Oral language has one signal weakness. Speech is transitory; it dies almost as soon as it is produced. Writing systems were invented to mitigate this weakness. States and institutions, which necessarily must reach across time and space, could not exist without writing.

Writing systems are cultural inventions. Writing is also a code that allows humans to produce and consume meanings interactively and to engage in joint activities. The code is a mapping from ideas (concepts) to (real or imagined) things via written symbols, symbols more permanent that spoken words. Writing came on the scene long after oral language had evolved and is a relatively recent invention. Few cultures have historically created a writing system, though many have borrowed one.

Writing systems are cultural inventions. Some writing systems are closely tied to speech (e.g., alphabets) and others are not (e.g., logograms). Unlike speech, in the case of writing systems, production (writing) is less common and more restricted than is consumption (reading). It is normal for people to be better at reading than writing and even the ability to read has rarely been universal in societies. The ability to write has never been.

There are no social gaps in terms of race, class, or gender in oral language as it first evolved, though we will see below that social groups, often in tandem with writing, have created forms of oral language which do give rise to gaps. Everyone speaks and hears the vernacular of their native language just fine, albeit in terms of different dialects. No one needs to be overtly taught their native language. It is acquired through normal social interactions with primary caregivers.

On the other hand, literacy regularly gives rise to social gaps where some groups have less access to or skill in certain forms of writing or reading than do others. Often these gaps reflect status and the distribution of power or wealth in society. All people need to be taught literacy in the sense that the environment must be arranged in certain special ways to ensure its acquisition. Every child learns his or her native language equally well at home, regardless of home-based differences, but reading and writing (especially of the sorts that make for success in school) are very sensitive to early home-based factors in how and how well they are acquired.

Writing systems almost always give rise to specialized forms of oral language, sometimes called “registers” by linguists. These are things like the language of law, physics, mathematics, or game design. These registers extend oral language to carry out special functions or activities that not all societies may have. They create a certain division of labor in terms of language. Registers create social gaps because they require access to the specialized social groups or institutions that use them. They also require skill with the functions the register is used to carry out and very often with the written forms of language that are also connected to these functions.

Oral language—a gift nearly all humans have—is, in reality, a set of design tools. All humans when they speak are designers. They organize words and phrases into patterns that will communicate not just information but effects of all different sorts. In fact, grammar can be seen as a design kit, full of tools with which to make meanings and effects, just like media of any sort. Human inequality starts when design kits are not open to all and literacy is one such design kit. In the case of such non-"open source" design kits, production is far less prevalent than consumption and, thus, design is restricted. A few people are "priests" and the rest are "laity". This, in fact, has been the history of writing and reading.

Literacy is multiple in the sense that there are different ways of writing and reading fit for and used for different functions. Therefore, no one is universally literate. There are, for all of us, forms of writing and reading, and their accompanying registers, that we have not mastered. A person may be highly literate in poetry, but illiterate in physics, and vice versa. In these respects, we all are both literate and illiterate.

Thus, it is problematic defining literacy as reading and writing—however obvious that definition may seem—because literacy requires forms of reading and writing tied to the ability to carry out different functions or activities. And these functions or activities are often tied to registers in oral language. A "literacy" (and there are many such "literacies") requires ways of writing and reading, ways of doing, and ways of speaking and interacting with others. Otherwise one is not literate in that way. This is also why teaching literacy without teaching doing and teaching registers (specialist ways of speaking and interacting to carry out special functions) does not work well, especially for closing social gaps.

Writing, of course, does not replace oral language. But writing does change the ecology or oral language. It creates new forms of it (specialist registers), makes new demands on it, demands new skills in it, and creates new patterns of inequality.

The term "digital literacy" is fully appropriate and not really just a metaphor. Each digital media is also a code that allows humans to produce and consume meanings interactively and to engage in joint activities. The code is a mapping from ideas (concepts) to virtual things (simulation of things) via computational computer code. Each digital media is a design kit. For digital media, as for writing, production is more restricted than consumption. Different sorts and degrees of mastery are sensitive to early home-based factors and digital media create social gaps. Digital literacies are multiple in the sense that they are tied to different functions or activities and, they too, are very often accompanied by specific special registers of oral language. They are, in many respects, just like writing and reading, i.e., what we traditionally mean by "literacy".

