

# *Future Reckoning: Calculating Devices in the Golden Age of Science Fiction*

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\*\*\*Mild Spoilers Below!\*\*\*

What is the Golden Age of science fiction? There is room for debate but one straight answer, according to scholars of such things, is that it is the period from 1939—when Flash Gordon comics and *Astounding Stories* pulp magazines were supplanted by books published by the mainstream firms—until various points all ending by 1960. This era featured literate stories told in a linear fashion of heroes overcoming seemingly unbeatable adversaries and social systems.<sup>1</sup>

One sarcastic answer, resented by many lifelong fans, is that the “golden age” of science fiction is “the age of twelve.”<sup>2</sup> Whenever a reader just entering adolescence finds this genre, *that* is his, her or their golden age. I will lower-case this sense of the term.

Many members of the Oughtred Society will recall their own golden age, and the thrill of discovering great tales of speculative fiction in their respective youths. Only after the peak of their sci-fi interest did some learn of the slide rule in their technical education and occupations. This article “crosses the streams,” to employ *Ghostbusters* terminology,<sup>3</sup> by illustrating the use of math instruments in selected works of three of the greatest Golden Age authors.

Many Golden Age stories concern scientific challenges. A society has forgotten the basis for its advanced technology; a puzzle must be deciphered or a planet will explode; an equation must be balanced in order to shorten a period of chaos, or keep an empire in check.

The authors cautiously tended to step out from some aspects of twentieth-century culture only by a single pace. When calculations were called for, the instruments employed were a modest remove from the current devices. Thus, we see references in the far future to microfilm, and we behold Mr. Spock in the original *Star Trek* television series using what appears to be an E-6B aviation slide rule, both already rare in our own day.

Your vision of technology tomorrow thus depends on the tools at your disposal today. It is not surprising that the calculators in these works bear a strong resemblance to devices we know today have become obsolete. As with the 1964 New York World’s Fair, much of Disneyland, and the Donald Fagen song

“I.G.Y.,”<sup>4</sup> so with science fiction—we feel nostalgia for future states that have yet to come, yet have somehow already passed.

The three Golden Age authors profiled here formed the backbone of my genre reading during my own golden age. The tales under discussion are ones I readily found involving calculating devices. There are many more stories that feature large-scale computers, robots and math, and stories by other authors showcasing devices. Alex Kasman maintains an excellent compilation on his website “Mathematical Fiction” (over 1300 works summarized at last count).<sup>5</sup>

The descriptions of the calculators are often clearer than are the explanations of the math operations. A recurrent trope is what I refer to here as “**goofball mathematics**,” the use of impressive-sounding but presently incoherent terms to dazzle and intimidate the reader.

## 1. ISAAC ASIMOV

Asimov, himself a biochemistry professor, was a prolific author of both fiction and non-fiction, including a very good slide rule manual.<sup>6</sup> Calculators and calculations make many appearances in his works.

### *Foundation*

This volume is one of the, well, “foundational” texts of the Golden Age.<sup>7</sup> It launched as a series of stories that appeared in *Astounding* magazine beginning in 1942. An ancient Galactic Empire was decaying in much the same fashion as the Roman Empire, as chronicled in Gibbon’s *Decline and Fall* thereof.<sup>8</sup> The challenge for the many protagonists over many centuries was to shorten the era of chaos before a *new* Galactic Empire could rise from the ashes. (As The Who sang, “Meet the new boss, same as the old boss.”<sup>9</sup>)

These magazine stories were collected into a book, published in 1951 as the first in what was originally a trilogy (extended after my golden age by sequels and prequels). In it, Asimov introduced the science of psychohistory. By analogy to the statistical mechanics of Maxwell and Boltzmann, he posited that although the actions of one human are unpredictable, the large-scale and long-term behaviors of a quintillion beings across a galaxy could be calculated with some precision. Those forecasts are premised on some conditions that, of course, are tested in the course of the series; otherwise it would not be much of a story. Nobel laureate Paul Krugman says he entered the field of economics because it was the closest discipline in reality to what he found and loved in Asimov.<sup>10</sup>

*Submitted for publication.*

The first part of the book, “The Psychohistorians,” showcases the founder of the field, Hari Seldon, on the galactic capital planet of Trantor. In chapter 4, he shows his protégé Gaal Dornick a **calculator pad** whose keys are well worn with use, and which displays its results in “red symbols glow[ing] out from the upper tier.”

The goofball math here includes “a set-transformation” undergoing a “socio-operation,” a step to which Dornick objects as normally forbidden but which it turns out Seldon can legally take via an expansion. Perhaps the socio-operation involves dividing by zero, and the expansion is a goofball Trantorian variant of Bernoulli’s or L’Hôpital’s Rule. (See Appendix 1.)

