The fine art of computer programming

Free software and the future of literate programming

Matt Barton

The free software and open source communities are changing what it means to write code. Specifically, they are extending its audience from a few fellow employees to, theoretically, anyone in the world who wants to read it. Code isn't just for computers and colleagues anymore and, gradually, we are seeing the beginnings of a body of literary critics and an appreciative readership for source code. What is happening is the gradual realization that *reading code can be enjoyable,* that code can be *artistic* as well as correct, and that in the decades ahead some coders will emerge as true artists of an exciting new literary genre. Code is becoming artistic and it's the free software and open source movements that are making this possible.

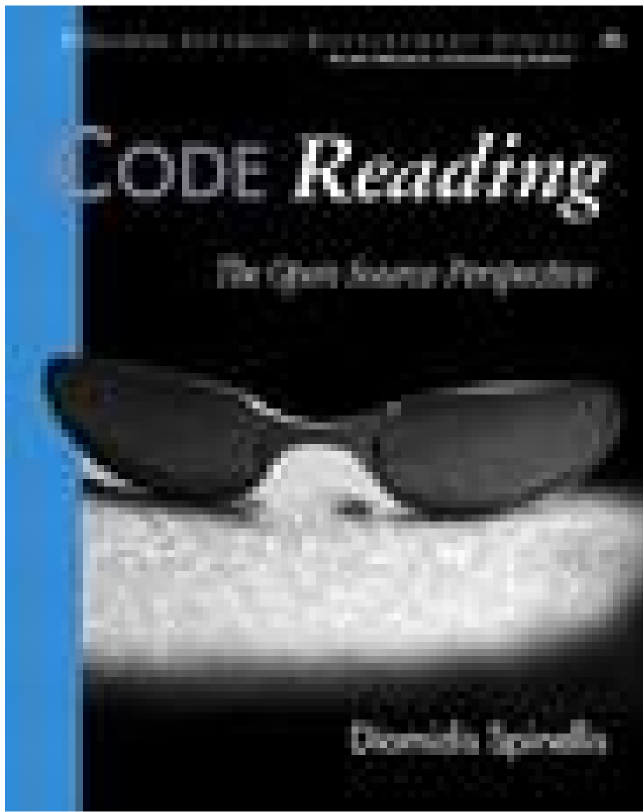
Reading code for pleasure

Diomidis Spinellis, author of *Code Reading: The Open Source Perspective,* is one of the first of what we will come to know as the literary critics of code. His book is unlike any other programming book that came before it and for a very exciting reason. What makes it unique is that Spinellis is teaching us how to *read* source code instead of merely how to write it. Spinellis hopes that after reading his book, "You may read code purely for your own pleasure, as literature" (2). What I want to emphasize here is that word *pleasure*. As long as we merely view code as something practical; as a *means* designed, for better or worse, to reach certain practical *ends*, then we will never see the flourishing of the literature that Spinellis describes. What must happen first is the cultivation of a new audience for code. We desire a readership that derives a different sort of pleasure from reading magnificent code than those who have come before them. Whereas, generally speaking, most readers of code today judge code based on the familiar criteria of *precision*, *concision*, *efficiency*, and *correctness*, these future readers will speak of the *beauty* of code and the *artistry* of a well-wrought script. We will, perhaps, print out the programs of our favorite coders and read them in the bathtub. Furthermore, we will do so for no other reason than that we will *enjoy* doing so; we will as eagerly await the next Miguel de Icaza as we would the novels of our favorite author or the films of our favorite director. Even now, the first rays of this new art are shooting across the horizon; tomorrow, we will shield our eyes against its brilliance.

What we need today are coders who are at once brilliant coders, expert judges, and artists of sufficient taste to convincingly explain to the rest of us how to know great code when we see it

Richard P. Gabriel and Ron Goldman's fabulous essay Mob Software: The Erotic Life of Code (`http://www.dreamsongs.com/MobSoftware.html`) makes many of the points that I will attempt to explicate here. One of their theses is that "When software became

Cover of Spinellis' book *Code Reading*.



Picture of Alexander Pope—Public Domain.

merchandise, the opportunity vanished of teaching software development as a craft and as artistry". For Gabriel and Goldman, faceless corporations have reduced coding to a lowly craft; code is just another disposable product that is only useful for furthering some corporate agenda. Such base motives have prevented coding from flourishing as a literature. Gabriel and Goldman describe the pitfalls of proprietary software development and ask a rather compelling question:

> It's as if all writers had their own private companies and only people in the Melville company could read *Moby-Dick* and only those in Hemingway's could read *The Sun Also Rises.* Can you imagine developing a rich literature under these circumstances?

