a cultural one which encompasses a growing number of artists, writers, scientists and critics who try to make public the biotech agenda and to bring to the attention of the people the implications of certain issues related to biotechnology and bioengineering.

One of the earliest works which some have classified as falling under the biopunk genre is H.G. Wells’ novel *The Island of Doctor Moreau* (1896), possibly the first science fiction work which alludes to what we nowadays call bioengineering. More recent known works include Paul Di Fillipo’s *Ribofunk* (1996), Michael Blumlein’s *The movement of Mountains* (1989) and Paul J. McAuley’s *White Devils* (2004).

Probably one of the most well known science fiction novels which discusses unconsidered biological tinkering is Michael Crichton’s worldwide bestseller *Jurassic Park* (1990), which was also adapted in 1993 into a film directed by Steven Spielberg. The movie grossed more than 900 million dollars being considered a worldwide blockbuster hit and it had a great impact on the public perception of bioengineering, stirring up strong debates and anti-biotech movements.

One of the most representative and influential figures of the biopunk movement is Meredith L. Patterson, an American technologist, journalist and science fiction author. She is one of the main promoters of biopunk and also the author of the biopunk manifesto called “Outlaw

Biology? Public Participation in the Age of Bio” presented in January, 2010 at the UCLA Center for Society and Genetics Symposium. The declaration is inspired by, and deliberately follows the form of the “Cyberpunk Manifesto” written by Eric Hughes in 1993, calling for public participation and describing the social actions that need to be taken in order to make biotech more open:

“We the biopunks are dedicated to putting the tools of scientific investigation into the hands of anyone who wants them.

We are building an infrastructure of methodology, of communication, of automation, and of publicly available knowledge.” (Patterson, 2010)

This manifesto makes clear evidence of the power that pop culture has and of the tools that it can use to bring the debate closer to the people and to promote social action.

## 6. *Nanotechnology and Nanopunk*

Even though we have discussed the general facts about nanotechnology in a previous chapter, and we shall amply look at the way in which nanotechnology is imagined in various science fiction works in a following one, it is also important to look at this new technology in the context of the timeline of emerging technologies.

Even though the idea of molecular manipulation and miniaturization is claimed to have appeared in 1959 with Richard Feynman speech “There’s Plenty of Room at the Bottom”, the concept seems to have evolved from much older works of literature, such as “*Waldo*”, a short story published in 1942 by Robert Heinlein. Nanotechnology came into the focus of popular culture and science fiction in the last two decades of the 20<sup>th</sup> century and it “burst into the

collective consciousness of technology aficionados at a good time to interface neatly with the mid 1980's wave of cyberpunk stories, in which characters experience the completely programmable virtual realities of cyberspace" (Collins, 2001, p. 86) From this point of view there was a shift in the perception of artificial intelligence and cyberspace. What was once locked in the infinite realm of the computer now manifested itself in the material world. "With full scale molecular nanotech it is not just virtual reality that is programmable. The intelligent agents and viruses of cyberspace become free to roam about in the air that we breathe and within our bodies" (Collins, 2001, p. 86) This was seen as a very interesting inversion from people loading their consciousness into machines to the release of intelligent particles that shape the outside world.

Similar to the development of Cyberpunk and the less known Biopunk, recently came into acceptance the new genre of speculative fiction called Nanopunk. This genre is still very young compared to its former predecessors and it is also very similar to them but it describes a world where the use of biotechnologies are forbidden or limited and nanotechnologies are in wide use. Because of the fact that nanotechnology is still relatively undeveloped and its applications are not so widespread, the Nanopunk genre focuses mainly on the social and ethical impacts that this technology may have.

Some of the most well known writers of Nanopunk are: Kathleen Ann Goonan, best known for novels which look at a world where nanotechnologies produce major changes in humans and the way they live, Linda Nagata and also Neal Stephenson who's novel *The Diamond Age* (1995) will be discussed in a following chapter.

Nanotechnology has also been presented in numerous movies, series, cartoons and comics since becoming a pop culture item. Some notable examples include *The Simpsons*,

*Futurama, Star Trek, Star Wars, Terminator 2: Judgment Day* and many others which make a more or less clear reference to this technology but which allude to the same ideas and ethical/moral dilemmas.

### **III. Science Fiction Literature and Emerging Technologies**

“Science fiction is arguably, and in several respects, the most challenging form of literature yet devised.” (Shippey, 2005 in Seed, 2005, p. 11) It is defined as a genre of fiction dealing with the impact of imagined innovations in science and technology, often in a futuristic setting (Merriam Webster Dictionary, 2010). The main target of science fiction is to explore the consequences of new technologies or imagined innovations. In the early days when the genre was gaining shape, Isaac Asimov defined it as “that branch of literature which is concerned with the impact of scientific advance upon human beings” (Modern Science Fiction, 1953, as cited in Gilks, Flemming and Allen, 2003)

Science fiction does not address only technically literate people, but on the contrary, it is a tool for the masses to better understand the technological world and the implications that it might have on their day to day lives. The general question that science fiction asks is “what if?” a fact that brings it somewhat closer to philosophy, by tapping into the moral and ethical issues of technology.

“Science fiction serves as social criticism and popular philosophy. Often taking us a step beyond escapist entertainment, science fiction imagines the problematic consequences brought

about by these new technologies and the ethical, political and existential questions they raise” (Dinello, 2005, p. 5)

In spite of the fact that some disregard science fiction as being an essential branch of culture, many acknowledge that science fiction truly matters, “that the actual development of technology and our response (or lack of response) to it are influenced by popular culture” (Dinello, 2005, p. 5) It draws a vision of our future from attitudes, moods and biases current among artists and their audiences and not only reflects popular assumptions and values, but also “gives us an appraisal of their success in practice” (Dinello, 2005, p. 5)

Regarding the rich vein of imaginaries that we have mentioned above, we can strongly connect science fiction narratives of utopia and dystopia with the ambivalence and conflicts surrounding emerging technologies and see how “science fiction helps focus the debate as it plays out potential implications of uncontrolled technological development” (Dinello, 2005, p. 7) and provides fertile ground in which the moral dilemmas of modernity are rehearsed (Macnaghten, Kearnes, Wynne, 2005, p. 19)

Though most science fiction proposes a pessimistic view of the future and of technology as an autonomous force which is anti-human, destructive and repressive, “the realization of oppression can spur action. Rather than promoting submissive surrender to a dangerous inevitable post-human future, science fiction encourages questions about the nature of technology and its unbridled expansion [...] Science fiction helps us understand the magnitude of the techno-totalitarian threat so we might invent tactics for confronting it.” (Dinello, 2005, p. 17)

In the next part of the paper we shall look at three examples of science fiction literature which were written in different moments in history, but which have common elements and

approaches towards emerging technologies and we shall analyze the way in which they present the technology and the impact that they had on society.

1. Mary Shelley's *Frankenstein, or, The Modern Prometheus* (1818)

In 1818 Mary Shelley published the first edition of the novel which would become known as the first ever work of science fiction. Even today there are many who contest *Frankenstein* as being the book which started the science fiction genre, but as Susan E. Lederer and Richard M. Ratzan state “although there remains disagreement about Shelley’s novel as the ur-text of science fiction, no one disputes that *Frankenstein* represented a significant moment in the historical development of the genre” (in Seed, 2005, p. 455)

Even though the subject of the novel is very well known, and it has become an archetype for numerous works that followed, we shall briefly remember the essential parts.

