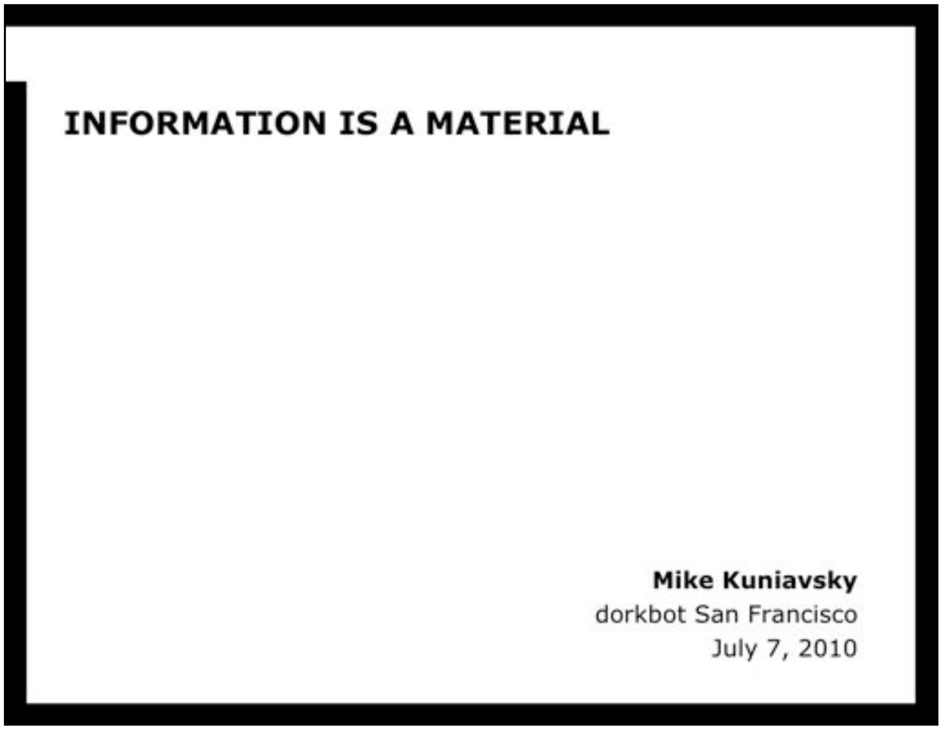
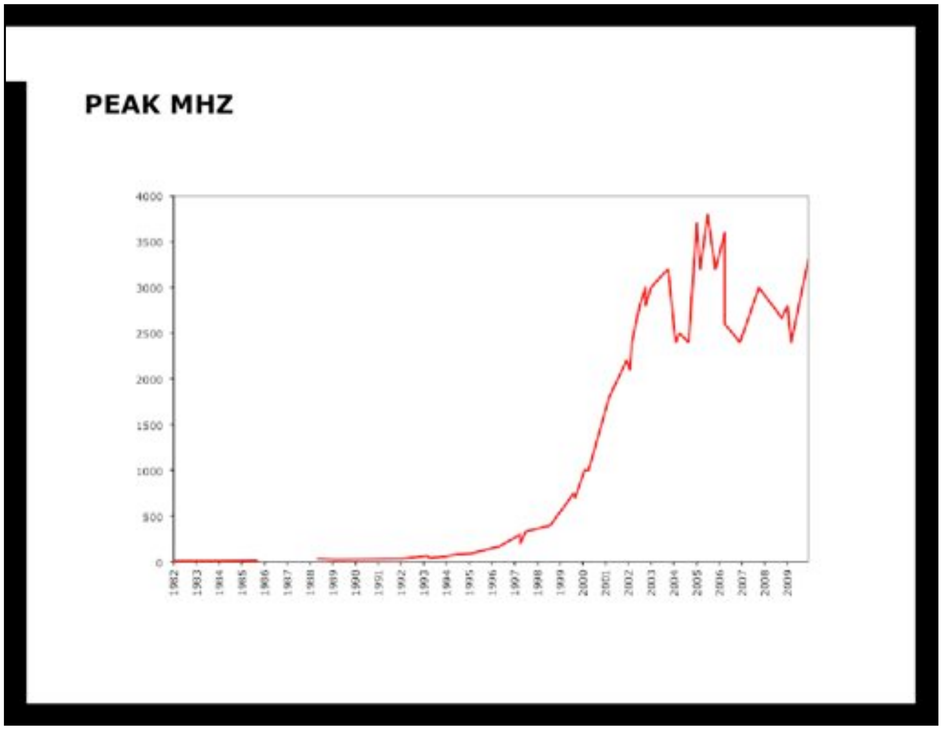


Thank you Karen for inviting me back to present. It's always a pleasure.

First, let me tell you a bit about myself. Most of my professional career over the last 17 years has been spent as a creative director, interaction designer, researcher and user experience strategy consultant, mostly on the Web. I've worked with hundreds of companies. Among those I have had extended relationships with these three, the bottom two as a founder. ThingM is my current company.