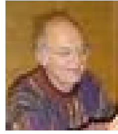
Newer models of software development aim to change this unpleasant and unproductive situation. As more and more skilled programmers and clever hackers license their code under the GPL or dedicate it to the public domain, a literature of code will slowly but surely emerge into public consciousness. Still, my point here is that it will take more than a huge body of available source code for coding to become an art. We will need bold and enlightened critics—we will need our Aristotle, our Horace, and our Alexander Pope. These "literary critics of code" will show us how to read great code and how to recognize and appreciate the *beautiful* as well as the useful.

Alexander Pope wrote his *Essay on Criticism* in 1711, when he was only 23 years old. Pope's essay, written in stunning verses, was one of the earliest works of literary criticism. It was a work designed to teach us how to judge other works of poetry. It is also contains some of the finest and most memorable lines in the history of the English language. Even if you have never heard of Alexander Pope, I bet you've heard the line "To err is human, to forgive, divine." Today, we can read Pope's essay with coding in mind and consider how writing verses of poetry compares to lines of code—to observe, along with Gabriel and Goldman, that "The connection to poetry is remarkable." Pope's purpose is to give advice not only to writers of poetry but also to critics of that poetry—all the while *demonstrating* his own mastery of both. And who else but a free software programmer could Pope *possibly* be describing in these lines:

> The learned reflect on what before they knew
>
> Careless of censure, nor too fond of fame,
>
> Still pleased to praise, yet not afraid to blame,
>
> Averse alike to flatter, or offend,
>
> Not free from faults, nor yet too vain to mend.

Those who are willing to release their work for public scrutiny are as likely to receive praise and blame. The worthiest among them will profit from both. What we need

Donald E. Knuth. Picture courtesy of Wikipedia.



today are coders who are at once brilliant coders, expert judges, and artists of sufficient taste to convincingly explain to the rest of us how to know great code when we see it. These literary critics will use their code to teach us how it can be beautiful—and inspire even the most humble BASIC programmer to feel something of that glorious and divine spirit that makes artists of men.

What makes Pope's essay so significant? Besides its historical, creative, and stylistic value, we find in Pope's essay tremendous literary value. He is at once a master *poet* as well as a master *critic of poetry.* This point is perhaps a bit elusive, so I will make it clearer. Pope could have simply written his essay in prose, or, if he were alive and well in 2005, perhaps a bulleted list. He chose instead to write in the same genre he was philosophizing about. Alexander Pope did for poetry what must be done for programming: We need a coder who understands how to *read* and *admire* code as well as how to write it.

It is perhaps time to elect a new Pope. To my mind, there is only one man of sufficient merit and tenacity to warrant such an honor: Donald E. Knuth. I nominate Knuth because of the development of what he terms *literate programming,* an approach to coding that involves incorporating a program's documentation into its source code—in much the same way that Pope wrote about poetry in a poem, Knuth wants us to write about coding in our code. Author of the classic *Art of Computer Programming* books, Knuth firmly believes that programming can reach literary proportions. As early as 1974, Knuth was arguing that computer programming is more artistic than most people realize. "When I speak about computer programming as an art," writes Knuth, "I am thinking primarily of it as an art *form*, in an aesthetic sense. The chief goal of my work is to help people learn how to write *beautiful* programs" (670). Knuth's passion and zeal for artistic coding is revealed in such lines as "it is possible to write *grand* programs, *noble* programs, truly *magnificent* ones!" (670). For Knuth, this means that programmers must think of far more than how effectively their code will compile.

The fine art of coding

In a 1983 article entitled "Literate Programming," Knuth argues that "the time is ripe for significantly better documentation of programs, and that we can best achieve this by considering programs to be works of literature" (1). Knuth's project at that time was *literate programming*, which is a combination of a document formatting language and a programming language. The idea was to greatly extend what can be done with embedded comments; in short, to make source code as readable as documentation that might accompany it. The goal was not to necessarily make code that would run more efficiently on a computer; the point was to make code more interesting and enlightening to human beings. The result of Knuth's efforts was WEB, a combination of PASCAL and TEX, and the newer CWEB, which offers C, C++, or JAVA instead of PASCAL. WEB and CWEB allow programmers like Knuth to write "essays" on coding that resemble Pope's essay on poetry.