Victor Frankenstein is a scientist who becomes interested in the process of imbuing inanimate bodies with life. He discovers a technique which allows him to reach his goal and he creates a creature by assembling various body parts from other dead bodies. After he does this, though, he abandons the creature which turns against him and seeks revenge. Frankenstein’s creation torments him and kills several of his family members and friends, including Frankenstein’s young wife, Elizabeth. Following these, the roles switch and Frankenstein hunts down the monster all the way to the Arctic Circle, near the North Pole. There Frankenstein dies of exhaustion and the creature vows to destroy itself so that no others will ever know of his existence.

The novel is representative for the motif of the scientist's creation which turns against its maker and it started a huge cultural wave which debates ethics and morality in science and which questions the limits of human knowledge. Even today, Frankenstein is a model for the modern scientists who breach the societal norms and want to test the limits of science. The Frankenstein metaphor is perfectly applicable to the issue of nanotechnology and the novel actually has many common elements with this new technology, even though they might not be visible at first.

The main fear regarding nanotechnology and the essential concern that exists within the scientific world is connected to containment, to the issue of whether or not we can control this technology. This concern is linked to the ability of certain nanotechnologies to self-replicate.

This "gray goo" scenario, which is also present in the famous article written by Bill Joy in *Wired* magazine, called "Why the future doesn't need us" (2000), is a dystopian scenario which can also be found, at a certain level, in *Frankenstein*. "For good reason, Dr. Frankenstein refused to provide a sex partner for his monstrous creation, fearing the disastrous consequences of a thousand Frankenstein monsters" (Dinello, 2005, p. 238)

Regarding the issue of emerging technologies we can observe a very interesting feature of the novel. The secret of life presented within the text is electricity and also electrical machinery appears prominently in the set designs of all the Frankenstein movies, but when narrating, Mary Shelley does not go explicitly into science and leaves it to the reader's imagination to create the laboratory in which the creature comes to life. Throughout the whole book, only two sentences allude to lightning and electricity.

In spite of that, as we have mentioned above, in the 1790's, Luigi Galvani, an Italian anatomist performed numerous experiments in which he applied electric sources to the dissected muscles of a dead frog, producing movement. These experiments became widely known and

drew the attention of Mary Shelley who took the idea and combined it with the popular consciousness that associated electricity with death and which feared this new unknown force. Thus she was able to create a scenario which would set the stage for thorough debate on the limits of human knowledge and the ethics and morals of science within the context of modernization and the Industrial Revolution.

*Frankenstein*, thus, is a clear example of how literature, pop culture and science fiction reacted to the emergence of a new technological force and played their essential role of imagining a potentially threatening scenario in order to stimulate the public and to draw its attention to the potential dangers and ethical implications of science and technology at the time.

## 2. Isaac Asimov's *I, Robot* (1950)

The next book that we shall look at, due to its strong pop culture influence and importance is Isaac Asimov's "*I, Robot*". The work is a collection of nine science fiction short stories which was first published in 1950 and contains narratives which appeared in various magazines for science fiction readers between 1940 and 1950.

The book is written in the frame story technique and the stories are told by Dr. Susan Calvin to a reporter, who is also the narrator, in the 21'st century.

All the stories share themes of interaction between robots and humans and pose very interesting questions of morality and humanity. The book contains the short story "Runaround" in which the Three Laws of Robotics, created by Isaac Asimov first appear. These are a set of rules which Asimov uses as a vehicle for various debate issues on ethics and morals. The laws are: 1. *A robot may not injure a human being or, through inaction allow a human being to come*

*to harm. 2. A robot must obey any orders given to it by human beings, except when such orders would conflict with the First Law. 3. A robot must protect its own existence as long as such protection does not conflict with the First or Second Law*

Asimov, just as Shelley targets an emerging technology, or technological wave, namely robotics and puts it on a stage for debate and analysis. The difference between Asimov and many other science fiction writers, and one of his greatest merits, is that the questions he poses in his narratives and the lessons that he draws counter the widespread robot phobia which existed at the time of his writings. “From the very first days, much of the actual narrative focus of the Robot stories has not been on robotics at all – not even, for that matter, directly on the Three Laws themselves – but on a long conflict between robots (and those who make and use them) and the very large number of people who irrationally despise and fear them.” (Clute, 2005 in Seed 2005, p. 369)

Asimov posed seemingly philosophical questions about an imagined world where robots and humans can live together. He showed many of the potential dangers that arise with this, but also, more importantly the benefits that may come with such a symbiosis. He sends positive messages about robots through his stories, and lobbies for their social acceptance but also highlights a certain technological determinism which can be considered dangerous. As his main character Dr. Susan Calvin states towards the end of the book “Only the Machines, from now on, are inevitable”.

Asimov’s book, and especially his three laws “revolutionized the science fiction genre and made robots far more interesting than they ever had been before” (Kreiter, 2004) It brought robots to the center stage of public debate and this attention had a strong impact on further

technological development and innovation in robotics. One good example for this is the name of the real-life manufacturer named U.S. Robotics which took its name directly from *I, Robot*.

### 3. Michael Crichton's *Prey* (2002)

Worldwide known science fiction thriller author, Michael Crichton wrote the most disturbing and scientifically accurate novel about a nano-robotic threat to human-kind. His book is a reaction to the growing attention given to nanotechnology in the past years and serves as a cautionary tale about the recent developments in science and technology, more specifically in genetic engineering, artificial intelligence and nanotechnology.

Crichton is also the author of the well known *Jurassic Park*, a novel showing the dangers of tampering with biology, in a way very similar to Mary Shelley's *Frankenstein*, which was written as a reaction to the biotechnology controversies of the time and which was very influential and led to the creation of the 1993 film, *Jurassic Park*, directed by Steven Spielberg, a blockbuster that won numerous awards and was critically acclaimed as a great success.

*Prey* is centered on Jack Foreman, a forty-year old computer programmer who loses his job and is forced to become a househusband, while his wife, Julia, is working on a top secret project for the Defense Department with her company, Xymos. The project is on developing a certain type of nanotechnology and it is taking place in the Nevada desert at the Xymos Corporation Plant.

Pretty soon things start to become weird for the Foreman family as their youngest child becomes ill and Julia is involved in a car crash. Jack is stunned by these events but before he can figure things out he is hired by Xymos as a consultant on his wife's project. He is quickly called

to the Nevada plant because of some problems, but once he arrives there everything goes wrong and he finds himself trapped in a battle for survival with highly evolved and deadly nano-swarms. While fighting for their lives, the people trapped in the plant soon discover that there is more behind their research project and that the nano-swarms pose a threat to the entire human-kind.

In its first 6 months of publication, more than one million copies of *Prey* were sold and the book was listed on the *Times* best-seller list for 15 continuous weeks (“New Clancy Novel”, 2003) “For millions of readers, *Prey* is a techno-thriller which depicts the convergence of three scientific domains – nanotechnology, biotechnology and information and communication technology” (Binks, Bowman, Hodge, 2007, p. 436)

In their 2007 article “Are we really the Prey? Nanotechnology as Science and Science Fiction”, Diana M. Bowman, Graeme A. Hodge and Peter Binks, state that “popular culture can play a significant role in shaping the acceptance of evolving technologies, with nanotechnology likely to be a case in point” (p. 435). They examine the role that scientists and popular culture play in educating society, and one another, about emerging technologies.