## **Second Foundation**

We skip ahead to the third volume of the trilogy, confusingly named *Second Foundation* (1953).<sup>11</sup> Halfway through, in chapter 1 of the second part, we are introduced to Arcadia Darell, a spunky teenage girl. Arkady wrestles with a **Transcriber dictation system** less advanced than the Dragon, Siri, and Alexa software of our own time. She uses the Transcriber to narrate a school report on ancient and recent history, which provides Asimov with an opportunity (really, an excuse) to recap the story so far.

In chapter 8, we learn of the **Prime Radiant**, a storage and projector device with computational uses. It is a small cube, responsive to brain waves, that illuminates a screen without casting shadows. It displays massive numbers of math equations in what can only be described as *Microsoft® Word Track Changes from Hell*—with the base equations in black and revisions and additions in red, green, blue, and who knows what other colors. (Apparently the *Review...* menu command “Accept All Changes and Stop Tracking,” well known to us today on the planet Sol III, has long been forgotten.) Here the goofball math entails “Rigellian integrals” and “neurochemical electromathematics.” Much like the slide rule for us, the Prime Radiant is four hundred years old when it is being used in the novel.

In chapter 9, we witness an **Analytical Rule**, “a distant relation—a skyscraper is to a shack—of that kindergarten toy, the logarithmic Slide Rule.” It is used to calculate “secondary Tauian waves” and related goofball results.

Later, in chapter 20, we behold a **Mental Static Device**, kind of a white-noise generator to foil psychics. And in chapter 22, there is even mention of **protractors and rulers**, as the tools of those who search across large distances on a three-dimensional map. (I might keep a protractor somewhere in my house, but I know not where.)

A running theme in the *Foundation* series is that societies decay when they no longer understand the technologies that enabled their ascent. Interstellar kingdoms have forgotten principles of atomic energy, and their craft traverse vast distances until they break down for want of maintenance. The motto of a main character is that “violence is the last refuge of the incompetent.”

But here, as in other works of science fiction, crises are still resolved by point-and-shoot blasters instead of our already more deadly and less discriminate weaponry.

## **The Feeling of Power**

I first heard of this Asimov story, published in 1958,<sup>12</sup> at an Oughtred Society meeting. Echoing both the *Foundation* series and Asimov’s equally famous *Robot* series, it features a culture that has grown so dependent on its computers that everyone has forgotten how to do basic arithmetic or even how to write numerals. (There are parallels. I cannot recall the last time I took a square root on paper.)

A worker (named Ladislav Aum in the original, and Myron Aum in the reprintings) reverse-engineers computer circuitry and performs arithmetic on his own using no calculating device stronger than a **stylus and paper**, leading to a math process exalted as **Graphitics**. The astounding discovery leads to sardonic commentary on the relative worth of machines and humans, and an ending that gives full meaning to the short story’s title.

## **2. ARTHUR C. CLARKE**

Clarke, a formidable thinker on technology, deserves considerable credit for the idea of satellites operating in geosynchronous orbits.<sup>13</sup> His fiction often involved clashes between cultures separated by vast differences in mental capabilities.

### **2001: A Space Odyssey**

Many of us have felt like Moon-Watcher, the intrepid man-ape in Clarke’s *2001: A Space Odyssey*, as visualized by Stanley Kubrick,<sup>14</sup> when we have *finally* understood some basic concept that has bedeviled us for some time. (For me, one such *aha!* moment was Richard Feynman’s casually using geometry in a lecture to explain why planets travel in ellipses rather than circles.<sup>15</sup>) Upon such an epiphany, we dimly hear the opening brass fanfare of Richard Strauss’s *Also Sprach Zarathustra*.

Clarke kept a private diary of his often-exasperating sessions with Stanley Kubrick during the making of *2001: A Space Odyssey*. It contains this refreshing entry:

July 9, 1964. Spent much of afternoon teaching Stanley how to use the **slide rule**—he’s fascinated.

A more typical diary entry reads “Now have everything—except the plot” (July 12, 1964). Ah, if only the **giant black monoliths** had had a sliding middle section...

### **Into the Comet**

This is a 1960 work of juvenile fiction<sup>16</sup> similar to Asimov’s *The Feeling of Power*. A spaceship is trapped in deep space with a failed computer. Fortunately, Spaceman George Pickett happens to have a Japanese mother who taught him how to use an **abacus**, which he happens to have stowed or made. As in the

Asimov short story, how a four-function (plus roots) calculator suffices for interplanetary travel is left unclear.