Most of this talk comes from a chapter in my upcoming book, called “Smart Things”, it’s on ubiquitous computing user experience design. It’s available for pre-order now and will ship sometime between the end of August and the middle of September.

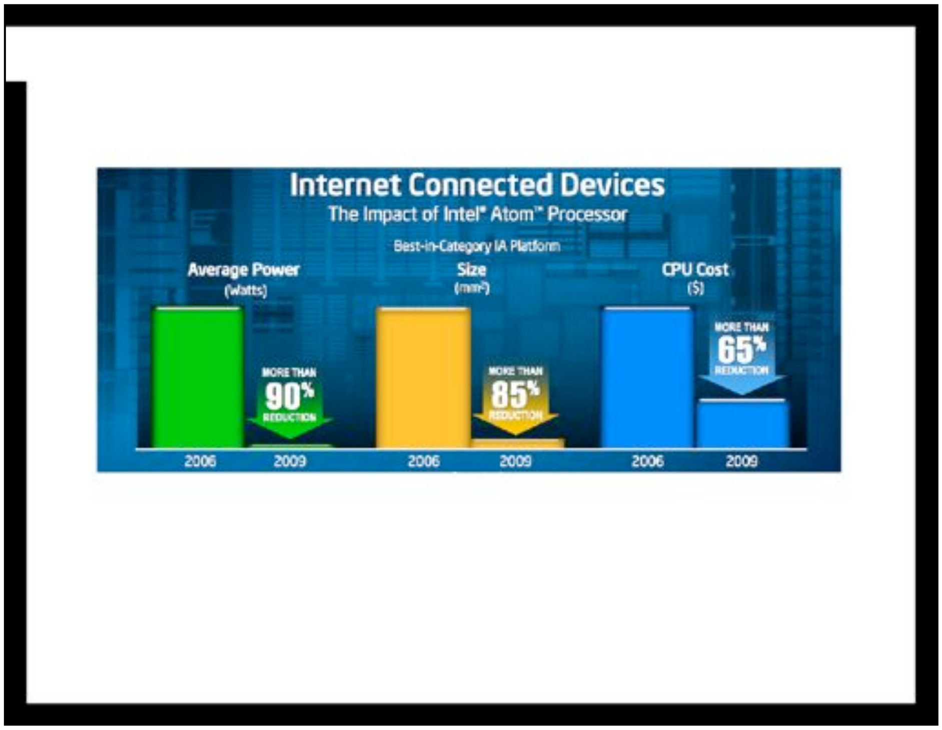


I want to start by mentioning a curious phenomenon. If you any of you follow developments in microprocessors, you'll notice that the clock speed of today's new CPUs is basically the same as that of CPUs from five years ago. For those of us who used computers in the 80s and 90s, this is very confusing. We watched clock speeds go from 6MHz in 1983 to 3GHz in 2003 and became used to clock speeds as the measure of power and value in information processing.

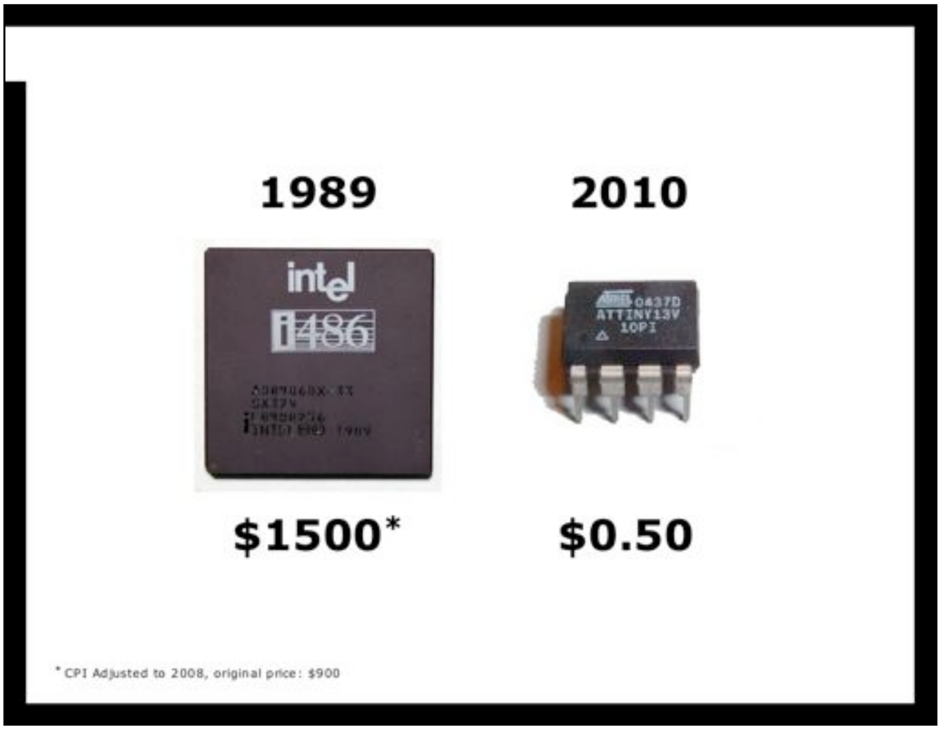
But after 20 years during which clock speed increased by 3 orders of magnitude, suddenly clock speed abruptly stopped going up in 2004. The industry went from exponential growth in clock speed to no growth, zero growth, in one season. It's like someone slammed the emergency brake.

