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The Anthropology of Computing
Fall 2004 MIT

Today, we want to <u>conclude</u> by thinking about the <u>future</u> of computing — and I've chosen a piece about <u>biocomputing</u>, "the use of biological components and processes toward nonbiological, computational ends," to get us thinking.

Biocomputing works on the promise and premise of transporting computing from the medium of microelectronics into the medium of the organic, with potential ramifications for how we define COMPUTING itself. Let me put some of this in the frame of the class.

We began this course by recognizing that COMPUTERS used to be people; *COMPUTING* was something PEOPLE did.

Let me take you on a trip down memory lane — showing you some overheads that will remind you, a la Vannevar Bush's MEMEX machine, of the associations we made this semester.

Beginning with Pascal, gathering steam with Babbage, COMPUTING became something done by DEVICES, MACHINES — variously mechanical and electronic.

So, the *meaning* of COMPUTING changed to being something *machinic*.

We saw, too, how the *meaning* of INTELLIGENCE changed. <u>Babbage</u>.

And INFORMATION, too. <u>Wiener</u>.

> an interlude on language, then. How did these transformations in meaning happen?

> METAPHOR: transfer of meaning from one domain to another

> `1. A figure of speech in which a name or descriptive`
> `word or phrase is transferred to an object or action`
> `different from, but analogous to, that to which it is`
> `literally applicable`

> COMPUTING, INTELLIGENCE, and INFORMATION were terms that were *metaphorically* extended to the ways we think about calculative machinery.

> Thing is, they've become so common sense that we now think of them as literal. They are what literary scholars call DEAD METAPHORS. DEAD LITERAL.

>> e.g. I don't have enough time.

> Part of the project of anthropology and of cultural analysis more generally is to poke at dead metaphors, to tell the history of how they *became* literal.

> METAPHORS in computing have CHANGED what we mean by intelligence, information — in a way, they have been not just dead metaphors, or undead

metaphors, not just mixed metaphors (loud colors), but extensions of metaphors to things that didn't previously have names, that is catachreses:

CATECHRESIS

> `Improper use of words; application of a term to a thing which it does not properly denote; abuse or perversion of a trope or metaphor.`

> when you misname something because there is no name for it, that is catachresis — e.g. leg of a chair; American Indian

genetic code

> **`code`**`: 3. b.` *`Telegr`*`. A system of words arbitrarily used for other words or for phrases, to secure brevity and secrecy.`

On this definition, in order for genes to be codes, DNA has to be a language — but of course, just because we can label the nucleotide bases in DNA with letters doesn't mean that we thereby have an alphabet. <u>DNA is not a language</u>.

Still, on the logic of catachresis, the notion of the genetic code has been *productive* for molecular biology, and, as a result, the meaning of the word CODE *changes*, to now allow us to speak of biological specificity and the relation between nucleotides and amino acids as being CODE-like. We have not so much a DEAD METAPHOR here, as an UNDEAD METAPHOR.

These metaphors, as Edwards reminds us, are part of *DISCOURSES* — facts and fantasies (*Blood Music* is obviously a fantasy about biocomputing)

So, biocomputing.

DNA COMPUTING
Lecture 12. December 6

Thacker, Eugene. 2004. Biocomputing: Is the Genome a Computer? In Biomedia. Minneapolis: University of Minnesota Press, pp. 87-114.

"biocomputing as the use of biological components and processes toward nonbiological, computational ends" (p. 89).

"From [the] basic principle of base pair complementarity, DNA contains two elements crucial to any computer: a processing unit (the enzymes that denature, replicate and anneal DNA), and a storage unit (the regulatory 'instructions' encoded in DNA strings). Not only does DNA form a highly efficient storage system (as estimated one bit per cubic nanometer), but in the living cell, instructions are carried out in a massively parallel fashion (in contrast to the sequential processing of instructions in many computers)" (p. 94).

"This combination of massive parallelism and storage capacity makes DNA an ideal 'computer'" (p. 95). Why does Thacker keep "computer" in quotation marks?

Let me ask you the question that gives Thacker's chapter its title: "Is the genome a computer?"

If yes, how?

"biocomputing begins from an assumption concerning the equivalency between genetic and computer 'codes'" (p. 97).

code as catachresis.

Does this mean that DNA *is* a computer?
No. Rather, it means that it can be *treated* as a computer.

"the biocomputer displays biological functionality because it creates a context in which selected biological components and processes may occur. ... However, this functionality serves no biological function, directly or indirectly, and is therefore quite different from DNA in the living cell or in the molecular biology lab. The DNA computer does nothing to the DNA itself that might be seen as beneficial from a biological, organismic, or medical perspective." (p. 108).

How is this biocomputing different from what Turing and von Neumann had in mind?

in the work of von Neumann and Turing, *intelligence* and *memory* were at the center of their theories about computers. These terms were transformed qualitatively.

You'll recall that Alan Turing said that he thought that by the end of the 20th century, people would have no trouble saying that computers would think. Is that true?

According to Thacker, Turing was wrong because he didn't foresee that the way we think about computing might not be about intelligence at all!

von Neumann and Turing use humans as the measure of intelligence and memory; biocomputing sidesteps the question of the human. "biocomputing suggests that the difference between organisms and machines is not anything human, but rather a difference between living and nonliving systems" (p. 106).

"For Turing and von Neumann, what is at stake is essentially mind, with the human as its most sophisticated manifestation (one that is nevertheless amenable to computation). For biocomputing, what is at stake is 'life,' by this meaning the ability of bimolecular systems to carry out exceedingly complex calculations 'naturally'" (p. 106).

What are the implications?

"the modern digital computer of Turing and von Neumann conceives of computation as a cognitive function, whereas in the PC era of biocomputing

research, computation is seen as inherently nonconscious, distributed, and in parallel" (p. 107).

So, what is a computer NOW? What is COMPUTING now?

Materially? Quantum Computing:

> "A quantum computer is any device for computation that makes direct use of distinctively quantum mechanical phenomena, such as superposition and entanglement, to perform operations on data. In a classical (or conventional) computer data are measured by bits; in a quantum computer the data are measured by qubits. The basic principle of quantum computation is that the quantum properties of particles can be used to represent and structure data, and that devised quantum mechanisms can be used to perform operations with these data." *Wikipedia*

Computing is no longer thought of as disembodied, immaterial — a la Descartes, Babbage, Weiner, Turing; it is becoming materially diverse — biocomputing, quantum computing.

It is no longer even about whether computers will compete as intelligent agents with humans. The Turing test may be outmoded. As Thacker argues,

> "For Turing and von Neumann, what is at stake is essentially mind, with the human as its most sophisticated manifestation (one that is nevertheless amenable to computation). For biocomputing, what is at stake is 'life,' by this meaning the ability of bimolecular systems to carry out exceedingly complex calculations 'naturally'" (p. 106). ARTIFICIAL LIFE

What are the social and cultural effects?

> Closed World? OpenSource?
>
> How will you hack it?
>
> Who will use it? Who will build it?

I think the paradigm shift we are seeing is that computing is no longer thought of as a grand reflection of a macrocosmic system — as it was for Babbage, Descartes, and Lull. Rather, it is becoming more about microworlds, about reformatting reality from the bottom up.