This introduction to the SHOT SIGCIS session *Examining the Interaction of Speculative Literature and Computing: Toward a Research Agenda* of October 2010 is taken from the introduction to *Science Fiction and Computing: Essays on Interlinked Domains* edited by David L. Ferro and Eric Swedin and forthcoming from McFarland.

Introduction by David L. Ferro

When I was in fifth grade, around the Christmas holidays, we were randomly paired up with someone else in the class to exchange gifts. I can't remember what I gave, but I recall what I received: a paperback book, its cover torn off. It was Isaac Asimov's *The Rest of the Robots*, a collection of short stories that opened up for me, not only a whole new literary genre, but a whole new way of looking at the world. I still have it on my shelf.

I didn't think much about receiving that book as the rest of my life unfolded and as I made the career choices that led me to writing this introduction. In retrospect, however, it was a defining moment. Today I teach in a computer science department and have a PhD in Science and Technology Studies. Asimov's book both inspired and reflects my life as well as the book you hold before you. The stories that Asimov wrote were thought experiments–using a fictional format–that explored the engineering and scientific development necessary for further advances in computers. They also dealt with the social implications of those advances. Only now, in researching this book, do I realize how apt Asimov was as the progenitor of inspiration. Asimov became a trained scientist in Biochemistry. In addition, he was influenced by the social sciences. In fact, the vision for the first short story he ever sold to John Campbell, the seminal editor of 'Golden Age' science fiction, came from the work of sociologist Bernhard J. Stern.[1]

Just as I was inspired by both science and fiction, my co-editor, Eric G. Swedin, and many of the authors of this collection, have comparable life stories behind their entries. They come from different - and, often, combined - disciplines yet have a similar drive to explore what science fiction has meant to them and to the world. This book has given them a venue to examine a topic in new ways. The level of excitement we heard from the prospective authors assured us that we were on the right path with this collection. In fact, we heard from a number of authors that this project took precedence over all others. It was a labor of love which gave them an opportunity to combine personal passion and explore disciplinary relevance.

The prevalence of science fiction readership among those people who create computers and programs is so well-known that it has become a cliché; but the cliché has remained largely unexplored by scholars. What role has science fiction truly played in the development of real computers? It was our intent to bring together voices from numerous disciplines. We wanted to broadly explore the past, present, and future importance of science fiction as a body of literature that has, through various means, potentially facilitated the invention, discovery, and use of computers. The expressed concerns for a decline in students entering STEM (scientific, technical, engineering, and mathematics) disciplines in the United States only serves to give increased import to this question.

We laid out five suppositions in our call for participation. First, that science fiction acts as a source of inspiration for invention and participation. Second, it supplies metaphors and analogies and facilitates communication within and outside a community of practitioners. Third, it helps create world views and shape critical thinking. Fourth, it plays a role in defining social relations and helps determine who is inside and outside of the community of the creators of

digital culture. Finally, it assists in imagining the implications of computing on society and ourselves, or, vice versa, the needs of a society that promotes computer development.

The authors assembled here took up the challenge we laid out. To address our suppositions they have written through the lenses of such disciplines as history, English, anthropology, sociology, philosophy, science and technology studies, computer science, technology management, literature studies, political science, cultural studies, and science fiction itself. They frequently threaded their responses to our five assumptions through 'case studies'. Taken as a whole, the articles address our suppositions and reveal evidence for the influence of science fiction on computing and society, and vice versa. The next section reviews the history of science fiction as a literary genre.

Defining a Fictional Form

Science fiction has a rich and vibrant history. It has been characterized in numerous ways over time. Most of the authors in this book benefit from a generous reading of science fiction's literary boundaries. Yet, exploring the relationship between science fiction, science, and society still requires some exploration of the genre and its history.

The definition of science fiction - alternatively labeled s.f., scifi, speculative fiction, and imaginative fiction (among other titles) - has been consistently criticized both from within and from without the genre. As Thomas Haigh notes, early 20th-century science fiction author and editor Hugo Gernsback created the term 'scientifiction,' which later morphed into 'science fiction' by 1929. Gernsback strived so hard to restrict the definition of the genre that classical authors, such as Jules Verne or H.G. Wells, considered science fiction (or at least proto-science fiction) authors today, could fail to make the grade. Gernsback's definition generally required erudite exposition of technological artifacts and/or scientific investigations. He expected that stories that met the requirements would also contain an optimistic view in the techno-scientific process and 'a sense of wonder' towards the universe. In time, this came to be known as 'hard' science fiction.