I call this phenomenon Peak MHz.

Unlike oil, we're not literally running out of CPU clock cycles, but we are seeing a reevaluation of how we understand the value that computers provide, and this has resulted in a shift in the strategy of microprocessor makers. What happened in 2004 was, broadly speaking, that chip manufacturers saw that we were running out of uses for big, energy-hungry, hot processors, and they shifted the game. Since 2004 the competition has shifted from raw CPU to making smaller, cooler, cheaper chips that can do as much work as older chips, while using fewer resources.



Here’s a slide from a talk Paul Otellini, the CEO of Intel, gave last year. Notice that instead of talking about numbers going up, processor manufacturing has become all about pushing numbers down. Instead of competing on doing more with more, they are now competing on doing more with less.



One of the main effects of this shift is that in addition to pushing the price and energy consumption of the latest CPUs down, it also pushes the price of all previous processing technologies down along with it. For example, at the beginning of the Internet era we had the 486 as the state of the art and it cost $1500 in today's dollars. It's the processor that the Web was built for and with. Today, you can buy that same amount of processing power for 50 cents, and it uses only a fraction of the energy. That is the same 3 orders of magnitude drop as the increase in speed to 2004. This is not unrelated, because both are the product of the same underlying technological changes.

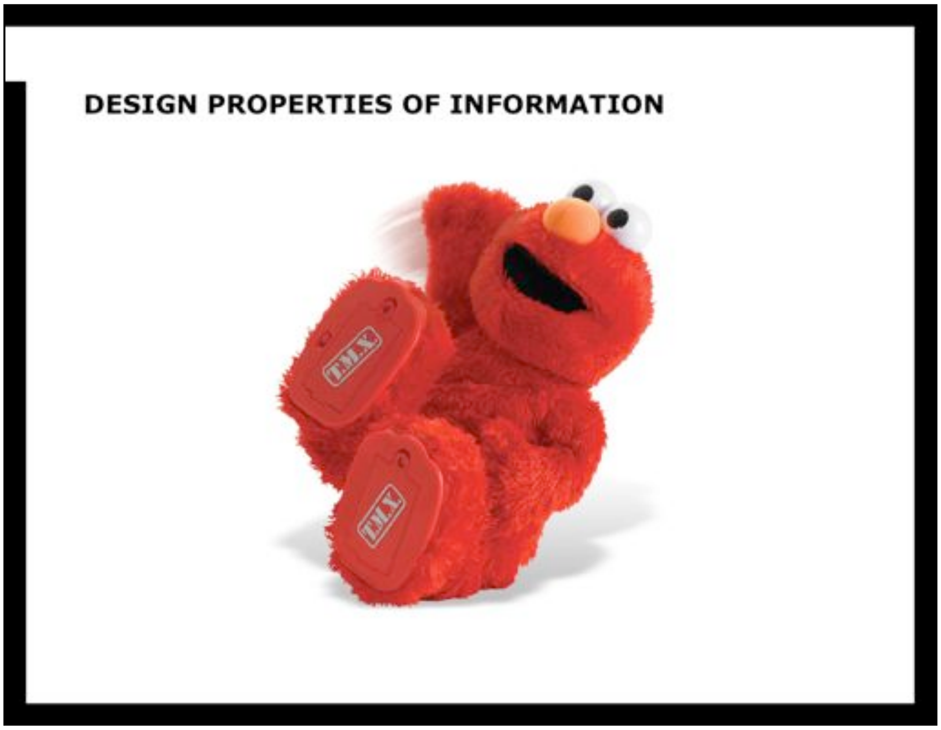
Here's another Otellini slide. It's essentially saying "look, we're making the same thing smaller and cheaper every year."

When a technology falls in price this much, it opens up enormous possibilities and creates fundamental changes in society. Steam engines similarly lowered the price of harnessing energy by orders of magnitude…and the Industrial Revolution was born as people found all kinds of new uses for readily-available mechanical energy.

You can see similarly transformative effects if you look at what happened when the price of extracting aluminum dropped by two orders of magnitude in the late 19the century, or when electric motors became significantly cheaper and smaller in the 1920s. When something becomes cheap, it quickly joins the toolkit of things we create our world with. It becomes a design material. Sometimes for better and other times for worse.