Michael Crichton’s novel is probably one of the best pieces of evidence which shows that science fiction and pop culture have a strong influence on the public perception of emerging technologies and that the information that people receive from these sources shape their expectations, stimulates their participation to the ethical and moral debates and guides innovation processes.

Interestingly, when asked how respondents had heard about nanotechnology, in a study, the most “dominant source of information was the mass media, such as television, movies and magazines” (Sheetz et al, 2005, in Binks, Bowman, Hodge, 2007, p. 437) Although nowadays

the general idea is that the public has very limited knowledge about nanotechnology, “Nordmann (2004) has suggested that popular culture such as texts and movies will become an important medium through which nanotechnology is communicated to society” (cited in Binks, Bowman, Hodge, 2007, p. 437)

Furthermore, the empirical work of Gaskell, Ten Eyck, Jackson, and Veltri (2005), which was a comparative study of public perception of nanotechnology in the United States and the European Union “found that *Prey* was one of three sources to dominate the increasing coverage of nanotechnology risk during 2002-2003”. They contend that “mass media will play a role in the shaping of public attitudes towards nanotechnology” (Gaskell, Ten Eyck, Jackson, and Veltri, 2005 as cited in Binks, Bowman, Hodge, 2007, p. 437)

In their survey of 1.536 randomly selected adults, Cobb and Macoubrie (2004) specifically examined the association of science fiction writing – in this case, “*Prey*” – and its impact on the public’s perception of nanotechnology. The overall conclusion of the researchers was rather more downbeat, when stating that “survey data show that public opinion is negatively affected by knowing the details of *Prey*” (Cobb, Macoubrie, 2004 as cited in Binks, Bowman, Hodge, 2007, p. 437). Their finding was afterwards labeled as “the Prey effect” and it has been noted in the nanotechnology discourse of many leading figures.

The article by Binks, Bowman and Hodge concludes that “popular culture will be a key factor in informing citizen beliefs about the coming nano-age” and also that “Michael Crichton’s novel is a great read, and if it is to follow on the footsteps of some of his other novels such as *Jurassic Park* and be developed into a blockbuster movie, it is likely to result in a surge of interest in nanomatters” (2007, p. 442)

#### IV. Nanotechnology in Literature

Science fiction, as we have seen before, responds to the main technological trends of a certain age and creates narratives which explore the limits of those technologies and challenge them in the view of society and for the benefit of entertainment as well as information and creating awareness. Besides the very well known example of *Prey*, that we have discussed above, there are also numerous other literary works which explore the field of nanotechnology. As it was the case before with space travel, time machines, virtual realities and cyberspace, nanotech has become today one of the core plot devices on which science fiction writers draw (Collins, 2001, p. 86) We shall make note of the most important works which explore this field and we shall see the way in which nanotechnology is portrayed in order to have a more clear view on the social impact that these narratives may have and on the way in which they might influence society's perception.

There are numerous works of science fiction which deal with this topic but out of all these three of them are particularly relevant to understanding the promises and dangers of nanotechnology: Greg Bear's 1985 novel *Blood Music*, Neal Stephenson's 1995 novel *The Diamond Age* and James Halperin's 1998 novel *The First Immortal*.

Some state that *Blood Music*, by science fiction writer Greg Bear, is actually the first story to describe nanotechnology, even though throughout the book the term is not actually used. (Miksaneck, 2001, p. 58) The plot of the book shows Edward, an obstetrician gynecologist who narrates the story, meeting up with an old college friend named Vergil Ulam, a scientist working inside a corporate nanotech laboratory doing military research. Ulam's work is focused on creating artificially intelligent cells which function based on organic microcomputers, or

Medically Applicable Biochips (MABs), which he develops unauthorized. When his work is discovered and his superiors threaten to destroy it, Ulam cannot bear it and he injects the biochips in his body so that he can smuggle them out of the laboratory. Inside his body the cells begin to evolve and to communicate, creating cooperative clusters that assemble themselves into a collective civilization that perceives Ulam as their universe, their God. Very soon though, the cells become more and more intelligent and realize that their creator is not the universe, so they break out and start multiplying and engulfing everything in their path to accommodate their own agenda. In the end nothing is left but an amorphous mass which absorbs all the individual human minds into becoming one entity.

*Blood Music* raises probably the most important issue surrounding the nanotechnology debate. It asks the question 'how can it be controlled?' "While Asimov-style safety measures have been proposed, the computer code which programs nano-reproduction will be subject to errors and glitches just like any other software. These errors could result in mutations altering the replicated nanodevice" (Dinello, 2005, p. 241)

The title of the novel is very unusual but also very suggestive, sending mixed messages related to various elements. "Music evokes human achievement and culture but when modified by the adjective blood, the term connotes something tainted or injured. In much the same way, nanotechnology holds positive and negative promise. It integrates mechanical and organic elements in a manner that has the potential to improve, expand, subjugate, or eliminate the human species." (Miksaneck, 2001, p. 59)

The book tells a frightening story which echoes with the possibilities and risks that are unraveled by the advancements of modern science. The author sends a clear warning that humanity will never be able to subdue nature and that tampering with the building blocks of life

will lead to disastrous consequences for those who pursue these goals as well as for their loved ones. Bear's story continues a long and very well known legacy of doomed scientists in literature, such as Dr. Jekyll in Robert Louis Stevenson's story from 1886, and Griffin in H.G. Wells's *The Invisible Man* from 1897 (Miksaneck, 2001, p. 58) The way in which the events are presented and the effects that the mutations have on the individuals and on humanity as a whole "will absolutely not sell the idea of nanotechnology to the reader" (Miksaneck, 2001, p. 58) and most probably will generally lower the public support for such a risky technology in a considerable way.

*The Diamond Age, or, A Young Lady's Illustrated Primer* is a novel written by Neal Stephenson and published in 1995, which presents a future world in which nanotechnology controls all aspects of life. The Vicky's are a technological elite which control society through "the Feed", an encrypted network of nanotechnology surveillance and weaponry. In this world, a highly intelligent nano-programmer named John Percival Hackworth is hired by a Vicky to devise a book that will educate his granddaughter in becoming a woman with a free mind and a strong character. The scientist delivers the task but violates the ethics of his tribe by creating a duplicate of the book (in the novel named "*A Young Lady's Illustrated Primer*") which gets stolen and ends up in the possession of Nell, a poor girl living in the slums. The Primer changes Nell, opening her mind and transforming her life. She learns everything about the world and gets profoundly attached to the human counterpart of the book (the live remote actor, or "ractor") which in time becomes somewhat of a mother to her. In the mean time, Hackworth is expelled from his tribe and forced to live amongst the Drummers, an underwater techno-society with a hive mind that allows them to solve extremely difficult nano-construction programming problems. Parallel to this, there is rising violence and protests against the Vicky hegemony from

opposing tribes who wish to bring down their oppressors and to replace the Feed system with “the Seed” a liberating and decentralized technology. Nell’s surrogate mother becomes a key player in the tribes’ plans to implement the Seed, but for the process to work she needs to be sacrificed. Because of this, in the final part of the story, Nell enters the world of the Drummers and saves her surrogate mother while shutting down the efforts of the opposing tribes to impose their counter-technology. In spite of the fact that she is against the control of the Vickys, Nell sees that the Seed technology is just as oppressive and that even though it promises freedom, this also comes with the price of conformity.