The field grew to include many authors who were not trained in science and engineering or overly interested in the hard approach. In addition, as Gary Westfahl has shown in *Cosmic Engineers*, the stories' hardness can be questioned. One reason is that plot and characterization often required scientific veracity in some parts of a story while precluding it in others.[2] Some 'blame' for the loosening of scientific rigor can be laid at the feet of John Campbell. As the editor of the magazine *Astounding Science Fiction,* he required that storytelling did not take a back seat to scientific exposition. Campbell's approach created better written stories. For example, science fiction author Robert Heinlein mastered the technique of the "gradual unfolding of exposition," where the technological and scientific details arise naturally in the story instead of through didactic asides.[3]

With Campbell, a sense of wonder did not disappear, although, not only utopian but dystopian ideas were published. The important element to include in a story was technologically deterministic: how society and the individual were affected by a contrived invention – i.e., the perennial 'What If?' question. What if people had gills in a world filled with water, for example. Another important wrinkle to 'hard' science fiction also emerged. In the

stories, scientists and engineers needed to act like human beings (sometimes heroic, sometimes not). They also needed to act like real-life scientists and engineers. By focusing on both the social impact of invention and the techno-scientific community of practitioners, the definition of 'hard' required a sociological and psychological outlook. This imperative persists today. For example, the scientific advisor to the movie *Sunshine* managed to insist on the characters "acting like scientists" despite the unbelievable science of the plot.[4]

An important myth exists within science fiction concerning its relationship to literature at large. Typically it entails the idea that once (circa 1900 and earlier) no difference existed between science fiction and mainstream literature but that science fiction became marginalized over time. The happy ending is that mainstream literature and society has, today, finally caught up to science fiction and is utilizing the genre's tools.

Reading and listening to science fiction authors and critics qualifies that version of history somewhat.   For at least a century science fiction has had a vibrant peer review mechanism. Many authors have compared it to that of science. Yet, many authors of science fiction simultaneously exhibit potentially conflicting needs. On the one hand there exists a desire to be considered seriously by readers and critics of mainstream literature. On the other hand they recognize the need to engage in the internal discussion of literary boundary maintenance; what counts and does not count as science fiction.

Of course, unlike most science, fiction needs to apply directly to the public for acceptance. Fiction must be sold. And much of the boundary definitions relate to addressing the market needs for fiction. But, here too, a sociological sense of science can be found. Many readers are part of the internal conversation through more than their buying habits. They also participate through conferences, online discussions, and letters to editors.

At the end of the day, many of the authors assembled here use rather broad and porous definitions of science fiction and that reflects a majority of the authors and readers of the genre today. We will allow our authors to explore those perspectives individually when necessary. In addition, in this volume, authors Thomas Haigh, Chris Pak, and Lisa Nocks all give extensive historical overviews of the genre that greatly expands on the few words I've written here. The next section will thread some of our themes through the authors' contributions.

Threading Our Themes

Measuring the degree to which science fiction has played a role in creating technology and defining culture is not trivial, nor do the analysts of science fiction necessarily believe science fiction to be the principal creative factor. Nevertheless, the authors here have parsed texts, interviewed principal characters, and reviewed literature and, in the process, have found evidence of its influence. In this section, I present some evidence of this influence to which the contributors of this book add their individual cases.

Examples for the absence of fiction's importance are easy to discover, even in places where it could be assumed it would play a larger role. For example, in *Bootstrapping*, Thierry Bardini's previously published investigation of Douglas Engelbart and the development of the graphical user interface, there is barely a mention of science fiction.[5]   Bardini focuses instead on other factors that influenced the creation of an alternative interactive computing environment, including yoga, recreational drug use, and the counter-cultural lifestyle celebrated by the *Whole Earth Catalog*.

The absence of fiction often tells us something important as well. Another example of a weak link to science fiction comes from an important text that promoted personal computing in

the years of its gestation: Ted Nelson's 1974 *Computer Lib/Dream Machines* with its famous cover, screaming "You can and must understand computers NOW."[6] In that book, science fiction is most visible by its studiously created absence. There are two exceptions I have found. One, if it qualifies as science fiction, is a quote from Alice in Wonderland.[7] The other exception is a quote from Fredrick Brooks during a speech to the Institute of Electrical and Electronics Engeneers (IEEE) where Brooks argues that the computer HAL from *2001: A Space Odyssey* is a model for the way computers should be. Nelson uses science fiction to respond negatively to Brooks' supposition using concepts from Asimov's *I,Robot* as well as *2001*.[8]