Because cheap processors have drastically lowered the cost of taking information in, evaluating it, manipulating it, rearranging it, and acting on it, information is very quickly becoming a material to design with. It is no longer unthinkable to have an everyday object use a small embedded processor take a small piece of information—say the temperature, or the orientation of a device, or your meeting schedule—and autonomously act on it.

This capability of everyday objects to make autonomous decisions and act using arbitrary information is as deep an infrastructural change in our world as electrification, steam power, and mechanical printing. Maybe it's as big of a deal as bricks. Seriously, it's a huge change in how the world works, and we're just at the beginning of it.



If information is a design material, what are its material properties? Sure, at some level there are the basic information theoretic properties such as bandwidth, noise and complexity, but those are the microscopic properties, the equivalent of basic nuclear forces in material science. They won’t help us design a Tickle Me Elmo Extreme, which is a device that’s only practical to make using cheap information as a material. What are the MACROSCOPIC properties of information that we can use as designers and artists?

It can sense the world. There are thousands sensors that convert states of the world into electrical signals that can be manipulated as information. This also includes sensors that sense human intention. We call these “buttons”, ”levers”, “knobs” and so on.

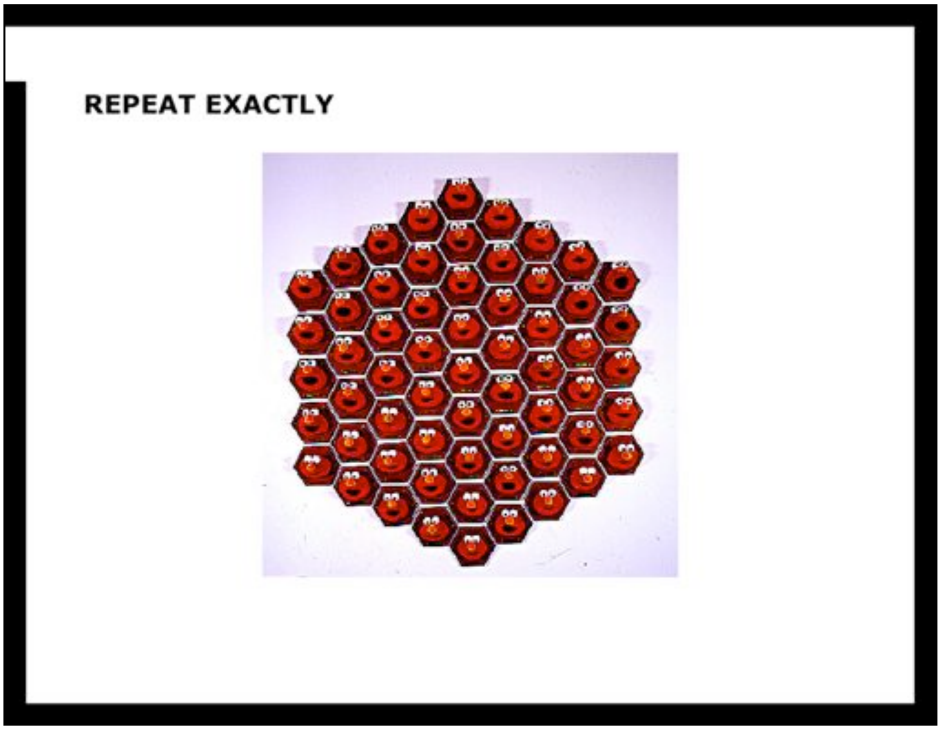
Actuators, which is the generic term for anything that can make a physical change based on input, can be triggered based on information. Thus, information can be used to autonomously affect the world in a way that no previous material was capable of.

Information can store be used to some knowledge about the state of the world that can be acted on later. This could be just a single piece of data, such as what a mechanical thermostat does when it stores the temperature you'd like to keep your house at, or something much more sophisticated, say, storing an image of everything you look at, which is what justin.tv was doing a couple of years ago.