### *Silence Please!*

This 1950 story, republished in *Tales from the White Hart*, is strikingly sophisticated.<sup>17</sup> In a pub, someone wishes “there was a way of shutting [ ] up” a fellow patron. A third guest promptly unveils a device called a **Fenton Silencer**. In describing the machine’s origin, the guest mentions (à propos of nothing) that it is easier to evaluate the integral of  $e^x$  than the integral of  $xe^x$ , which is true. He reveals enough detail for a reader with a technical bent to infer that this unassuming box is a harmonic analyzer that calculates Fourier transforms and produces waves completely out of phase with ambient sound—a precursor of our noise-cancelling headphones. (See Appendix 2.) The results are comic, but the math is sound with nary a goofball in sight.

### 3. ROBERT A. HEINLEIN

Heinlein today is something of a problematic writer. Over the years he became an ultra-libertarian, and his attitude toward authority, war, sexual relations and other subjects is almost guaranteed to offend most folks on some score.<sup>18</sup>

A Naval Academy graduate with a disdain for mere administrators, Heinlein was a champion of “hard science fiction.” In military yarns like *Starship Troopers* (1959), there are no rear garrison officers, only combat officers; in the spaceship sagas, the captains themselves are mathematicians. He did give names to some unknown concepts, like the Lyle Drive for interplanetary travel in *Stranger in a Strange Land* (1961), but in general he stuck to technology and math that his audience would readily recognize.

### *Slide Rule Tales*

A great quotation for Oughtred Society members comes from the juvenile novel *Have Space Suit—Will Travel* (1958):<sup>19</sup>

“Dad says that anyone who can’t use a **slide rule** is a cultural illiterate and should not be allowed to vote. Mine is a beauty—a K&E 20-inch Log-Log Duplex Decitrig.”

That is an N4081-5, I believe. This Keuffel & Esser model was current in 1958, current in Heinlein’s future as visualized in 1958, and a wonderful rule to this day.

Hard science shows up in the early story *Misfit* (1939) with the character Andrew Jackson “**Slipstick**” Libby. Slide rules are also referred to in *The Rolling Stones*, *Rocket Ship Galileo*, *Space Cadet*, and *Destination Moon*.

### *Starman Jones*

It has been half a century since I last devoured *Starman Jones* (1953),<sup>20</sup> during my golden age. It is still a gripping tale, though I just re-read it on a smartphone app far more advanced than anything dreamed up by Heinlein for the far future.

The goofball features include a “Horst-Conrad-Milne interplanetary space drive,” with “impellers that clutched at the fabric of space itself,” and “Calculated Solutions of the Differential Equation of Motion by the Ricardo Assumption.” A character uses clothing to explain wrinkles in time so clearly that I bet Madeleine L’Engle appreciated this book, if not perhaps Heinlein’s views on religion.<sup>21</sup>

We are introduced to a circular astrogator slide rule and six **astrogator books**—the equivalent of logarithm and trigonometry tables, one assumes. These physical objects are the McGuffin that drives a breathless plot to conclusion, and our Horatio Alger-like hero to adulthood. We can laugh at the juvenile work’s “woefully backward future technology.”<sup>22</sup> But *Starman Jones*—the novel, if not the hero’s math—has stood the test of time.

### 4. SCIENCE FICTION AND SCIENCE MYTH

Conspicuous by his absence from this list is the fourth great author of my golden age, Frank Herbert. I found no calculators in his works, but there is goofball math in *Children of Dune* (1976):<sup>23</sup>

*This is the classic n-fold extended aggregate of n dimensions... we are either confronted by new properties of time or (by reduction through the infinity calculus) we are dealing with separate systems which contain n body properties. For Muad’Dib, we assume the latter...*

By Herbert’s time, the scholars’ Golden Age was over. The narratives were not as predominantly linear, and the focus of many works was less on a hero than on a counterfactual concept or a social commentary. This is not to denigrate the later books—on the contrary, numerous vibrant novels have followed. But just as the act, process and art of calculating have become less front and center for us, calculating devices may have receded from science fiction. If you no longer give much thought to how answers are calculated today, neither will your protagonist tomorrow.

Will anyone in the future believe that humans created great works and accomplished great things using such limited instruments? Will this Buzz Aldrin photograph be treated like a hoax, as just another example of “fake science”?



Figure 1. Aboard Gemini with a Pickett

How could a myth about science develop in a sophisticated culture? Easier than one might think. I read a book on the production of petroleum from shale formations by hydraulic fracturing—called “fracking” in some circles—and came across this passage:<sup>24</sup>

Remember your seventh grade math class? You were instructed in the use of the “slide rule”. Do you recall how to use it? Do you know anyone who has one? It was the finest tool in the science class room. A giant one hung at the top of the blackboard and was taken down to use for precise calculations. It was an amazing tool. Its accuracy was strangely universal.

The demonstration rule “was taken down to use for precise calculations?” Uh, no. This is in a serious non-fiction book published in 2012, mind you.

I surmise that its author was old enough to have seen, maybe in 1972, a large yellow Pickett demonstration rule in his school’s advanced math classroom. By the time this fellow took that course, the overhead slide rule would have been long gone, only a faint memory.