So far digital literacies have created the sorts of inequalities and social gaps we associate with traditional literacy. Higher-order, value-added forms of digital literacy—

like “modding” in the case of video games—appear to be the preserve of the more privileged, as do the more sophisticated forms of writing. Privileged young people get more access, mentoring, and modeling early in life in regard to digital literacies than less privileged children, as they do also in the case of traditional literacy.

We have long known that school-based forms of literacy flourish in the homes of young children who have lots of mentoring, attachment parenting, and complex, sustained interactive talk with adults. The same seems to be true with digital literacies that “pay off” in terms of success in school or in society. In part, in both cases, such mentoring, parenting, and talk gives rise to non-cognitive skills like confidence, persistence, delayed gratification, coping with challenge, and meta-cognition that highly correlate with success in school and society, where, more and more, traditional and digital literacy interact.

Some say digital media hold out more opportunity for all people to be producers than did traditional literacy. But writing was always potentially open to everyone, just as is production with digital media. The real potential that digital media unleashed was the opportunity to learn out of school and to learn from a much wider array of peers and adults. In Western society, schools have long had a monopoly on traditional literacy, but they have no such monopoly on digital literacies, though some would like to see them gain such a monopoly. Thus, while writing still stagnates in our schools, it flourishes on fan fiction sites, facilitated by digital tools.

Nonetheless, the use of digital media and writing on digital sites is subject to the Pareto Principle: 10 percent of the people at best make 90 percent of the contributions. Furthermore, higher-order contributions are often restricted to a small group of aficionados. In this sense, one danger is that digital media can simply replicate the inequalities that school creates, albeit out of school. The fact that digital literacies have spread primarily out of school has not yet made them a real force for equality, at least in regard to their higher-order, value-added forms.

The Maker Movement opens up yet another set of design kits, another set of literacies, what we can call “maker literacies”. Maker literacies are not new. People have been making things like quilts and furniture at home of hundreds of years. What is new is the proliferation of making and the ways in which everyday people can compete with businesses, experts, and industry today thanks to digital media. The special part of the Maker Movement I want to concentrate on here is digital fabrication, what we can just call “Fab”. Fab is the newest literacy beyond digital literacies.

Fab is also a code that allows humans to produce and consume meanings interactively and to engage in joint activities. The code is a mapping from ideas (concepts) to real things via computational computer code.

Oral language refers to things in the world. Language is indexical in the sense that it points to or refers to things, but it cannot touch and handle them. Things always stay just out of reach. Digital literacies simulate things, virtual things that can be handled and transformed by the very code that produces them. But like language, digital media cannot touch and handle real things; it can just manipulate them on a screen.

Fab makes real things. It can handle and transform them. It has been argued that what constituted human intelligence in the beginning was our ability to think and plan in our heads deeply prior to acting . Digital media greatly enhanced this human trait. Such media allow us to think and plan on screens in forms that go far beyond the powers of unaided human thought.

Humans have always, of course, been able to make things. Indeed, some scholars have defined humans as tool makers and homo faber. But prior to Fab making was a one-way street. You could go from conception to construction, but not back again. Fab makes making a two-way street. We can now turn bits (digital code) into atoms (things) by "printing" the code and we can turn atoms into bits by reality capturing devices that digitize things and make them into digital code. "Printing" here means machines that can add or subtract material to make things on demand from digital code.

Language and digital media are complementary. Language is good at creating abstractions out of lived experience by finding and naming patterns in that experience. Writing takes abstraction to its furthest extent, especially in special symbol systems like mathematics. Digital media is good at creating new experiences or mimicking old ones. Digital media allow us to think through external images and simulations and not just through conceptual abstractions. One of the greatest powers of digital media is that it can allow people to have experiences that are hard for humans to have in the real world (or to have more than once), experiences that, nonetheless, words can refer to, such as being an electron or sky diving without a parachute. Digital media can, thus, greatly enhance the ability humans have to find and name patterns in experience, the basis of language and learning.