REPEAT EXACTLY

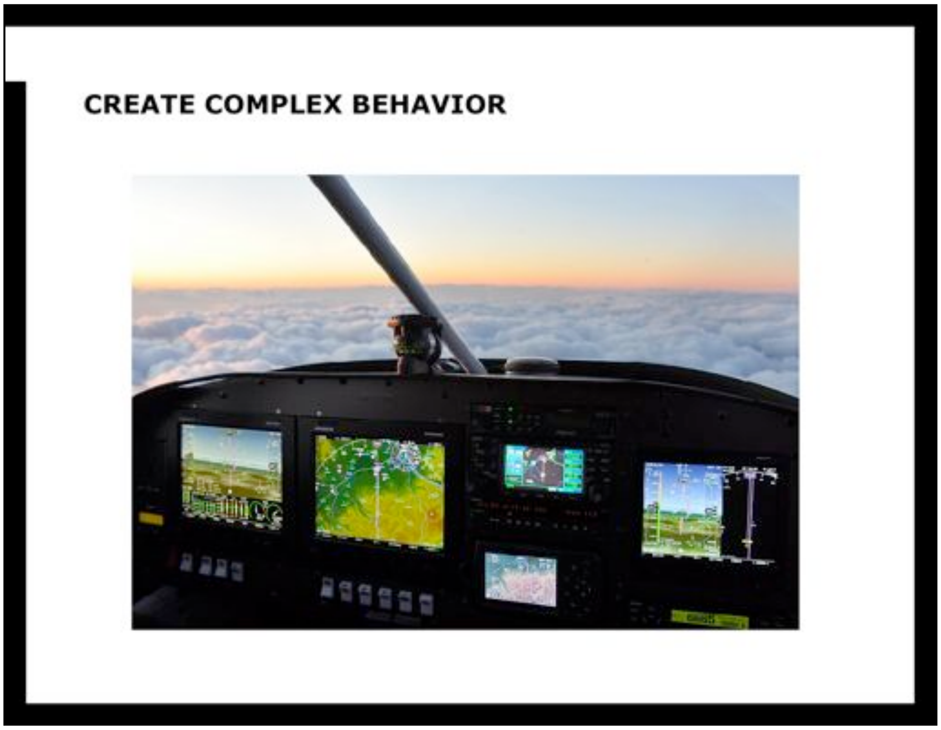
One of the most transformative qualities of information is that it can be duplicated exactly and transmitted flawlessly. This has already changed the music and video industry forever.

Image: UPI: http://www.upi.com/enl-win/9b95da78f449e1a5dc28a05efc4d55a4/



But it also means that device behavior can be replicated exactly. We've become acclimated to it, but--stepping back--the idea of near-exact replication in a world full of randomness and uncertainty is a pretty amazing thing, and is a core part of what makes working with information as a material so powerful.

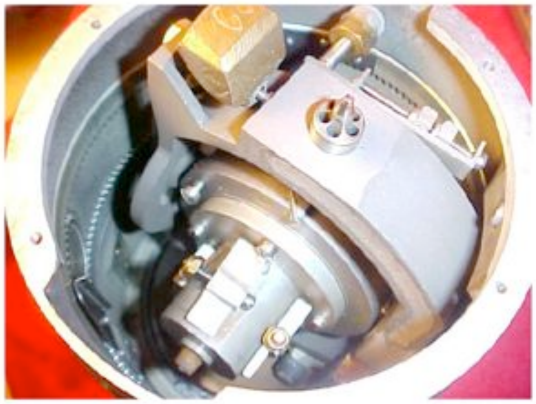
Image: N-Trophy, 2000-2003, Kelly Heaton, Feldman Gallery: http://www.feldmangallery.com/pages/exhsolo/exhhea03.html



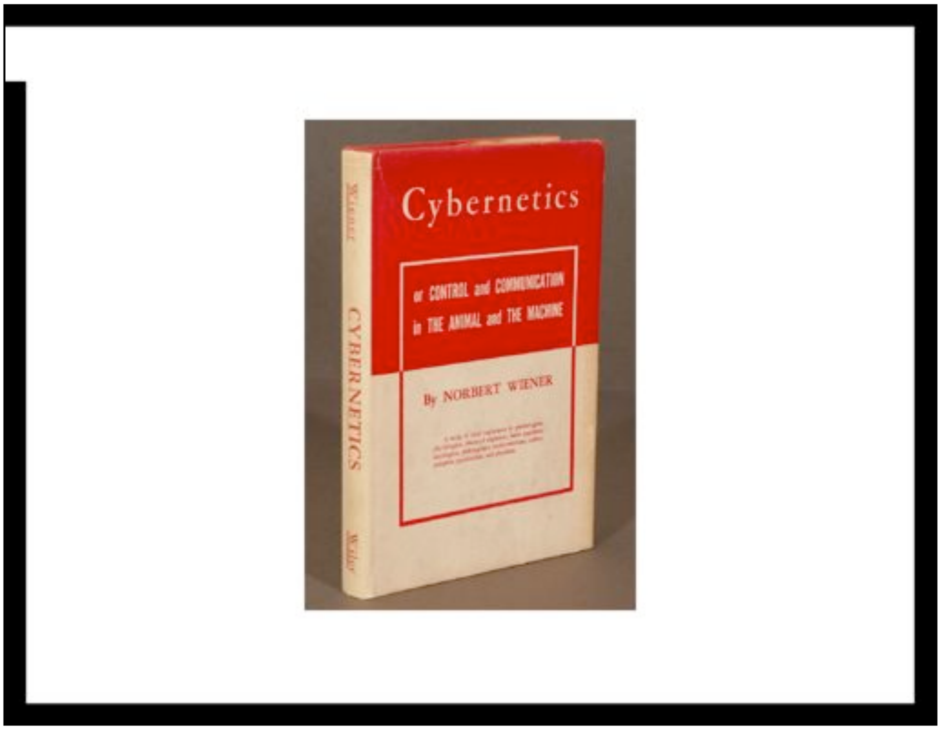
Information enables behavior that's orders of magnitude more complex than possible with just mechanics, but at a fraction of the cost. This is a modern small airplane avionics system. It consists of a bunch of small fairly standard computers running special software.