The nanotechnology imagined in *The Diamond Age* brings numerous benefits “yet its use ultimately serves oppressive ends as it forces people to accommodate to its Feed/Seed system. This is what Langdon Winner calls ‘reverse adaptation’ – the adjustment of human ends to match the character of the available means” (Dinello, 2005, p. 234)

In this novel, Stephenson portrays a nano-dystopia based on technological dictatorship. The technology has developed in a positive way and it is still under human control, but the choices that humanity makes regarding the direction in which this technology should be used is flawed and reveals an immense risk. Thus we can see that containment, as presented in Greg Bear’s novel is only one of the many problems that need to be addressed. Should nanotechnology develop, in ways more or less similar to those presented in the science fiction novels that we are discussing, we need to take into account all the potential risks that may arise, not only connected to the technology itself, but also to the people developing and handling it.

*The Diamond Age* contains elements which may appeal to numerous techno-optimists but can also have a negative social impact on those people who consider various government structures as oppressive or intrusive. The novel also contains useful information on

nanotechnology and its basic concepts and may serve as a source of information besides fulfilling its goal to entertain. There have been discussions and several news sources show that *The Diamond Age* will be also adapted into either a short series or a motion picture. This will surely increase the interest in the topic and bring the nano-dictatorship debate closer to the public.

James Halperin's novel, *The First Immortal* differs from the previous two that we have discussed by portraying a very positive and controlled nanotechnology in a future where death has been defeated and biological immortality exists. This is achieved by the development of cryonics, the preservation of one's body at very low temperatures for a long period of time until medicine is developed enough to reanimate it and resolve its medical condition.

The story focuses on a man, Benjamin Franklin Smith, who is born in 1925 and suffers a heart attack in 1988 that makes his death inevitable. In spite of this, he chooses to be cryogenically suspended hoping that medicine will advance in the future so as to be able to repair his heart and bring his body back to life. Just as the man predicted, nanotechnology greatly advances and his great grandson, a scientist by the name of Trip Crane, develops a technology which allows frozen bodies to be brought back to life, repaired and even improved to be healthier and younger. Thus, after being frozen for more than 80 years, Benjamin Franklin Smith is revived and he reunites with members of his family, many of which are also brought back from cryogenic suspension. The book concludes with Smith's family celebrating his 200<sup>th</sup> birthday and with his warning "that the only things that threaten immortality are gullibility, fear, self-destruction and boredom" (Miksaneck, 2001, p. 63)

Halperin's story paints a much brighter picture of the future than most other science fiction books. Similar to Asimov in the quest to advocate for technology and to support a future

where humans and machines live together, the author “optimistically presents a future world that has not only developed a technology that revolutionizes medicine but also the ethical and philosophical principles to guide it.” (Miksaneck, 2001, p. 63)

In spite of this, though, the issue of immortality is a very delicate and subjective one with numerous controversies. Transhumanists will greatly support the ideas that this book proposes but on the other side there will be many to challenge the morals and ethics of living forever and the dangers that may come to humanity as a whole. Even when we are faced with a techno-utopia in which the greatest challenges of our natural condition have been overcome, there are still numerous complications that arise. Thus, even though nanotechnology might develop under our control and the apocalyptic futures envisioned by some may be avoided, this technology might still bring severe changes to our societies and to our way of life and we need to anticipate these changes, analyze them and subject them to public debate.

*The First Immortal* may have a very positive impact on techno-optimists and transhumanists and might increase the support of nanotechnology towards achieving the goals envisioned in the novel, but on the other hand it might create opposition to this technology on the side of those who highlight the ethical and moral risks of immortality as well as counter the idea of “playing god”.

As we have stated above, there are numerous other literary works which discuss nanotechnology, envision future worlds shaped by it and look into the social changes that this technology triggers. Some notable examples include: Kathleen Ann Goonan’s Nanotech Cycle, with *Queen City Jazz* (1994), *Mississippi Blues* (1997), *Crescent City Rhapsody* (2000) and *Light Music* (2002); Kevin J. Anderson’s *Fantastic Voyage: Microcosm* (2001), Greg Bear’s *Queen of Angels* (1990) and *Slant* (1997) as well as Paul J. McAuley’s *Fairyland* (1997).

## V. Nanotechnology in Film

“Over the last decade there has been a significant shift in the attitudes of philosophers as they have become increasingly receptive to the opportunity to apply methods of philosophical inquiry to film, television, and other areas of popular culture. In fact *receptive* is far too mild a word to describe the enthusiasm with which many philosophers now embrace popular culture” (Sanders, 2008, p. 1)

Ever since the public’s attention became somewhat focused on the issue of nanotechnology, and mostly after the release of Drexler’s *Engines of Creation*, numerous films have envisioned this new technology and presented it in various ways. A dark view of nanotechnology has been represented in a series of science fiction films, particularly *The Hulk*, *Agent Cody Banks*, *Jason X*, *Cowboy BeBop*, *G.I. Joe*, *The Day the Earth Stood Still* and *Terminator 2: Judgment Day*. In the following part we shall look at a few recent motion pictures which present nanotechnology and see how it is envisioned and what impact this may have on the general public.

*The Day the Earth Stood Still* is a 2008 motion picture, directed by Scott Derrickson and starring Keanu Reeves and Jennifer Connely. The movie is a remake of the 1951 science fiction classic and presents the visit of an alien named Klaatu and his robot counterpart to Earth. The movie had an estimated budget of 80 million dollars and a worldwide box office gross of over 230 million. It was seen as a box office hit but the reviews by critics were generally negative.

In spite of the subject and the disappointment of the fans of the original, the movie contains state of the art special effects and probably the most well represented imagination of the “gray goo” scenario. Even though the word nanotechnology is not mentioned in the movie, the

technology presented is clearly linked to it. A small robot insect, very similar to a nanobot is released by Klaatu's robot which then creates another one and so on, until a huge grey cloud of nanobots sweeps through the world engulfing everything in its path. The nanobots consume everything they encounter and the cloud grows bigger and bigger until it is stopped by Klaatu.

The technology presented in the movie is destructive and anti-human. It is an alien technology which we cannot understand and which enslaves humanity within hours from its release. The messages that this scenario sends are predominantly negative and even though the mention to nanotechnology is not made, the public correlated the movie to this technology and were given a close look on a possible outcome of a nanotechnology accident, spreading, maybe, even more fear in the heart of techno-skeptics.

The only other cinematic envisioning of the gray goo scenario is found in *The Blob*, a 1988 horror remake of a 1958 film. Even though the term nanotechnology is not mentioned again, the plasmid life form presented in the movie is built from organic matter rich in carbon, similarly to how nanomachines will likely be developed from carbon nanotubes. The Blob is a "predatory mound of viscous, corrosive sludge" (Dinello, 2005, p. 242) which engulfs everything in its path and dissolves it while enlarging itself more and more. The truly dark part of the movie is not the monster itself, but the government unit that shows up to counter the threat. They want to freeze the monster and use it as a biological weapon stating that the lives of the town's inhabitants are expendable. This movie, even though declared a disaster itself by the critics, sends an anti-military warning (just as numerous other similar films) and imagines the danger of an immensely powerful technology falling into the wrong hands. It makes the audience ask the question whether or not scientists and decision makers are capable of making the right choices in critical situations and when faced with new technologies that might have unforeseen results.