One of Knuth's projects was to take the Will Crowther masterpiece *ADVENTURE* and rewrite it with CWEB. The results are marvellous. It is a joy to read this code. The best way I can describe the pleasure I derive from reading it is to compare it to listening to really good director's commentary on a special-edition DVD. It's like having a wizened and witty old friend reading along with me as I study the code. How many source code files have you read with comments like this:

> Now here I am, 21 years later, returning to the great Adventure after having indeed had many exciting adventures in Computer Science. I believe people who have played this game will be able to extend their fun by reading its once-secret program. Of course I urge everybody to play the game first, at least ten times, before reading on. But you cannot fully appreciate the astonishing brilliance of its design until you have seen all of the surprises that have been built in.

Knuth has something here. Knuth's CWEB "commentary" of *Adventure* isn't the heavily abbreviated, arcane gibberish that passes for comments in most source code, nor is

it slavishly didactic and only concerned with teaching. It is in many ways comparable to Pope's essay; we have a coder representing *in code* what is magnificent about code and how one ought to judge it. It is something we will likely to be studying fifty years from now with the same reverence with which we approach "The Essay on Criticism" today.

It seems inevitable that as free and open source software community continues to grow, the need for "literate" programming techniques will increase exponentially

Jef Raskin, author of *The Humane Interface,* recently presented us with an essay entitled "Comments are More Important Than Code." He refers to Knuth's work as "gospel for all serious programmers." Though Raskin is mostly concerned with the *economic* relevance of good commenting practice, I welcome his criticism of modern programming languages "that do not allow full flowing and arbitrarily long comments is seriously behind the times." It seems inevitable that as free and open source software community continues to grow, the need for "literate" programming techniques will increase exponentially. After all, programmers that no one understands (much less admires) are unlikely to win much influence, despite their cleverness.

Coding: art or science?

Of the many intriguing topics that Knuth has contemplated over the years is whether programming should be considered an art or a science. Always something of a linguist, Knuth examines the etymology of both terms in a 1974 essay called "Computer Programming as an Art." His results indicate that real confusion exists about how to interpret the terms "art" and "science," even though we *seem* to know what we mean when we claim that computer programming is a "science" and not an "art." We call the study of computers "computer science," Knuth writes, because "there is something undesirable about an area of human activity that is classified as an 'art'; it has to be a Science before it has any real stature" (667). Yet Knuth argues that "when we prepare a program, it can be like composing poetry or music" (670). The key to this transformation is to embrace "art for art's sake," that is, to freely and unashamedly write code for *fun.* Coding doesn't always have to be for the sake of utility. Artful coding can be done for its own sake, without any thought about how it might eventually serve some useful purpose.

Daniel Kohanski, author of a wonderful little book entitled *The Philosophical Programmer*, has much to say about what he calls the "aesthetics of programming." Now, when most folks talk about *aesthetics*, they are speaking about what makes the beautiful so beautiful. If I see a young lady and tell you that I find her aesthetically pleasing, I'm not talking about how much she can bench-press or how accurately she can shoot. Yet this seems to be what Kohanski means when he talks of aesthetical programming:

> While aesthetics might be dismissed as merely expressing a concern for appearances, its encouragement of elegance does have practical advantages. Even so prosaic an activity as digging a ditch is improved by attention to aesthetics; a ditch dug in a straight line is both more appealing and more useful than one that zigzags at random, although both will deliver the water from one place to the other. (11)

I feel a sad irony that Kohanski chooses the metaphor of a *ditch* to describe what he considers aesthetic code. Coders have been stuck in this rut for quite some time. We take something as wonderful and amazing as programming, and compare it to perhaps the lowliest manual labor on earth: the digging of ditches. If conciseness, durability, and efficiency are all that matters, programmers work without art and grace and might as well wield shovels instead of keyboards.

Let me set a few things straight here. When most people try to establish "Science and Art" as binary oppositions, they would generally do better to use the terms "Engineers and Artists." Computer programming *can* be thought of from a strictly engineering perspective—that is, an application of the principles of science towards the service of humanity. Civil engineering, for instance, involves building safe and secure bridges. According to the *Oxford English Dictionary,* the word *engineer* was first used as a term for those who constructed siege engines—war machinery. The word still carries a very practical connotation; we expect engineers to be precise, clever, and so on, but expect a far different set of qualities from those we term *artists.* Whereas

the stereotypical engineer is an introvert with a pocket protector and calculator wristwatch, the stereotypical artist is someone like Salvador Dali—a wild, eccentric type who is poorly understood, yet wildly revered. We expect our artists to be unpredictable and delightfully social beings—who really understand the human condition. We expect engineers to be pretty dull folks to have around at parties.