Found on: http://www.vansairforce.com/community/showthread.php?t=51435

CREATE COMPLEX BEHAVIOR



Compare that to a traditional gyroscopic autopilot where every single component is unique, it does very little, and to change its behavior you have to completely reengineer it.



If you just thought, “You’re just saying things we already know, and Norbert Weiner’s Cybernetics covered much of of this 1948!” you’re right. We’re all intimately familiar with computers, so many of these qualities seem obvious, and Weiner certainly predicted a lot of this first, but he was writing from theory, and most of our experience is with general purpose computers that were designed when information was still a pretty expensive material to work with. We’re crossing into a new era of direct, widespread embedding of information as a key component of wide variety of special purpose devices, so examining these ideas is now more important than ever.

Now that we've broken information as a material down to components, what does this mean for the design of devices?

Let’s start small. Because information can abstract knowledge, it makes it easier to reduce complexity, including the complexity of information technology itself.

Embedded processors make it possible to create an abstraction layer around basic sensing, processing and actuation components to creates building blocks that are meaningful in human terms, rather than just electronic terms. Each block has a CPU and communicates with other blocks over a network. Rather than starting from basic principles of electronics, you as a designer or artist will soon be able to focus on what you’re trying to accomplish, rather than which capacitor to use. You don’t have to smelt your own iron to make things out of metal, or grow your own wood to make things out of wood. Similarly, object-oriented hardware will turn information from a raw material into a design material.

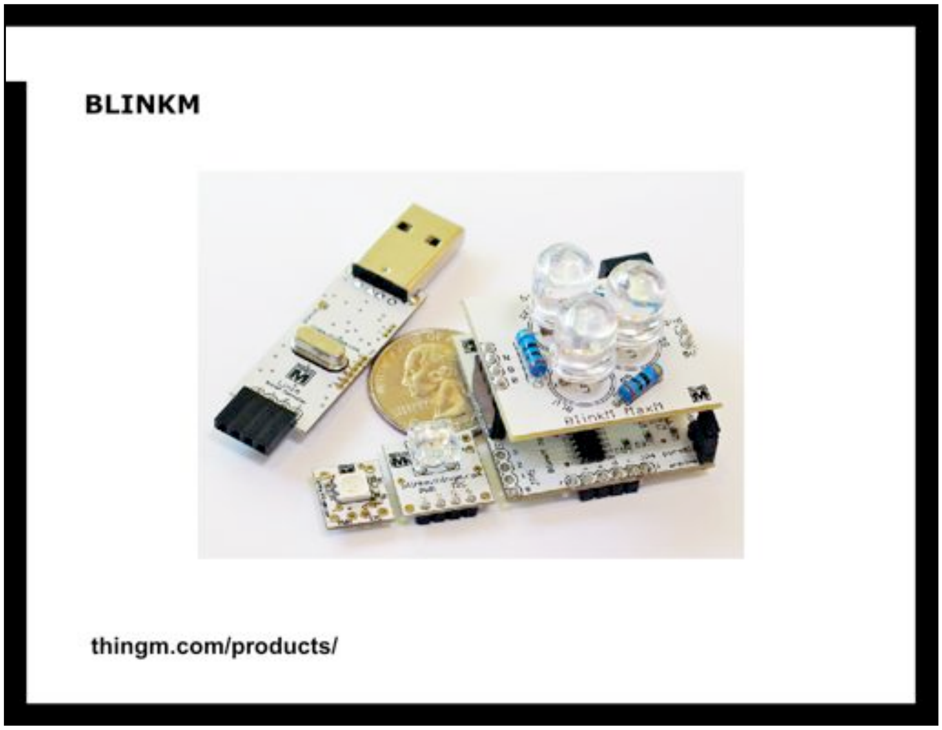
What you see here are mostly all prototypes, but these devices are the atoms of information as a material, the blocks from which other information devices will be made.

Most images from Jacob Nielsen’s PhD, “User-Configurable Modular Robotics”

Also LittleBits from Bdeir, Hoefs, et al.

