

Epochs in Endourology

Three Laws of Robotics and Surgery*

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Abstract

Introduction: In 1939, Isaac Asimov solidified the modern science fiction genre of robotics in his short story “Strange Playfellow” but altered our thinking about robots in *Runaround* in 1942 by formulating the Three Laws. He took an engineer’s perspective on advanced robotic technologies. Surgical robots by definition violate the first law, yet his discussions are poignant for our understanding of future potential of robotic urologic surgery. **Methods:** We sought to better understand Asimov’s visions by reading his fiction and autobiography. We then sought to place his perceptions of science fact next to the Three Laws (he later added a fourth law, the zeroth). **Results:** Asimov’s Three Laws are often quoted in medical journals during discussions about robotic surgery. His First Law states: “A robot may not injure a human being, or, through inaction, allow a human being to come to harm.” This philosophy would directly conflict with the application in surgery. In fact, most of his robotic stories deal with robots that come into conflicts with the laws. Robots in his cleverly orchestrated works evolve unique solutions to complex hierarchical conflicts with these laws. Asimov anticipated the coming maelstrom of intelligent robotic technologies with prescient unease. Despite his scholarly intuitions, he was able to fathom medical/surgical applications in many of his works. These fictional robotic physicians were able to overcome the first law and aid in the care and management of the sick/injured. **Conclusions:** Isaac Asimov published over 500 books on topics ranging from Shakespeare to science. Despite his widespread influence, he refused to visit the MIT robotics laboratory to see current, state-of-the-art systems. He managed to lay the foundation of modern robotic control systems with a human-oriented safety mechanism in his laws. “If knowledge can create problems, it is not through ignorance that we can solve them” (*I Asimov*).

Introduction

ISAAC ASIMOV (1920–1992) WAS A POLYMATH but is best remembered as a writer, teacher, philosopher, and scientist.¹ He published his first science fiction piece at the age of 20, a positronic robotic piece. The positronic brain is a remarkable piece of science fiction that allowed his “robots” to be more advanced, almost humanlike, than any prior author. Almost no discussion of contemporary engineering or robotic surgical literature is complete without mentioning Asimov’s major contributions from his science fiction genre. He admitted to being immensely frustrated with the characterization of “robots” in science fiction in general, but specifically with the “rogue plots” that were the cookie-cutter method since Mary Shelley’s *Frankenstein*.² But as with much of epistemology, Asimov was neither the first at representing robots and their effects upon society nor the first to use Karel Capek’s new term *robot*.³ Asimov’s most endearing

legacy is the Three Laws of Robotics, which brings us to the premise of this article.

The often confused beginnings of the literature of robots and how this applies to our contemporary quotations referenced in scientific articles need elucidation. First we have to establish *a priori* with the literature of science fiction and proto-science fiction in order to appreciate Asimov’s frame of reference. Second, we must establish a timeline for the early genre, science fiction, in order to grasp Asimov’s own position. There is a substantial classical legacy of robots beginning at the very foundations of Western thought. Next, we must explore the role of allegory in regards to storytelling and literature. Specific emphasis is placed upon allegorical robots as our primary impetus is upon applications to modern robotic surgical systems. Finally, we will review the definitions of robots in order to appreciate our current state-of-the-art da Vinci Surgical System™ (Intuitive Surgical, Sunnyvale, CA).

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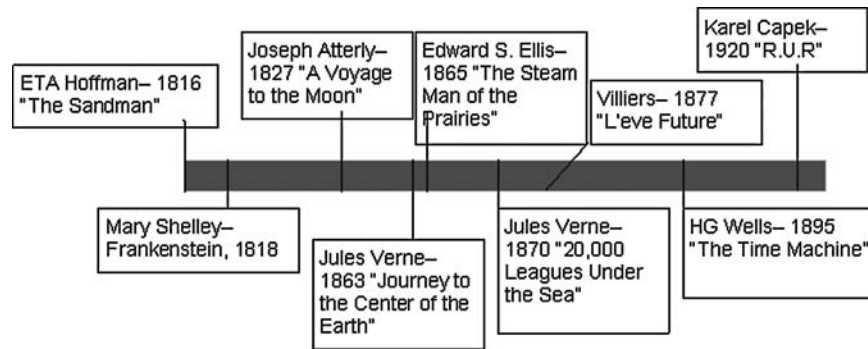


FIG. 1. Timeline for proto-science fiction with the development of allegorical interpretation of knowledge.

Methods

Homer wrote about the first robot, Talus, the warder of Crete and defeated by the Argonauts. The god Haephestus built the mythic robot and infused this being with god's blood, ichor.⁴ Next, the great bard Edmund Spenser would later catch the same fervor, and Talus becomes Talos, morphed into the faithful servant to Sir Arthegal, hero in the Faerie Queen.⁵ Finally, L. Frank Baum would continue in this tradition by captivating his heroine's fascination with a mechanical man, no, not the Tin Man but a clockwork automaton named TicTok.⁶ All of these primordial robots tell us something about the people and social circumstances in which they were written. These metal men are the archetypical mechanisms of each of these authors' allegory.