Although Nelson's combined book *Computer Lib/Dream Machines* has an almost science fiction style graphic novel presentation, it portrays computers as part of a cultural and workplace revolution. It goes out of its way to position computers strictly as tools, not magical or strange devices that are only incrementally different from other, more familiar tools, such as household appliances.   As Swedin & Ferro note in this book, the science fiction author William F. Jenkins (pen name Murray Leinster) proposed a similar work up for mainframe computers during the 1950s. Jenkins wanted to create a book that made mainframe computers appear commonplace and not frightening.   In fact, both Nelson and Jenkins deliberately avoided science fiction.   Interestingly, Jenkins' 1946 "A Logic Named Joe" created a scenario that fairly describes many aspects of the networked personal computers we use today. Yet, that would have been too much science fiction for his 1950s proposal. Science Fiction appears now and then in those publications engaged with computer development, however, the extent to which it is evident is likely dependent on the venue and the intent of the publication.

Despite the frequent difficulty in finding links between fiction and computer development, it is not impossible. In fact it can occasionally be serendipitous. An important inspiration for this collection came from the work of Sherry Turkle, author of one of the most influential books on childhood development and computing: *The Second Self: Computers and the Human Spirit.*[9] Visiting her at her MIT office in the early 1990s I noticed the ground-breaking cyberpunk novel *Neuromancer* on the shelf and commented on it. Apparently, many of her young students were reading it.

I wondered if literature, like *Neuromancer*, might be influence careers in science and technology. Turkle, in fact, has spent a considerable amount of time detailing the objects that have inspired and shaped the thinking of students and professionals in the scientific and technical fields. These stories have been collected in two volumes: *Falling for Science* and *The Inner History of Devices*.[10] While the principal goal of these books have been to examine the use of artifacts such as Legos, Tinkertoys, and video games, references to fiction do arise. A few examples from *Falling for Science* and *The Inner History of Devices* demonstrate the point. In "Erector Set," Former MIT student Kwatsi Alibaruho writes "In time I imagined worlds both concrete and futuristic. I read Buck Rogers books and watched Star Trek; my designs drew on their worlds to build my own."[11] In discussing how he and his friend arrived at the right shape for battling Lego ships, another former student, Andrew Chu, writes, "These were designs surely influenced by the aesthetic of Japanese robot cartoons." He continues, "Our ships evolved to something close the shape of the Imperial Empire battle cruisers of Star Wars, and we pretty much left it at that."[12] In a moving entry, former student Alicia Kestrell Verlager uses a blind character's experience with a 'sensor net' in a Star Trek episode to think of her own prosthetic eyes.[13]

This use of science fiction didn't only happen for new students attending MIT. Psychiatrists have used it to understand patients. In *The Inner History of Devices,* Aslihan Sanal reports a patient in dialysis who describes his self perception after wounds appeared on his back while swimming. Sanal writes: "The experience confirmed for him that he was a robot, just

like Arnold Schwarzenegger in the Terminator. He felt more a machine that would break in water than a human who would not."[14]   Another contributor to Turkle's book, child psychiatrist John Hamilton writes that "online life offers a window in transference, the feelings that the patient brings to the therapist from other relations." [15] In roleplaying exercises, one patient creates stories from characters in *The Lord of the Rings* and the Harry Potter series and, with the therapist, explores "exaggerated masculinity."[16]

As objects have been inspirational, so has science fiction been an inspiration for those entering scientific and technical fields. The science fiction authors of the twentieth century were fully cognizant of their role in creating inspirational fiction. Some embraced it. For instance, Robert Heinlein wrote many books aimed at adolescents in which the language and situations glorified technical and scientific excellence and self-sufficiency. Note the back cover from his 1952 young adult novel *The Rolling Stones.*

> [T]he Luna family is pleasantly daft along with being terribly intelligent: Mother is an M.D.; Father an engineer who doubles as a television script writer for Earth; the twin boys are mathematical whizzes; Sister is not far behind them; the four-year-old brother is a chess expert; and Granny is an engineer![17]

Much as individuals have explored their involvement in techno-science through objects, the authors in this book have explored involvement through fiction. The chapters by Janet Abbate, Paul Ceruzzi, and David Kirby all note how fiction has inspired particular technological development. The chapter by Joshua Cuneo notes the inspiration *Star Trek* had on many entering science and engineering fields.