Such oppositions are seldom useful and more often misleading. We might think of the man insisting that programming is a "science" as equally intelligent as his companion, Tweedledum, who insists that it is quite obviously an art. The truth, according to Knuth, is that programming is "both a science and an art, and that the two aspects nicely complement each other" (669). Like civil engineering, programming involves the application of mathematics. Like poetry, programming involves the application of aesthetics. As with bridges, some programs are mundane things that clearly serve only to get folks across bodies of water, whereas others, like the Golden Gate Bridge, are magnificent structures rightly regarded as national landmarks. Unfortunately, the modern discourse surrounding computer programming is far too slanted towards the banal; even legends of the field cannot bring themselves to see their calling as anything but a useful but dull craft. They are the painters who have convinced themselves that because they cannot sell their frescoes, that painting houses is the only sensible thing one can do with a paintbrush.

The future of programming as art

Computer programming is not limited to engineering, nor must coders always think first of efficiency. Programming is also an art, and, what's more, it's an art that shouldn't be limited to what is "optimal". Even though programs are usually written to be parsed and executed by computers, they are also read by other human beings, some of whom, I dare say, exercise respectable taste and appreciate good style. We've misled ourselves into thinking that computer programming is some "exact science," more akin to applied physics than fine art, yet my argument here is that what's really important in the construction of programs isn't always how efficiently they run on a computer—or even if they work at all. What's important is whether they are beautiful and inspiring to behold; if they are sublime and share some of the same features that make masterful plays, compositions, sculptures, paintings, or buildings so magnificent. A programmer who defines a good program simply as "one that best does the job with the least use of a computer's resources" may get the job done, but he certainly is a dull, uninspiring fellow. I wish to celebrate programmers who are willing to dispense with this slavish devotion to efficiency and see programming as an art in its own right; having not so much to do with computers as other human beings who have the knowledge and temperament to appreciate its majesty.

It is all too easy to transpose historical developments in literature and literary criticism onto computer programming. Undoubtedly, such a practice is at best simplistic—at worst it is myopic. Comparisons to poetry, as Gabriel and Goldman point out, are all too tempting. Like poetry, coding is at once imaginative and restricted:

> Release is reined in by restraint: requirements of form, grammar, sentence-making, echoes, rhyme, rhythm. Without release there could be nothing worth reading; the erotic pleasure of pure meandering would be unapproached. Without restraint there cannot be sense enough to make the journey worth taking.

It is quite possible to look at the source code of a C++ program and imagine it to be a poem; some experiment with "free verse" making clever use of programming conventions. Such comparisons, while certainly intriguing, are not what I'm interested in pursuing. Likewise, I am not arguing that artistic coding is simply inserting well-written comments. I would not be interested in someone's effort to integrate a Shakespearean sonnet into the header file of an e-mail client.

Instead, I've tried to assert that coding itself can be artistic; that eloquent commenting can *complement*, but not substitute for, eloquent coding. To do so would be to claim that it is more important for artists to know how to describe their paintings than to paint them. Clearly, the future of programming as art will involve both types of skills; but, more importantly, the most artistic among us will be those who have defected from the rank and file of engineers and refused to kneel before the altar of efficiency. For these future Byrons and Shelleys, the scripts unfolding beneath their fingers are not some disposable materials for the commercial

benefit of some ignorant corporate juggernaut. Instead, they will be sacred works; digital manifestations of the spirit of these artists. We should treat them with the same care and respect we offer hallowed works in other genres, such as Rodin's *Thinker,* Virgil's *Aeneid,* Dante's *Inferno,* or Pope's *Essay on Criticism.* Like these other masterpieces, the best programs will stand the test of time and remain impervious to the raging rivers of technological and social change that crash against them.

This question of *permanence* is perhaps where we find ourselves stumbling in our apology for programming. How can we talk of a program as a "masterpiece", knowing that, given the rate of technological development that it may soon become so obsolete as not to function in our computers? Yet here is the reason that I have stressed how insignificant it is that a program *actually works* for it to be rightly considered magnificent. Indeed, I find it almost certain that we will find ourselves with programs whose utter brilliance we will not be capable of recognizing for decades, if not centuries. We can imagine, for instance, a videogame written for systems more sophisticated than any in production today. Likewise, any programmer with any maturity whatsoever can appreciate the inventiveness of the early pioneers, who wrought miracles far more impressive in scope than the humble achievements so brazenly trumpeted in the media today. To really appreciate the fine art of computer programming, we must separate *what works well in a given computer* from *what represents artistic genius,* and never conflate the two—for the one is a fleeting, forgettable thing, but the other will never die.

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Matt Barton is an English professor at St. Cloud State University in Minnesota. He is an advocate of free software, wikis, and the Creative Commons. He also studies and writes about videogames.