Proto-science fiction could begin at any time, but modern technology should probably be utilized in the yardstick that we need to begin this study of Asimov. For our purposes here, a simple timeline will be utilized (Fig. 1). E.T.A. Hoffmann wrote "The Sandman" in 1816, and in this story a mechanical woman is created and fascinates his protagonist.⁷ Edward S. Ellis followed this lead, giving us a nonsentient automaton, "Steam Man," that became very popular in 1865.⁸ Next, Atterly, Verne, and Wells followed with massively popular scientific applications and humanity's response. Villiers de L'Isle-Adam followed with a disturbing, prophetic version of cybersex and robots in his 1877 play, *L'Ève Future*.⁹ In 1909, the futurist poet Filippo Tommaso Marinetti wrote a play about mechanized humans called *Elettricità sessuale* "(sexual electricity).¹⁰ Finally, in 1921 the first performance of Czech writer Karel Capek's play *R.U.R.* gave the world a new name, "robots."¹¹

Why allegory? Charles Dodgson was an Oxford mathematician who formulated the mathematical theory of "multiply connected spaces," the space-time problem or "wormholes" in modern terms. He wrote a book to express his ideas to an unsuspecting public, but used the pseudonym Lewis Carroll, and his book was called *Through the Looking Glass*.¹² The wormhole is a mirror and on one side is England while on the other is Wonderland. This allegorical method is employed in early science fiction and applies to robots and humanity. In order to appreciate the influence that Asimov had, the ability of science fiction and science writers to utilize readily appreciated comparisons became the major vehicle to achieve the fiction that allowed these authors to explore the social implications of technology and to communicate to the rest of us.

Results

Isaac Asimov was a prolific writer. There are debates on the exact number of books he published, but the number is well above 500. It took this gifted youngster 19 years to publish his first 100 books. Then, 10 more years to publish his second 100. In the ensuing 5 years he published his third 100.¹³ During this time period, he was also a professor of biochemistry in Boston and developed the dramatic allegorical tool to explore how robotics could alter our view of humanity. The "Three Laws" Asimov penned in "Robbie" in May 1939 was submitted to John Campell of *Astounding Science Fiction* who turned it down. Later, Fred Pohl (another gifted writer/publisher) printed the story. Two years and two more stories later, "Reason" became his second robotic story. The third story is "Liar" and a key new character, Dr.

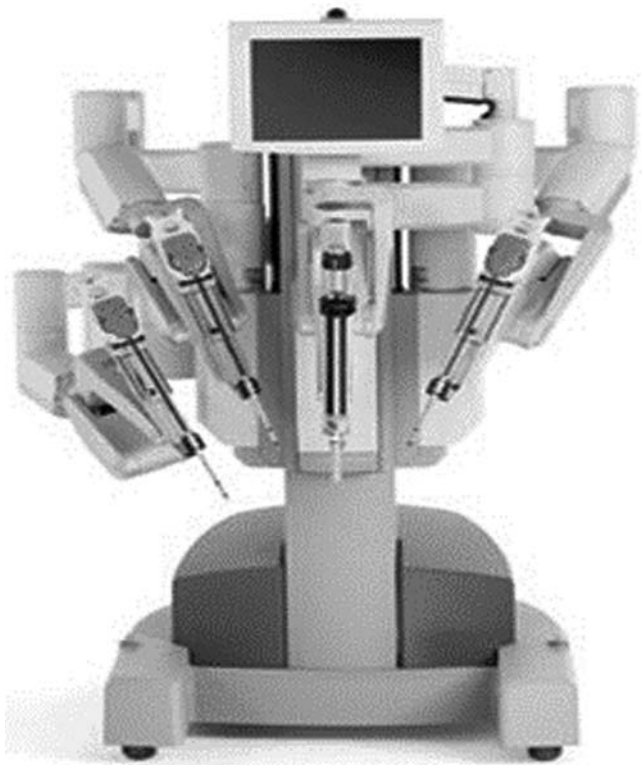


FIG. 2. The da Vinci S[®] Surgical System[™], Intuitive Surgical, Sunnyvale, CA.

Susan Calvin, a robopsychologist, is added. It was during the development of this third robotic piece that Asimov and editor John Campbell worked out the Three Laws of Robotics in May 1941.¹³

In the 1920's science fiction was becoming a popular art form for the first time . . . and one of the stock plots . . . was that of the invention of the robot. . . . Under the influence of the well known deeds and ultimate fate of Frankenstein and Rossum, there seemed only one change to be rung on this plot—robots were created and destroyed their creator. . . . I quickly grew tired of this dull hundred-times-told tale. . . . I began in 1940, to write robot stories of my own—but robot stories of a new variety. . . . My robots were machines designed by engineers, not pseudo-men created by blasphemers. (*I. Asimov*¹³)

The Three Laws of Robotics 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 orders given it by human beings, except where 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 once quipped “Many writers of robot stories, without actually quoting the three laws, take them for granted, and expect the readers to do the same.” The laws represent a logical straightforward paradigm of dealing with complex robotic-human interactions, an allegorical method. But they clearly set up ambiguities, and Asimov took full advantage of these in many of his subsequent writings. “There were just enough ambiguity in the Three Laws to provide conflicts and uncertainties required for new stories, and, to my great relief, it seemed always to be possible to think up a new angle out of the 61 words of the Three Laws.”