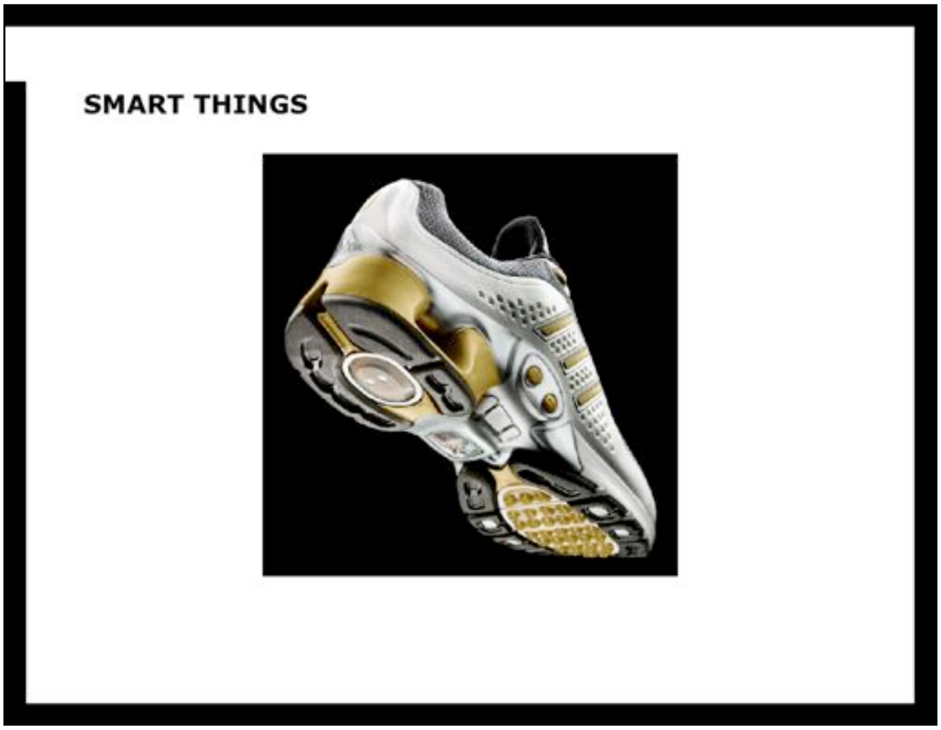
Tinkerkit from Tinker.it

Bug Labs



ThingM, my company, makes a set of such atoms that emit light. Our BlinkM line of smart LED products makes it very easy to put controllable RGB light into arbitrary locations with no electronics knowledge or color theory. Burning Man is around the corner, pick some up today at fine retailers worldwide.

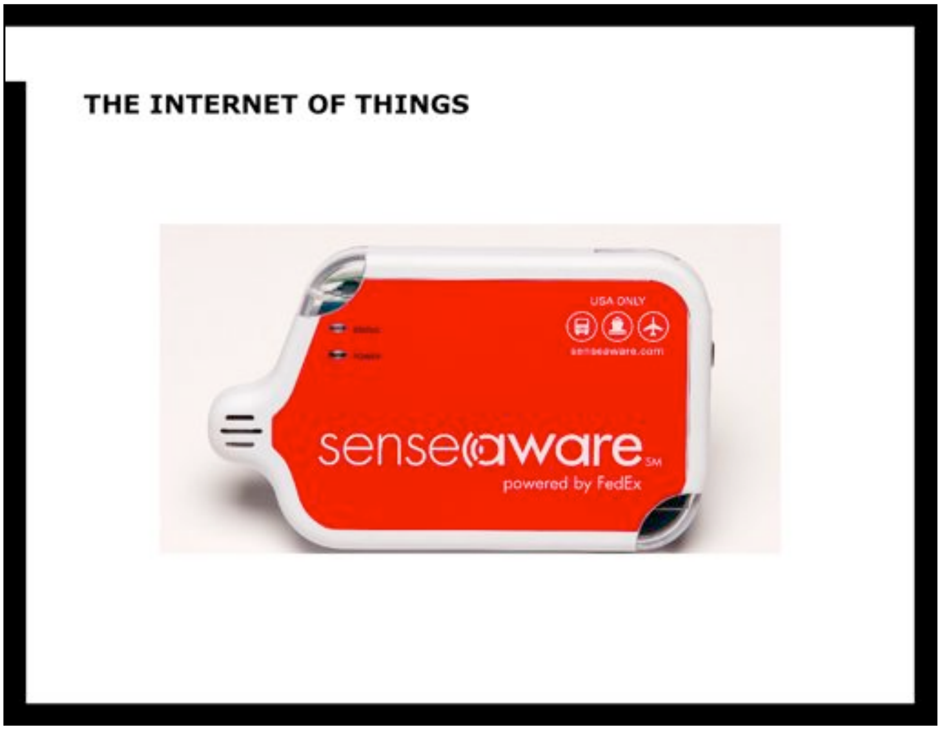
OK, end of sales pitch.



So what’s made with these atoms?