Science fiction's influence can be found in journalistic treatments of the world of computing as well. Indeed, science fiction shaping technology makes a good story. For instance, an article in *Wired* magazine linked the novel *Snow Crash* as directly influencing a program that eventually became Google Earth.[18] In another example, Scott Rosenberg's *Dreaming in Code,* a business study of a complex open source project, all the metaphors and analogies are taken from science fiction. Individuals featured within the pages reference *Star Wars*, *Star Trek*, *The Lord of the Rings*, and *Monty Python*. Rosenberg notes that one of the programmers he was following had used a language called Python, invented by a Dutch programmer named Guido van Rossum who named it in honor of Monty Python's Flying Circus. Rosenberg comments that "Monty Python's form-smashing absurdism has always found some of its truest fans in computer labs." Furthermore, Rosenberg himself uses a Star Wars analogy when he explains to the reader the concept of the back end and front end of a computer by writing, "In Star Wars terms, the front end is the butlerish C3PO; the back end is the unintelligible R2D2."[19]

Examining the written works of well-known computer scientists, including Richard Stallman, Ray Kurzweil, Bill Joy, and Eric Raymond, gives us an understanding of how Science Fiction is a part of the Lingua Franca of computer development. For example, computer scientists, such as Danny Hillis, Timothy May, and Marvin Minsky, contributed to a compilation of essays about the seminal work, *True Names*, written by science fiction author and fellow computer scientist Vernor Vinge.[20] Scientists David Stork, Donald Norman, Daniel Dennet, Raymond Kurzweil, Murray Campbell, and others used HAL from *2001* to discuss advances in computing.[21] Richard Stallman indicated that "[a] lot of programmers are science fiction fans, and there's a tendency in science fiction fandom to accept non-standard relationships. . . and explore alternative realities . . .."[22] Eric Raymond, author of the open-source 'manifesto,' *The Cathedral and the Bazaar*, argued that the ego-driven aspects of open source participation are

not unlike those found in science fiction fandom and that reading science fiction is important to becoming a good hacker.[23]

Science fiction also plays a role in debates among those creating technology. Ray Kurzweil has spawned an entire sub-genre of science fiction by arguing for the actual inevitability of what has been termed the *Singularity*. The Singularity is a moment in time when artificial intelligence, nanotechnology, genetic engineering, and robotics become so advanced that they combine to create a future (or lack thereof) for humanity that is unpredictable and distinct.[24] Co-founder of Sun Microsystems, Bill Joy, wrote an article for *Wired* in April, 2000, entitled "Why the Future Doesn't Need Us" in response to Kurzweil's prediction. The letter, which is a warning to those pursuing the technologies listed by Kurzweil, clearly lists science fiction as important to him as a young man. He also notes "While I had heard such talk before, I had always felt sentient robots were in the realm of science fiction. But now, from someone I respected, I was hearing a strong argument that they were a near-term possibility." It would appear that for Bill Joy, sentient robots should remain in fiction.[25]

Explorations in the use of language, including metaphors and analogies and their effects, by those internal and external to technological practice, can be found in all of the chapters in this book. For example, in Janet Abbate's piece, science fiction and computer scientist, Vernor Vinge (noted earlier), is inspired by a real life event, stating "I realized that I had just lived a science fiction story." Abbate, Thierry Bardini , and R.C. Alvarado all show us how the fiction they examine creates vocabulary for those working in computer science. Lisa Nocks approaches the language we use from the perspective of the machines we have built. She shows how human language as used by machines impedes their understanding of humans. Paul Ceruzzi explores the use of metaphors by historians of technology as well as scientists and engineers. He uses the idea of technological trajectory to explore the "Kubrick paradigm" of artificial intelligence (Stanley Kubrick directed *2001: A Space Odyssey*).

In his description of a software project potentially spinning out of control, Rosenberg in *Dreaming in Code* often cites the non-fiction work of Frederick Brooks' *The Mythical Man-Month* (Brooks, as we noted earlier with Nelson's *Computer Lib/Dream Machines*, mentions *2001: A Space Odyssey* in a speech to the IEEE). *The Mythical Man-Month* is a reflection on the development of the IBM 360 operating system which Brooks managed. The book is often cited by technology managers during the project development cycles of computer software. The man-month is a unit of measure for how much a man working for a month might accomplish. The myth is that you could take four men and get the same job done in a week. According to Brooks, this is a myth because the four individuals have different abilities and project knowledge and accommodating those differences will add time to the project. When describing software development, Brooks seems to invoke a metaphysics which dissolves the boundaries between fiction and reality. He notes "The programmer, like the poet, works only slightly removed from pure thought-stuff." He continues "He builds his castles in the air, from air, creating by exertion of the imagination. Few media of creation are so flexible, so easy to polish and rework, so readily capable of realizing grand conceptual structures."[26] Reflecting on Brooks, one wonders if fiction plays an inevitable part in the creation of software and computers in general.