They influenced young and old alike, but the Three Laws caught particularly the attentions of George Devol (patent from December 10, 1954, “Programmed Article Transfer” device), which was a polar coordinate design robot, marketed with Joseph Engelberger as Unimate.¹⁴ The company, Unimation, sold 8500 robots but unfortunately, unlike the “robots of allegory,” the Unimate industrial robot had been the cause of several fatalities, violating Asimov’s First Law of Robotics. The Laws themselves are simple allegory and science fiction; though well intended, they are an art form. The truths, particularly scientific, are made to be manipulated in order for the author to explore man’s reactions to his technology and society’s dilemma.

A priori status is often given to Asimov, but as with all things philological, a sentinel source is often sought.¹⁵ There are almost always precursors and Isaac Asimov knew this as well as anyone. The best example is perhaps Asimov’s most famous work, *I, Robot*, which he drew upon the published work of another, one Eando Binder.¹⁶ The work entitled, “I, Robot,” actually first appeared in *Amazing Stories* in 1939.¹⁷ Eando Binder was a pseudonym for the father and son team of Earl and Otto Binder. Clearly the transformation of Capek’s concept of a “robot” from a biologic construct to a machine had already occurred and was socially acceptable.

Conclusions

So, is the da Vinci Surgical System™ a robot (Fig. 2)? Utilizing Karel Capek’s definition (robots are biologic organisms that perform the dangerous work of humans), the answer would be a resounding *no!*³ Utilizing Isaac Asimov’s much more advanced notion, the answer would be an unquestionable, *yes!* Asimov, though, would not have looked favorably upon any of the current industrial, medical, or space applications favorably because he believed that the intelligence of the control systems have been inadequate for true humanlike performance. The American Society of Robotics uses the definition “a robot is a reprogrammable, multifunctional device designed to manipulate and/or transport material through variable programmed motions for the performance of a variety of tasks.” Here a robot must exhibit three key components:

1. programmability—implies computerized or symbol-manipulating ability (a robot is at least part computer)
2. mechanical capability—enabling it to act on its own environment
3. flexibility—can manipulate/transport in a variety of ways

Science fiction is not science fact. Allegory is the fundamental method that ideas from this art form bring meaning to the tale. The idea of operating with a sophisticated computer-driven, three- or four-armed master-slave system with piano wire end effectors may or may not be a robot, but it is getting closer to reality. If the patient perceives that it is a safe, highly accurate, and precise technologic innovation, that is enough. Whether this system will obey none of Asimov’s Three Laws is almost as silly as Asimov himself not wishing to visit MIT’s robotic laboratories during his lifetime.

Acknowledgments

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References:

1. Asimov I. *It’s Been a Good Life*. Prometheus Books, New York, 2002.
2. Asimov I. *Robot Visions*. Byron Priess Pub., New York, 1990.
3. Moran M. Rossum’s Universal Robots—not the machines. *J Endourol* 2007; 21(12):1399–1402.
4. Moran M. Hellenistic legacy and surgical robots. *J Endourol* (Submitted)
5. Spenser HA. *Faerie Queene*. Longman, New York, 1989.
6. Baum LF. *Ozma of Oz*. Reilly & Lee, Chicago, 1907.
7. Hoffmann ETA. *The Sandman*. Available at: http://www.fln.vcu.edu/hoffmann/sand_e.html.
8. Guinan P. *The Steam Man*. Available at: <http://www.bigredhair.com/steamman/index.html>.
9. Lathers M. *The Aesthetics of Artifice: Villier’s “L’Eve Future.”* AMS Press, London, 1992.
10. Poggi C. Metallized flesh: futurism and the masculine body. *Modernism/Mod* 1997; 4(3):19–43.
11. Capek K. *R.U.R.*, trans. Paul Selver, Doubleday, New York, 1923.
12. Carroll L. *Through the Looking Glass*. Available at: <http://www.gutenberg.org/etext/12>.

13. Asimov I. I. *Asimov: A Memoir*. Bantam Book, New York, 1994.
14. Devol G. U.S. Patent 2,988,237. "Programmed article transfer." Filed December 10, 1954 and issued June 13, 1961.
15. Lienhard JH. *How Invention Begins. Echoes of Old Voices in the Rise of New Machines*. Oxford University Press, New York, 2006.
16. Asimov I. I. *Robot*. Bantam Books, New York, 1991.
17. Binder E. "I, Robot." *Amazing Stories*, 1939.

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