Think of Dungeons and Dragons played as a role playing game with paper and pencil. This is traditional literacy. Here players use words and other symbols (and the occasional plastic figures) to create images in their heads (imaginations) and in the other player's heads. A video game (including a D&D game like Neverwinter Nights) involves players manipulating images on a screen, not in their heads. Imagination becomes externalized. One is not better than the other. They are complementary ways of thinking, learning, and problem solving.

Fab, our newest literacy, involves a code that maps from ideas to atoms (and back again) via bits. What you can design in a computer, you can order machines ("printers" and "extractors") to make. What is in the world can be captured digitally ("reality

capture"), put in a computer, re-designed, and "printed" back out into the world. The atoms can be materials, cells, or chemicals. Humans are on the verge of erasing the lines between the imaginary, the digital, and the "real" and moving effortlessly back and forth among them. Bits no longer need to create just virtual things; they can now create real ones. In turn, real thing can now easily become virtual ones.

The day may come where we can "print" an organ like a liver or even (the initial cellular plan for) a living thing like a dog. As of now we can print skin, cells, cakes, and houses. Fab is not indexical. It doesn't point to things. It is not a simulation. It does not make just virtual things. Fab is material. It makes and manipulates matter. Fab trades not in concepts or simulations alone but in physical things as well. It is the "word become flesh", formerly the domain of magic and religion. The ideas in our minds and the images on our screens can now be born in the world and the world can enter our minds and computers to be re-born as something new. A whole new material form of thought and planning opens up for humans.

Fab is a set of design kits to make things into bits and bits into things. It creates an entirely new way of writing and reading the world. Fab will proliferate into different literacies, different ways of producing and consuming meaning for different functions, accompanied by new registers of oral language. Fab is a cultural invention like literacy. It will without doubt create social gaps and inequalities if we let it.

Fab is a form of literacy where production ("writing") is the main form. It finally reverses the polarity of traditional literacy and digital literacy, where consuming ("reading") proliferates, but production ("writing") does not, creating priests and laity. To be literate in Fab you must be a maker or at least know how a digital object will translate into a real one (and vice versa). It is as if we had demanded that to be literate in writing you had to be a writer and not just a reader, to be literate in digital game literacy, you had to be a designer and not just a player. In fact, a culture of Fab could lead to just such demands.

Just as writing made new demands on and demanded new skills in oral language, and digital lieracy made new demands on and demanded new skills in both oral language and written language, Fab makes new demands on and demands new skills in oral language, in literacy, and digital literacy. The ecology of oral language, of writing, and of digital literacy—and their various combinations and integrations—will change. Language, literacy, and digital literacy will become yet more complicated. The social gaps in each will compound, along with whatever gaps Fab literacy creates unless we will it otherwise.

Fab could create a world with yet deeper inequalities than we currently have, a world where only a few engage in the alchemy of turning ideas into bits into atoms and back again. The rest will live in a world where the stuff of life and the world--objects, cells,

materials—are owned and operated by only a few. Fab is a new literacy and we have as yet no real idea how it will work out. But it is a special and, in some sense, final one. For centuries, since Shakespeare at least, being modern has meant to fashion oneself and writing has played a massive role in this process. Now being modern will mean to fashion ones world as the stage on which one plays and lives.

Each new literacy ups the ante on ethical questions beyond issues of inequality. Words can hurt and harm, we know. Writing can greatly spread that harm. Digital media can spread it yet faster and further. But Fab can literally remake the world we live in, exhausting it or expanding it, destroying it or renewing it. Fab can make and remake the very stage on which we humans act for good and ill.

How many of us will get to be homo faber? Humans have always been the ultimate took makers. Soon the tools for world making will be cheap enough to be in the hands of everyone, should we want to make that happen. Will we, as a species, make a better world or a worse one when some or many or all of us become god-like creators, calling worlds into being?