The "castles in the air" noted by Brooks could include the idea of a "thought experiment." In this volume, the work of Howard Taylor, Richard L. McKinney, and David Toomey write about the fiction that technologists and scientists use in thought experiments, creative exercises that assist in understanding the repercussions for a theory or proposed device. The 'predictive' aspects in some science fiction stories can play this role as well; the prediction acting as a thought experiment. Haigh, Taylor, Swedin & Ferro, and Thierry Bardini all address prediction

in their work here. In addition, both R.C. Alvarado and Bardini show how prediction (or prophesy) becomes a critical aspect of creating a techno-scientific culture.

Thought experiments that include the implications for people and society and, further, become part of the public exchange regarding those implications are manifest in this book. For example, Chris Pak notes both the optimistic and pessimistic literary approaches to computers over time. Hunter Heyck explores the public discussion of what it means to be human. Joshua Cuneo addresses the television show *Star Trek*.

Several authors in this book investigate thought experiments that take place both internally and externally to the discipline under investigation. For example, Janet Abbate examines conversations concerning the virtual human beginning with Vernor Vinge's *True Names*. McKinney takes on the use of science fiction in discussions of nanotechnology.   David Kirby, in revealing the back story to *The Lawnmower Man*, shows how that movie became the principal means for the public to understand the latest thinking in virtual reality.

Fiction reveals a great deal about the individuals involved in creating the fiction and the historical context within which it is written. Many of the authors in this volume demonstrate that in their work. In Gary Westfahl's detailed review of the popular comic series, Superman, the changing cultural understandings of technology during most of mid-20th-century America shine through the pen and ink drawings he describes. By using a Finnish robot adventure series of the 1940s, Jaakko Suominen explores 1940s Finland through a fictional lense. Alfredo Suppia uses Brazilian film in the 1960s to explain Brazilian attitudes towards imported technology. Both Thomas Haigh, in a broad historical view, and Paul Ceruzzi, looking at the space program and artificial intelligence, write historical perspectives. They simultaneously posit the examination science fiction as useful to historiographical approaches.

One of the goals we stated in the beginning of this work was discovering if fictional forms help define the boundary of a techno-scientific subculture and mainstream culture. Although the authors in this book do not approach this question directly, the answer is implicit in much of the work here. As I have noted earlier, contributors such as Janet Abbate, Paul Ceruzzi, and David Kirby work to varying degrees from the premise that communication can occur from within a community of experts to the general public.

Contrarily, contributor Graham J. Murphy, in citing the fictional work of Cory Doctorow, takes on the usefulness of the concept of a boundary between those inside and outside of the community of scientists and engineers. His subject, Cory Doctorow, a proponent and facilitator of open source software, flaunts such distinctions in his work and his fiction. Doctorow's stories are 'mash-ups' of classic fiction and contemporary sensibilities with stories such as "I Row-Boat," a riff on the classic Isaac Asimov book *I, Robot*.

Distinctions between the techno-scientific communities of practice and the mainstream culture can be found, however, and deserve further exploration. For example, for six years I have been surveying my students in computer science, history, business, and honors courses regarding science fiction and its role in their lives. Many overlaps exist in the kinds of media that students enjoy. However, according to survey results, the amount of science fiction oriented material consumed by students in the science and technology fields is greater than the other fields. Additionally, in response to a question about how important science fiction has been in their understanding of the future, the science and engineering students report a much greater significance than the remaining students. If Murphy and Doctorow, noted above, are

correct, the differences between those inside and outside the techno-scientific fields may narrow over time. Currently, however, there remains something for a researcher to explore.

Conclusion

Since the themes of the book reflect the development of science fiction, computers, and society over time, we have chosen to present the chapters in roughly chronological order. The first two chapters give an extensive overview of the history of science fiction and its importance over the last century. The majority of the remaining chapters address issues of a particular timeframe. We begin by looking at science and fiction of the 1940s and end in present-day.

As an interdisciplinary collection, the approaches and methodologies of each work included in this book is unique. As such, we have tried to not dwell overly on some kind of totalizing methodology. Each work speaks for itself and reflects the community from which it is written. Because of this there are varieties in the style and format of the works. We have tried to honor the communities that they represent. In addition, however, all the authors have attempted to address a general audience. In order to accomplish a broader appeal we have attempted to keep jargon at least to a level where a reader from any background can enjoy and benefit from the collection. We hope we have been successful.