On the next larger scale, we will see new personal tools. Today we have digital pedometers, Internet connected bathroom scales, networked parking meters, and cars that don’t stall, but there will be many more. Pick nearly any object, add information to it, and you get a new object. My favorite example of this the adidas_1 shoe, which was put out 5 years ago and then almost immediately discontinued. It has a pressure sensor that it uses to estimate the qualities of the surface being run on an adjusts the heel in between strides to optimize the resiliency regardless of what surface you’re running on. The buttons adjusts how it responds.

For me it represents how a small amount of information, carefully deployed can profoundly change an object.



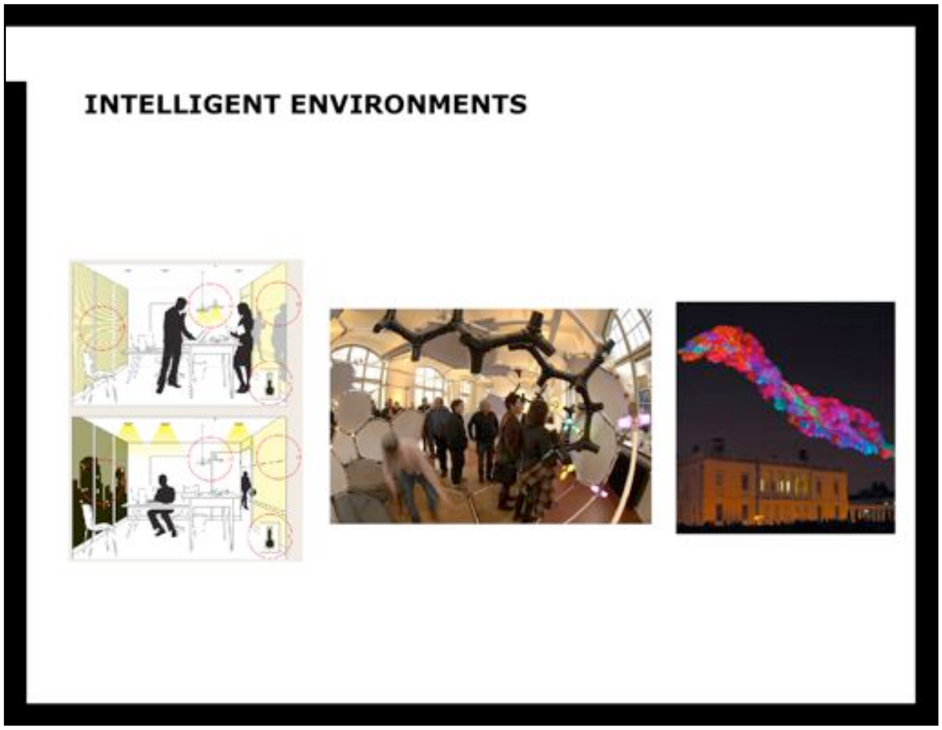
Making things with information makes it easy for devices to provide continuous telemetry to each other, in what's being called M2M or machine to machine communication. That capability of information is at the core of the Internet of Things. You can check on the status of your Amazon order because there are hundreds of devices that are automatically tracking nearly every single atom Amazon is responsible for using barcodes. Soon these will become RFIDs and after that they'll be active devices, like the FedEx Sensaware smart tag, which has a bunch of sensors, a GPS and the equivalent of a phone in it for sending data about where a package is and what conditions it's traveling in.

Cheap processing also creates the opportunity to use information as a decorative material. A lot of data visualization today is as much about decoration as it is about information analysis or communication, and that trend is only going to continue. Information is no different a material than any other material. Wood can hold up a house, or you can make a sculpture with it. Information can be used to create incredibly beautiful, profound esthetic experiences. It has already revolutionized music and cinema, but treating as a permanent material, rather than a medium, creates fantastic new opportunities.

Shelf by Jean-Louis Frechin

Floor by Enteractive

Buddy Beads by Ruth Kikin-Gil



When taken all together, all of these changes mean that at a large scale, our environment is growing increasingly information-based on a fractal level. Small information devices make large information devices that combine to form whole environments made with information as a core material.

From Herman-Miller's "Always Building"

TU Delft's Interactive Environment project

Usman Haque's Sky Ear

Hello.Wall

Where will this lead? Well, just as we didn't get our flying cars, but we didn't have to fight atomic hydroplaning Soviet battleships, working with information as a material is a negotiation with the technology the material represents. New materials create both possibilities and problems. The most important thing is to engage with the material as a material that you work with, rather than something you abdicate to others. If you are here at dorkbot, you make things with technology. This means that it's your responsibility to understand the properties of information, explore its capabilities, and build tools that make it easier to do the right thing with information than to do the wrong thing. It is our responsibility to do these things much more than it is Intel's, or LG's or the government's.

So, please, when you do strange things with electricity, or with information, do it knowing that you are using a material we barely understand. Be bold, be careful, and share your results.


SMART THINGS
Ubiquitous Computing User Experience Design
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Thank you.