The 2009 film *G.I. Joe: The Rise of Cobra* is an action movie inspired by the Hasbro line of toys, which presents nanomite-weapons used by an evil organization to destroy the world. Nanomites are synonyms to nanobots in the movie and they are a technology developed only for destruction and used for evil purposes. While the “good guys” in the movie use traditional mainstream weaponry, the nanomite weapons are used only by the evil organization. This sends a strong anti-nano message by classifying the weapons which use nanotechnology as evil. Furthermore, there is even a scene where the Eiffel tower is destroyed by such a weapon and the nanobots consume its steel and make it collapse.

*Gamer* is a 2009 science fiction film set in a dystopian future, starring Gerard Butler. In the movie, nanotechnology is presented as a human enslaving technology, with the main antagonist explaining how nano-cells are implanted in the brain and they attach themselves to regular brain-cells which afterwards are computer controlled. This is a completely negative portrayal of nanotechnology. It is seen as a human-enslaving tool which can bring about the ultimate techno-totalitarian future. From the point of view in which the technology is imagined we can actually see a clear mix between the intelligent nano-cells presented by Greg Bear in *Blood Music* and the centralized control of individuals through nanotechnology as portrayed by Neal Stephenson in *The Diamond Age*.

Interestingly, we look at the 1991 motion picture *Terminator 2: Judgement Day*, directed by James Cameron and starring Arnold Schwarzenegger. The movie is considered one of the best science fiction films of all time and was a worldwide box office hit. It was also extremely well received by critics and fans of the genre alike and has left an important mark in the history of cinema. The main antagonist in the movie is a shape-shifting, liquid metal robot which is said to be an amorphous structure composed of millions of tiny self-assembling nanobots. This

character, which later became an iconic pop culture villain, was sent back in time from the future, by the machines, with which the humans are at war, in order to change the course of history.

The personification of nanotechnology within the body of a villainous robot sends a clear message against this new technology. Furthermore, in the film, the shape-shifting robot is battling another robot, a defender of the humans, which is built using more familiar robotics technology. This is a very interesting metaphor which shows the battle between old or contemporary technologies and new technologies, which are feared and seen as oppressive and anti-human, stemming from our general fear of the unknown.

Because of the huge success of the movie and because of its strong influence on popular culture we can clearly say that it had, and probably even today has, a great influence on the public perception of new technologies, namely nanotechnology, but it is very hard to say whether this impact is predominantly negative or not.

Shifting the focus towards the famous, worldwide phenomenon which is the *Star Trek* universe, we look at the Borg, a fictional race of cybernetic organisms which plays the role of a major alien threat. The Borg travel the universe and forcefully assimilate other species and technologies into their collective. In the movies and the series, the Borg are said to have already assimilated numerous other species in the universe. Whenever they encounter a new race they merely attribute a number to them, symbolizing the lack of importance given to other cultures and the sole purpose that they have of extending their own collective. The process of assimilation is done through the injection of nanoprobes (or nanites) in the individual's bloodstream by a Borg drone. The nanoprobes travel throughout the victim's body and attach themselves to blood

cells like a virus. This process is very powerful and impossible to fight, as the Borg say themselves, a phrase which has become iconic: “resistance is futile”.

The Borg has become a symbol in pop culture of an ever expanding entity, driven by the single goal of assimilating everything in its path. The nanotechnology used in the movies “subverts liberal values of freedom, autonomy and individuality and frequently represents the ultimate techno-totalitarian dystopia” (Dinello, 2005, p. 237)

Given the fact that *Star Trek* is such a widespread and influential phenomenon we can clearly state that the use of nanotechnology in the movies has a certain influence on the way the public perceives it. In spite of the fact that the Borg technology is seen as ultimately oppressive, there are also other brief mentions of nanotechnology which is used for less diabolical purposes.

As we have mentioned above, there are also numerous other movies in which nanotechnology is presented in various ways and many of them have a clear impact on the general population and influence their perception on new technologies.

Furthermore, Sheetz et al. (2005) argued that “the most devastating mention of nanotechnology is yet to come. The motion picture version of *Prey* will include not just a casual mention of nanotechnology, but will portray it as the villain at large that mercilessly threatens mankind. This will become the loudest and most destructive mention of nanotechnology to date (p. 336)” (as cited in Binks, Bowman, Hodge, 2007, p. 442)

Twentieth Century Fox has already purchased the motion picture rights to Michael Crichton’s *Prey* as soon as the book came out.

## **VI. Discussion and Main Points**

Coming to the discussion part of our paper we look above and see arguments in favor of claiming that there is a clear connection between pop culture and science fiction, and the way in which new technologies are socially accepted, debated and introduced in society.

From a social sciences perspective we see that many interventions are analytically attuned to the future when discussing nanotechnologies because of their emergent quality. Daniel Barben, Erik Fisher, Cynthia Selin and David H. Guston state in their paper that

“Prominent expectations about nanotechnologies run in two directions: towards an elixir for postindustrial ills through seamless interaction with nature, instantaneous and non-polluting production, and unprecedented wealth and health (Drexler, 1986; Anton, Silbergitt, Schneider, 2001; Wood, Jones & Geldart, 2003) and toward an Armageddon wrought by self replicating nanobots (Joy, 2000) or, more soberly, environmental hazards, unintended consequences (Tenner, 2001), shifts in privacy and security (MacDonald, 2004) and greater economic inequalities (Meridian Institute, 2005)” (2007, p. 985)

In our paper we contribute to the field of STS by looking at the role of science fiction in the development of nanotechnologies and contradict the view that science fiction is “a kind of smoke screen hovering over more sober issues of concern” (Alpert, 2007, p. 266)

There are many who consider that the pop culture fantasies of nanotechnology might be dangerous and throw back public support for this technology, their argument being the historical negative public reactions to nuclear power generation, recombinant DNA, GMO's etc. and “the media's well known tendency to pit extreme against extreme, aggravating the polarization of opinion” (Alpert, 2007, p. 266). Here, on the other hand, we argue that science fiction visions of

the future are an essential part of foresight, which “aims to enrich futures in the making by encouraging and developing reflexivity in the system” (Barber, Fisher, Selin and Guston, 2007, p. 986)

Nevertheless, we acknowledge that in science fiction, as a form of literature and thus a form of art, there are works of various values and quality, just as in any other art form. It goes without saying that there are numerous works of science fiction which do not achieve their goal of asking the “what if” question and merely paint a picture of the future or of certain technologies that stem from the author’s imagination but do not contain any social criticism or philosophical substrate. We focus here on the works of science fiction which are valuable for the public for several reasons and which pose valuable questions about ethics, morals and humanity.

One thing that we notice, as we have mentioned above in a previous chapter, is that science fiction generally paints a predominantly negative picture of the future. Most science fiction works imagine post-apocalyptic futures and technology out of control, humanity enslaved and a constant battle between us and technology (or “the machines”). Nanotechnology falls into the same science fiction category, and because of its high level of risk and worldwide consequences, it is generally portrayed as the ultimate negative technology, a force which we cannot understand but which seems to be the root of evil or the primary tool used by those who wish to harm humankind.