This collection is extensive but not exhaustive in covering of the themes of this book. Much scholarly work remains. This book represents only one manifesto, of sorts, that the work should attract scholars. But for now, it is time for the editors to get out of the way, and let the authors contributing here tell their stories.

Notes

[1] Isaac Asimov and Janet Jeppson Asimov, *It's Been a Good Life* (Amherst, NY: Prometheus Books, 2002), page 54. These comments also can be found in his address to Newark College of Engineering, given November 8, 1974 (http://www.asimovonline.com/oldsite/future_of_humanity.html).

[2] Gary Westfahl writes a considerable exposition on the etymology of the term 'science fiction' in his *Cosmic Engineers: A Study of Hard Science Fiction* (CT: Greenwood Press, 1996).

[3] Orson Scott Card, *Masterpieces: The Best Science Fiction of the Century* (NY NY: Ace Books, 2004).

[4] Taken from a conversation with David Kirby at the Annual Meeting of the British Society for the History of Science at Manchester, UK, July, 2007. David Kirby has an article in this collection.

[5] Thierry Bardini, *Bootstrapping: Douglas Engelbart, Coevolution, and the Origins of Personal Computing* (CA: Stanford University Press, 2000).

[6] Theodor H. Nelson, *Dream Machines/Computer Lib* (Redmond, Washington: Tempus Books, a division of Microsoft, 1987 Edition. Original copyright 1974).

[7] Ibid, *Computer Lib*, page 16.

[8] Ibid, *Dream Machines*, page 125.

[9] Sherry Turkle, *The Second Self: Computers and the Human Spirit* (NY: Simon & Schuster, 1984).

[10] The two books are Sherry Turkle (ed), *Falling for Science: Objects in Mind* (Cambridge, MA: MIT Press, 2008) and Sherry Turkle (ed), *The Inner History of Devices* (Cambridge, MA: MIT Press, 2008).

[11] Ibid, *Falling*, page 134.

[12] Ibid, *Falling*, page 156.

[13] Ibid, *Inner History*, page 36.

[14] Ibid, *Inner History*, page 148.

[15] Ibid, *Inner History*, page 65.

[16] Ibid, *Inner History*, page 71. It would be interesting to explore ideas of exaggerated masculinity with my mostly male computer science students and how they view the user of the technology they create.

[17] This New York World-Telegram quote is taken from the back cover of Robert A. Heinlein, *The Rolling Stones* (NY: Ace books 1952).

[18] From an article by Evan Ratliff including an interview with John Hanke, the director of Google Earth, in *Wired*, "Google Maps Is Changing the Way We See the World", June 26, 2007 (http://www.wired.com/techbiz/it/magazine/15-07/ff_maps?currentPage=all). Interestingly, one of the co-founders partially dismissed the suggestion. See the web page of Avi Bar-Zeev, one of the co-founders of Keyhole, the maker of the program Earthviewer, which became Google Earth. (http://www.realityprime.com/2006/07/24/notes-on-the-origin-of-google-earth).

[19] Scott Rosenberg, *Dreaming in Code* (Crown Publishers, 2007), page 86.

[20] Vernor Vinge and James Frenkel, *True Names: And the Opening of the Cyberspace Frontier* (Tor Books, 2001).

[21] David G. Stork (ed), *HAL's Legacy: 2001's Computer as Dream and Reality* (Cambridge, MA: MIT Press, 1997).

[22] Richard Stallman quoted in an article by Annalee Newitz in *Salon*, May 26, 2000 (http://www.salon.com/technology/feature/2000/05/26/free_love)

[23] Eric S. Raymond, *The Cathedral and the Bazaar: Musings on Linux and open source by an accidental revolutionary* (CA: O'Reilly Media, 2001). Also see http://www.firstmonday.org/issues/issue3_3/raymond/.

[24] Raymond Kurzweil's work on the Singularity can be found in many locations including his *The Age of Spiritual Machines, When Computers Exceed Human Intelligence* (Viking / Penguin Books, 1999).

[25] Bill Joy, "Why the Future Doesn't Needs Us," *Wired*, April 2000. (http://www.wired.com/wired/archive/8.04/joy.html)

[26] Frederick Brooks is cited on page 64 of *Dreaming in Code* by Scott Rosenberg. *The Mythical Man-Month* was published in 1975 by Addison-Wesley.