Our author might have thought that surely such a grand instrument *must have* had a computational use, and inferred this story. Perhaps he imagines the teacher used a magnifying glass or microscope to tease out the seventh, eighth and ninth significant digits of the answer.

Our generation is the last that will be able to refute this myth by means of personal experience. Fresh students may disbelieve the improbable facts and may trust the more plausible fiction instead.

The actual tales, of how we launched and returned spacecraft and produced engineering marvels with implements of wood

and bone, risk being discounted and rejected. Guarding against that risk is reason enough for the Oughtred Society to endure.

Arthur C. Clarke famously observed that “any sufficiently advanced technology is indistinguishable from magic.”<sup>25</sup> To warp that adage, the stories of the tools that once built an advanced civilization may be dismissed as magic by those who come sufficiently afterwards.

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## FOOTNOTES

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3. Ivan Reitman, *Ghostbusters* (Columbia Pictures 1984).
4. Donald Fagen, “I.G.Y.,” in *The Nightfly* (Warner Bros. Records 1982).
5. Alex Kasman, *Mathematical Fiction*, website available at <http://kasmana.people.cofc.edu/MATHFICT/>.
6. Isaac Asimov, *An Easy Introduction to the Slide Rule* (New York: Houghton Mifflin, 1965).
7. Isaac Asimov, *Foundation* (New York: Gnome Press, 1951).
8. Edward Gibbon, *The History of the Decline and Fall of the Roman Empire* (1776-1789).
9. The Who, “Won’t Get Fooled Again,” in *Who’s Next* (Decca Records, 1971).
10. Paul Krugman, Foreword to *The Foundation Trilogy* (London: Folio Society, 2012 ed.).
11. Isaac Asimov, *Second Foundation* (New York: Gnome Press, 1953).
12. Isaac Asimov, “The Feeling of Power,” in *If...* (February 1958), republished in *Robot Dreams* (New York: Berkley Books, 1986).
13. Arthur C. Clarke, “Extra-Terrestrial Relays,” 51 *Wireless World* (October 1945), p. 305.
14. Arthur C. Clarke, *2001: A Space Odyssey* (London: Hutchinson, 1968) and Stanley Kubrick, *2001: A Space Odyssey* (MGM Films 1968), inseparably linked, one to the other. The diary entries are from “Christmas, Shepperton”

in Arthur C. Clarke, *The Lost Worlds of 2001* (New York: New American Library, 1972).

15. Richard Feynman, *The Character of Physical Law* (London: BBC, 1965).
16. Arthur C. Clarke, "Into the Comet," in *Fantasy & Science Fiction* (October 1960), republished in *The Best of Arthur C. Clarke: 1937-1971* (London: Sidgwick & Jackson, 1973).
17. Arthur C. Clarke, "Silence Please!," in *Science-Fantasy* (Winter 1950), republished as "Silence Please" in *Tales from the White Hart* (New York: Ballantine Books, 1957).
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19. Robert A. Heinlein, *Have Space Suit—Will Travel* (New York: Charles Scribner's Sons, 1958).
20. Robert A. Heinlein, *Starman Jones* (New York: Charles Scribner's Sons, 1953).
21. Madeleine L'Engle, *A Wrinkle in Time* (New York: Ariel Books, 1962).
22. Michael Z. Williamson, Afterword to *Starman Jones* (Riverdale, N.Y.: Baen Books, 2011 ed.).
23. Frank Herbert, *Children of Dune* (New York: G. P. Putnam's Sons, 1976).
24. John Graves, *Fracking: America's Alternative Energy Revolution* (Keene, N.H.: Pathway Book Service, 2012).
25. Arthur C. Clarke, *Profiles of the Future: An Inquiry into the Limits of the Possible* (London: Victor Gollancz Ltd, 1962).

## APPENDIX 1

Briefly, if an expression  $f(x)/g(x)$  has an indeterminate form because it equals or approaches  $0/0$  or  $\pm\infty/\infty$ , L'Hôpital's Rule allows you to evaluate it by taking the derivatives  $f'/g'$ .

Johann Bernoulli probably found this rule. But he had signed an employment contract giving rights in his discoveries to one Guillaume de l'Hôpital. Posterity has judged that arrangement a fair bargain.

## APPENDIX 2

The integral with respect to  $x$  of  $e^x$  is just  $e^x$  again while that of  $xe^x$  is  $xe^x - e^x$ , in each case plus the pesky constant  $C$ , which I almost forgot to include on my midterms.

One version of the Fourier transform is

$$F(s) = \int_{-\infty}^{+\infty} f(x)e^{-j2\pi sx} dx ,$$

an impressive-looking equation. At least it shows why facility with integral calculus for exponential functions was germane to the Fenton Silencer.