Thus we can say that the message sent by most of the pop culture materials about nanotechnology is a negative one and that the public perception of nanotechnology may be predominantly negative, but this does not mean that science fiction is not doing its job. Because we are faced with such a powerful technology and because its implications may change the way in which we see the world and the way we live, we also need to be informed about the potential

risks and about the worst case scenarios that may occur. By providing the population with a great quantity of imaginaries we facilitate its analysis of the situation and allow it to weigh out the benefits against the risks and decide whether or not it will accept the technology.

This can be considered a general cycle for all new technologies as we have seen above, the case being the same in the 1950's with the issue of robotics. Society is very skeptical when faced with technologies that can bring so much change, but if they have a broad sphere of "risk assessments" (if we may call them so) provided by science fiction and pop culture, they may chose to accept the technology and allow it to penetrate society and their day to day lives.

This social acceptance of technology is essential because the general population has the capacity to guide technological advancements through the democratic process. If a technology is not socially accepted and if the public interest is not guided towards it, than the research interest in that technology and the funding available will surely drop.

Nowadays, nanotechnology is in the emergence stage and huge amounts of money are invested in it by states and organizations alike. This is the moment when the population of the world needs to be informed about the benefits and the risks of this new technology. But the channels of communication with the public when it comes to new technologies are very complex and hard to maneuver. As Jose Lopez notices "science fiction as a literary genre is, in fact better at opening up a space for critical reflection than is the NST [nano-science and technology] discourse [...] In other words, ironically, literary science fiction succeeds where NST discourse fails" (2004, p. 147)

The most pessimistic science fiction views depict humanity as the victim of an oppressive, omnipresent technological force, "despair, cynism and fatalistic thought often rationalize capitulation to the apparent inevitability of technological expansion [...] But the

realization of powerful repression often provokes an equal powerful response that shifts the dynamic [...] Science fiction often argues for a progressive political agenda, urging us to ask questions and confront the ideology of techno-totalitarianism” (Dinello, 2005, p. 275) The finest feature of science fiction is that it projects a dark future but at the same time encourages us to create a better one for ourselves.

“After all, in the midst of today’s intellectual debates around science, global greats such as Hawking continue to remark that ‘tomorrow’s science is today’s science fiction’”(Binks, Bowman, Hodge, 2007, p. 438). Following this trail of thought we can clearly observe that there is a very thin line between the dreams of today and the science of tomorrow.

In his 2010 article “Modifiable Futures – Science Fiction at the Bench”, Colin Milburn states that “historical and literary studies of science have become increasingly attentive to various ‘literary technologies’ in scientific practice, the metaphorical features of scientific discourse, and the impact of popular science writing on the social development of scientific knowledge.” (p. 560) He shows how in many ways, the normal activities of scientists in laboratories resemble activities of science fiction fans like sampling and building on the works of others, taking the successful parts from one experiment and using it in another, imitating best practice etc. Thus he suggests that the understanding of how science fiction actually works at the bench would be improved by seeing scientists as cultural consumers or science fiction fans which have at their disposal tools and resources for making cultural materials usable for science. Furthermore he coins the term “science fiction mods” as forms of modifying science fiction for usability by technoscience and identifies “blueprint mods”, “supplementary mods” and “speculative mods”. All of these refer in a certain way to efforts of bringing the elements of a science fiction text closer to the technical reality.

There are already numerous examples of these mods that facilitate the process of extracting scientific and technical resources from science fiction such as *The Science of Anime: Mecha-Noids and AI-Super-Bots* (2005) by Lois H. Gresh and Robert E. Weinberg; *The Real Science Behind the X-Files: Microbes, Meteorites and Mutants* (1999) by Anne Simon; *The Science of Harry Potter* (2002) by Roger Highfield and *The Science of Star Wars: An Astrophysicist's Independent Examination of Space Travel, Aliens, Planets and Robots as Portrayed in the Star Wars Films and Books* (1999) by Jeanne Cavelos. These works “remix popular culture with elite science and [...] often attend to elements of science fiction that, in their native (i.e. diegetic) form, cannot be directly adapted to technical purposes.” (Milburn, 2010, p. 567)

Having these in mind we look at the field of nanotechnology, which is still in its infancy compared to other technologies and we see the potential that the science fiction works which we have discussed in previous chapters have on the future development of science and technology. Many such works are written by people who are technically literate and who develop their stories starting from scientific ideas which are potentially achievable but in a relatively distant future. The fact that more and more such stories are written increases the chances that they become widespread and that they will draw the public attention towards nanotechnology. This will not only lead to development in this field but also could supply scientists with ideas and starting points for valuable research with useful applications. “Science fiction does not only drive science, any more than science simply drives science fiction. Rather they have a relationship of ongoing and productive mutual modification” (Milburn, 2010, p. 568)

In order to fully benefit from the relationship that science fiction has with science and technology, Milburn, in the same article also draws attention towards the etymological impact

that the word “influence” has and the way in which it should be correctly used and understood. He states that “if we continue to speak of influences or infections, it should be in this upgraded sense of end-user modifications and inter-textual negotiations” (2010, p. 569)

Also very interesting, Langdon Winner, in his well known article, “Do artifacts have politics?” (Winner, 1980) brings to the floor an exciting idea. He questions whether or not technological objects, structures, buildings etc. embody specific types of power and authority relationships. In order to make his point more clear he uses the example of Robert Moses, the urban planner of mid 20<sup>th</sup> century New York City, Rockland County, Long Island etc. who built a large number of low hanging overpasses over the verdant parkways that lead from New York City to the beaches of Long Island, thus preventing public busses, serving mainly low-income groups of people, from accessing the beaches, while those part of the upper class owning automobiles had no such problems. He states about Moses that “many of his monumental structures of concrete and steel embody a systematic social inequality, a way of engineering relationships among people that, after a time, becomes just another part of the landscape” (Winner, 1980, p. 53-54). Furthermore, Martijnitje Smits states in the article “Langdon Winner: Technology as a Shadow Constitution” (2001) that “technological objects and systems form what I might call a ‘shadow constitution’, a hidden political power in society, an unwritten set of laws that establish social roles and relations.” (Smits, 2001, p. 149).

Keeping this in mind and looking at nanotechnology we see a very strong connection and numerous underlying messages that exist in the science fiction narratives discussed previously. The Drummers in Neal Stephenson’s *The Diamond Age* and the Borg in *Star Trek* both use the very well known motif of the hive mind, facilitated by nanotechnology. The hive culture has been portrayed in science fiction for a very long time. Robert Heinlein’s novels *Puppet Masters*

(1951) and *Starship Troopers* (1959) as well as the 1954 film *Them!* “reflected American fears associated with Communism: the anti-individualistic ideology is symbolized by the communal mentality of the invading force of parasites, insects and ants” (Dinello, 2005, p. 236) More recently we also have valuable examples such as the nanobot swarms in Michael Crichton’s *Prey* (2002) or the army of robots from the movies *Star Wars Episode I: The Phantom Menace* (1999) and *I, Robot* (2004) which “all follow in the technophobic tradition of the hive mind as a technological horror. The merged consciousness of the collective destroys individual identity, eliminates the boundary of the body and undermines a coherent sense of self” (Dinello, 2005, p. 236)

Thus, we can clearly see that the way in which nanotechnology is imagined in narratives and films might send subtle political messages and also influence the public perception in various ways. Science fiction metaphors can be a powerful vehicle for hidden meanings that seek to enhance or undermine the support for nanotechnology and we need to pay very careful attention to the type of politics which might be willingly or unwillingly implemented in them.

## **Conclusions and Further Research**

After having gone through all of the above we now have a clearer image of the way in which nanotechnology is presented in science fiction literary works and movies as well as of the way in which popular culture is reacting to this emerging technology. There is definitely a strong link between science facts and the ideas presented in science fiction. We see how numerous authors are inspired by real scientific and technological discoveries and how they take real life elements and project them into possible future scenarios where their potential impacts on society are discussed. Scientists on the other hand also look towards the world of the imaginaries and may extract useful elements which they can use in real life applications. Even though they are constrained by the laws of nature which apply to our natural world, they can still be inspired by creative ideas which spring from the minds of those who are not bound by the limits of science and who let their imaginations create technological wonders.

Regarding the way in which popular culture and science fiction influence the public perception of nanotechnology we can state that due to the little knowledge that the public has about this technology, and the fact that most of the literary and film works developed on this topic portray dystopian futures in which nanotechnology is either out of control or used for diabolical purposes, the messages sent towards the public may be generally negative. As we have stated above, stemming from the lessons learned in the past we can deduce that this is actually a process that all powerful new technologies need to go through. The public actually should be skeptical about the implications of a new technology so as to subject it to a sort of a peer review through which all the glitches and the possible negative outcomes are taken into consideration and eliminated. There is also a risk that all the negative portrayals of this technology and the

dangers that it implies may also reduce support for its development because of public rejection. This situation is highly undesirable because the public needs to be better informed also about the numerous benefits that such a technology would bring in order to make a correct assessment of its impacts and to decide whether or not it is worth researching.

As we have previously mentioned, there are numerous methodological difficulties when researching such a topic and concrete clear answers cannot be given without the shadow of a doubt. We need to make a clear distinction between the messages that science fiction narratives send towards the public about a certain technology and the effects that these messages may have. Given the fact that we do not have the necessary tools to evaluate the impact on the public we need to restrain our focus towards the message part. Because of this, we can only presume, relying on the evidence that we have discussed before, that there is an overall negative tendency in the messages that popular culture sends in society when dealing with nanotechnology.

As Colin Milburn describes, in the 19<sup>th</sup> century, Jules Verne and H.G. Wells presumed that their amazing stories would promote the awareness of scientific knowledge and advancements in technology. Hugo Gernsback as well understood science fiction as a “means of educating the public to the meaning of science as well as providing the most delightful and stimulating entertainment” (Milburn, 2010, p. 562) Thus we see the importance that this literary genre has, and how along with the field of popular culture it plays an essential role in drawing the public’s attention towards new technologies and creating awareness about important social issues related to them.

Because of these we see the need for thorough research on imaginaries and the importance that they play within society. Our current study is only a small starting point, offering an introduction and an overview into a line of research that should be amply looked into.

Nanotechnology is still in an incipient state of development and that it why this is the perfect time to look into its implications until the emergence of the technological advancements which may have a large impact on our lives and maybe even on the world. Hence we suggest that detailed research be done in analyzing the way in which nanotechnology is portrayed, not only in literary works and films, but also in video games, comic books, graphic novels, television programs etc. Moreover, these studies should be done through the development of reflexive relationships with scientists and other social actors, within academic laboratories, government research sites as well as within corporate research and development settings.

Very importantly, as we have also seen in our study, the means of communicating information about nanotechnology are highly underdeveloped and that is why research should be done towards the development of new and innovative communication channels. Also the approach of a structured dialogue should be taken instead of the more frequent and inefficient means of unilateral communication.

Furthermore, researchers should focus on exploring the role of narratives in scenarios of techno-moral futures but should also focus on developing techno-ethical scenarios about nanotechnology's implications on society, which should be tested in focus groups, and active dissemination strategies should be pursued so that these scenarios are brought to the attention of the larger audience for information purposes.

Finally, we would like to highlight the need for an interdisciplinary approach whenever discussing nanotechnology. Researchers from the fields of physics, chemistry, engineering as well as philosophy, politics and science and technology studies should pool resources and interact so that their fields become complementary and the knowledge spillovers that are created benefit society and stimulate innovation, research and development.

## References

### Analyzed Works:

#### Literature

Asimov, I. (2004 [1950]) – “I, Robot”, Bantam Dell, New York

Bear, G. (1985) – “Blood Music”, E-reads.com

Crichton, M. (2002) – “Prey”, Harper Collins, New York

Halperin, J. L. (1998) – “The First Immortal”, Ballantine Books, New York

Shelley M. (2003 [1818]) – “Frankenstein, or the Modern Prometheus” Bantam Books, New York

Stephenson, N. (1995) – “The Diamond Age, or A Young Lady’s Illustrated Primer”, Bantam Books, New York

#### Films

“The Day The Earth Stood Still” (2008), Directed by Scott Derrickson, Produced by Twentieth Century Fox Film Corporation

“The Blob” (1988), Directed by Chuck Russel, Produced by Palisades California Inc.

“G.I. Joe: The Rise of Cobra” (2009), Directed by Stephen Sommers, Produced by  
Paramount Pictures

“Gamer” (2009), Directed by Mark Neveldine & Brian Taylor, Produced by Lionsgate  
Pictures

“Terminator 2: Judgement Day” (1991), Directed by James Cameron, Produced by Corolco  
Pictures

“Star Trek: First Contact” (1996), Directed by Jonathan Frakes, Produced by Paramount  
Pictures

### **Scientific Sources:**

Adorno, T. (2005) - „Culture Industry Reconsidered”, in Adorno T. & Bernstein J.M. *The Culture Industry: Selected Essays on Mass Culture* (p. 98-107) Ed. Routledge, London & New York

Adorno, T. (2005) - „How to look at Television”, in Adorno T. & Bernstein J.M. *The Culture Industry: Selected Essays on Mass Culture* (p. 158-178) Ed. Routledge, London & New York

Adorno, T. (2005) - „The Schema of Mass Culture”, in Adorno T. & Bernstein J.M. - *The Culture Industry: Selected Essays on Mass Culture* (p. 61-98) Ed. Routledge, London & New York

Allhoff F., Lin P., Moore D. (2010) – “What is Nanotechnology and Why Does it Matter? – From Science to Ethics” Blackwell Publishing, UK

Alpert C. L. (2007) – “Public Engagement with Nanoscale Science and Engineering” in Roco M.C., Bainbridge W.S. (eds.) *“Nanotechnology: Societal Implications – Individual Perspectives”* (p. 265-274), Springer, Dordrecht

Arendt, H. (1993) – “The Crisis in Culture: Its Social and Its Political Significance” in *“Between Past and Future: Eight Exercises in Political Thought”* (p. 197-227), Middlesex, England

Bainbridge, W.S. (2002) – Public Attitudes toward Nanotechnology. *Journal of Nanoparticle Research* 4 (6): 561-570

Barben D., Fisher E., Selin C., Guston H. D. (2007) – “Anticipatory Governance of Nanotechnology: Foresight, Engagement and Integration” in Hackett J.E., Amsterdamska O., Lynch M.E., Wajcman J., Bijker W.E. (Eds.) *“The Handbook of Science and Technology Studies”* (p. 979-1001), MIT Press

Barriga C.A., Shapiro M.A. and Fernandez M.L. (2010) - Science Information in Fictional Movies: Effects of Context and Gender. *Science Communication*. Vol. 32. Nr. 3, p. 3-24

Bartter Martha (Ed.) (2004) – “The Utopian Fantastic” Praegers Publishing, USA

Berger, R. (1972) – “La Mutation Des Signes” Paris: Denoel

Bowman D.M., Hodge G.A. and Binks P. (2007) – Are We Really the Prey? Nanotechnology as Science and Science Fiction. *Bulletin of Science Technology & Society*. Vol.27, Nr. 6, p. 435-445

Brown N. & Michael M. (2003) - A Sociology of Expectations: Retrospecting Prospects and Prospecting Retrospects. *Technology Analysis & Strategic Management*, Vol. 15, No. 1, p. 3-18

Burri, V.R. & Bellucci S. (2008) – Public Perception of Nanotechnology. *Journal of Nanoparticle Research*. Vol. 10, p. 387-391

Clute J. (2005) – “Isaac Asimov” in Seed D. (Ed.) “*A Companion to Science Fiction*” (p. 364-375) Blackwell Publishing, UK

Cobb M.D. (2005) - Framing Effects on Public Opinion about Nanotechnology. *Science Communication* Vol. 27, Nr. 2, p. 221-239

Collins P. G. (2001) – Shamans of Small. *Scientific American*, September, p. 86-91

Cornea Christine (2007) – “Science Fiction Cinema – Between Fantasy and Reality”  
Edinburgh University Press, Edinburgh

Dijck, J. van (2006) – Picturizing Science: the science documentary as multimedia spectacle. *International Journal of Cultural Studies*, Vol. 9, Nr. 1, p. 5-24

Dinello, D. (2005) – “Technophobia – Science Fiction Visions of Posthuman Technology”  
University of Texas Press

Dobrescu, P. (2003) – “Geopolitics”, Ed. Comunicare.ro, Bucharest

Encyclopedia Britannica Online, accessed 12.06.2011: <http://www.britannica.com/>

Gilks M., Fleming P., Allen M. (2003) – *“Science Fiction: The Literature of Ideas”*,  
accessed 23.06.2011: <http://www.writing-world.com/sf/sf.shtml>

Gordon, R. (2009) - Learning From Fiction: Applications in Emerging Technologies. *Bulletin of Science Technology & Society*. Vol. 29, Nr. 6, p. 470-475

Joy, B. (2000) – Why the Future Doesn't Need us. *Wired Magazine*. Vol. 8, Nr. 4

Kellner, D. (1995) – “Media Culture: Cultural Studies, Identity and Politics between the Modern and the Post-modern”. London: Routledge Ed.

Kjolberg K.L & Wickson F. (2010) – “Nano meets Macro – Social Perspectives on Nanotechnology” Stanford Publishing Ltd., Singapore

Kreiter, T. (2004) - Revisiting the Master of Science Fiction. *Saturday Evening Post*. Vol. 276, Nr. 6, p. 38

Lazarsfeld F. P., Merton K. R. (1999) – “Mass communication, popular taste and organized social action” in Marris P., Thornam S. (Ed.), *Media Studies: A Reader*, Edinburgh University Press, Edinburgh

Lederer S. E., Ratzan R.M. (2005) – “Marry Shelley: Frankenstein, or The Modern Prometheus” in Seed D. (Ed.) *“A Companion to Science Fiction”* (p.455-466) Blackwell Publishing, UK

Lopez, J. (2004) - Bridging the Gaps: Science Fiction in Nanotechnology. *HYLE--International Journal for Philosophy of Chemistry*, Vol. 10, No.2 (2004), pp. 129-152

Lull, J. (2000) – “Media, Communication, Culture – A Global Approach” New York: Columbia University Press

Lull, J. (2006) – “The Push and Pull of Global Culture” in Curran J. and Morley D. (Ed.) *Media and Cultural Theory* (p. 44-59) Routledge, London

Macnaghten P., Kearnes B.M., Wynne B. (2005) – Nanotechnologies, Governance and Public Deliberation: What Role for the Social Sciences?. *Science Communication* Vol. 27, Nr. 2, p. 268-291

Merriam Webster’s Medical Dictionary, accessed 18.06.2011: <http://www2.merriam-webster.com>

Miksaneck, T. (2001) – “Microscopic Doctors and Molecular Black Bags: Science Fiction's Prescription for Nanotechnology and Medicine” *Literature and Medicine*, Vol. 20, Nr. 1, pp. 55-70

Milburn, C. (2002) - Nanotechnology in the Age of Posthuman Engineering: Science Fiction as Science. *Configurations* – Vol. 10, Nr. 2, pp. 261-295

Milburn, C. (2010) – Modifiable Futures: Science Fiction at the Bench. *Isis* Vol. 101, p. 560-569

Morley, D. (2006) – “Globalization and Cultural Imperialism Reconsidered” in Curran J. and Morley D. (Ed.) *Media and Cultural Theory* (p. 30-44) Routledge, London

Negus, K. (2006) – “Rethinking creative production away from the culture industries” in Curran J. and Morley D. (Ed.) *Media and Cultural Theory* (p. 197-209) Routledge, London

Patterson, M. (2010) - “*Outlaw Biology? Public Participation in the Age of Bio*” accessed 20.06.2011: [www.maradydd.livejournal.com/496085.html?thread=3824853](http://www.maradydd.livejournal.com/496085.html?thread=3824853)

Riper, A.B. Van (2002) – “Science in Popular Culture: A Reference Guide” Westport: Greenwood Press

Ritzer, G. (2004) – “The McDonalidization of Society” London: Sage Publications

Roberts, A. (2000) – “Science Fiction – The New Critical Idiom” Routledge Publishing

Roco M.C., Bainbridge W.S. (2007) – “Nanotechnology: Societal Implications – Individual Perspectives” Springer, p. 241-295

Sanders M. Steven (2008) – “The Philosophy of Science Fiction Film” The University Press of Kentucky

Shippey, T. (2005) – “Hard Reading: The Challenges of Science Fiction” in Seed D. *“A Companion to Science Fiction”* (p. 11-27) Blackwell Publishing, UK

Smits, M. (2005) Langdon Winner: Technology as a Shadow Constitution. in H. Achterhuis (Ed.) *American Philosophy of Technology: The Empirical Turn*, Bloomington and Indianapolis, Indiana University Press

Storey, J. (2003) – “Cultural Studies and the Study of Popular Culture” Second Edition, Edinburgh: Edinburgh University Press

Thompson, B. J. (1995) – “The Media and Modernity: A Social Theory of the Media” Stanford University Press

Thompson, B. J. (2005) – The New Visibility. *Theory, Culture and Society*. Vol. 22, Nr. 6, p. 31-52

Toumey, C. (2007) - Narratives for Nanotech: Anticipating Public Reactions to Nanotechnology. *Techné: Research in Philosophy and Technology*, Vol. 11, Nr. 1, p. 88-118

Wiedemann, P.M. & Schutz, H. (2008) - Framing Effects on Risk Perception of Nanotechnology. *Public Understanding of Science*, Vol. 17, Nr. 3, p. 369-379

Winner, L. (1980) - Do artifacts have politics? in D. Mackenzie and J. Wajcman (Eds.) *The Social Shaping of Technology* (1999), p. 50-65, McGraw Hill Education / Open University