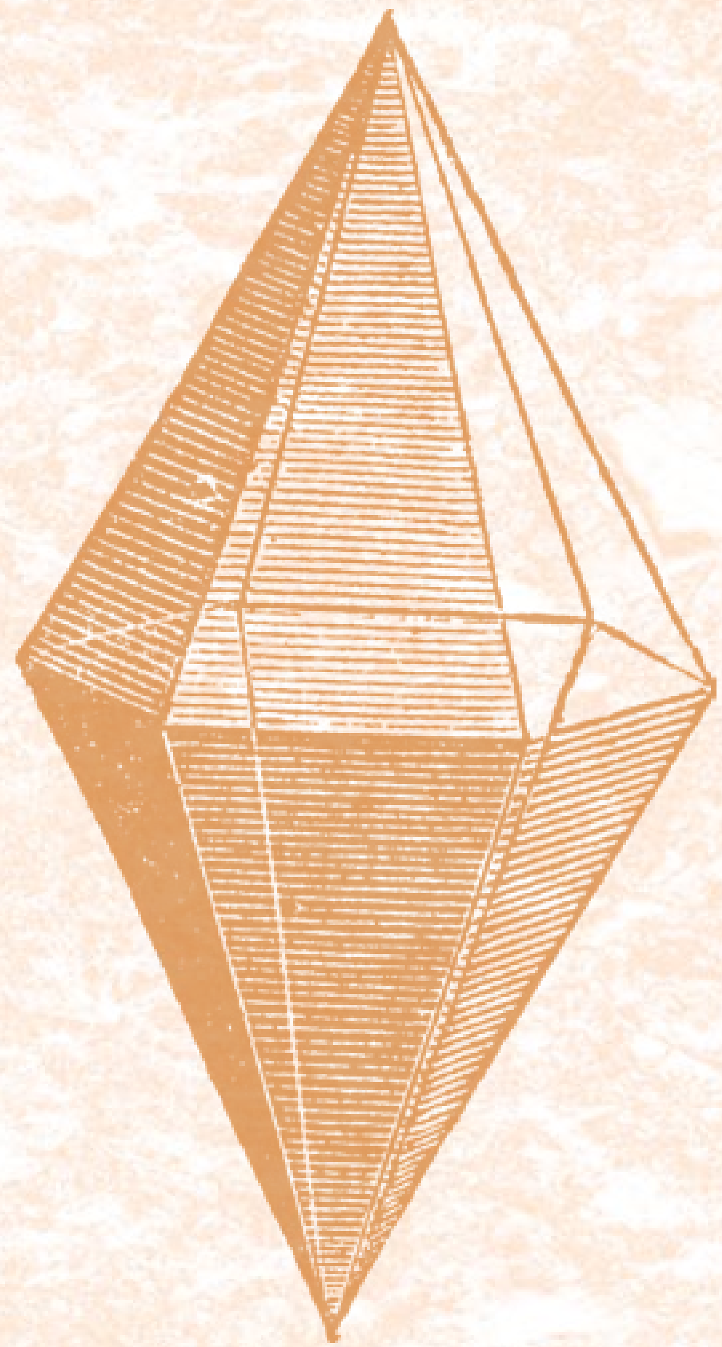
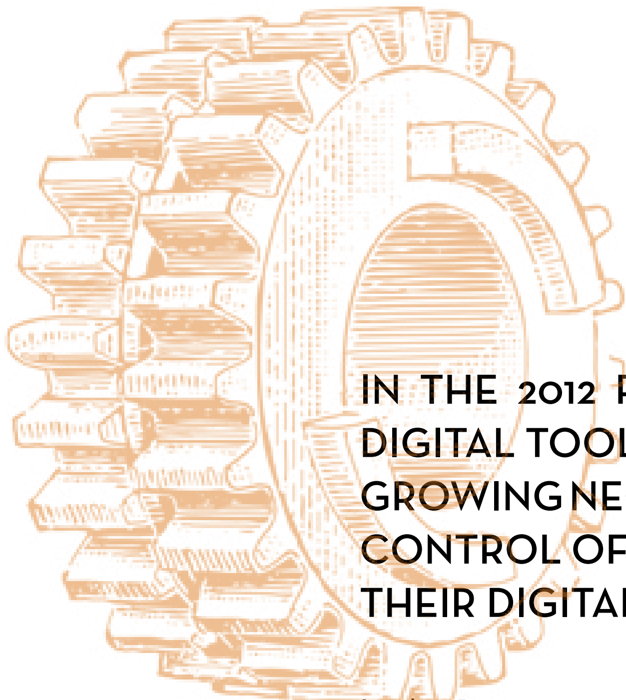
PHYSICAL PIXELS

– DIGITAL IMAGES LOOK GREAT, BUT THERE IS ONE BIG DISAPPOINTMENT: THEY DON'T EXIST IN REALITY, THEY ARE NOT REAL –

FLORIAN KAPS





IN THE 2012 REPORT, WE REVEALED THE IMPORTANCE OF PEOPLE EMBRACING DIGITAL TOOLS IN ORDER TO BUILD THEIR SOCIAL INFLUENCE. WE DISCUSSED THE GROWING NECESSITY OF LEARNING TO MANAGE AN ONLINE REPUTATION AND KEEP CONTROL OF ONE'S DIGITAL FOOTPRINT AS PEOPLE UNDERSTAND THE IMPACT OF THEIR DIGITAL ACTIONS ON THEIR REAL LIFE (SEE SOCIAL SHAKE UP TREND).

In the Reinvention Era people are no longer satisfied with digital experiences alone. We are witnessing an over-pixelisation of the everyday: the fact that people are spending more time on screens. Surveys report that over 50% of kids between 13 and 17 spend over 30 hours a week recreationally in front of a screen[1]. Especially for digital natives, first experiences often occur online before happening in the real world, from playing to striking friendships, dating, etc. A survey found that about 12% of children aged 2 to 4 use computers every day, and 24% use them at least once a week[2]. Online experiences are increasingly becoming a natural part of the everyday, but humans are "sensual" beings, and they need physical and tangible experiences to be fulfilled individuals (see Additional Insights). In a world where everything is available online, real-world alliances and lived experiences will enable people to differentiate themselves and develop to their sense of identity. As a result, we are already witnessing a growing appetite for analogue experiences (see Supporting Facts) as real, tangible things; not just their representations. In the Reinvention Era, there will be a renewed interest in the physical over the digital. People will aspire to become makers: individuals who can turn pixels into atoms thanks to the expansion of affordable means of self-production. Digital technology that enables instant prototyping and hyper-personalisation will be important for them. The long tail, first defined by Chris Anderson[3], will consist of the things created thanks to the democratisation of manufacturing. It will create a complementary ecosystem and an alternative to the global economy. At the same time, technology will be re-thought to respond to the over-pixalisation phenomenon,

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and will bring more tangibility in interaction with users. New physical interaction paradigms will be created so that technology enables people to feel and experiment in a more tactile and "physical" way. The Physical Pixels trend demonstrates the importance of re-introducing more physicality into our everyday lives by enabling people to become makers: individuals who are transformed from the passive role of users of technological advancements into active creators that embrace technology to turn their digital dreams into tangible realities.

MAKERS EMBRACE HYPER-PERSONALISATION AND INSTANT PROTOTYPING

Children have always been interested in making things. The difference is that the possibilities for "making" things today are infinite. Children's dreams can be turned into tangible realities, and even more importantly, they can do it themselves. Indeed, software such as KidCAD offers affordable architectural programs that allow kids to make 3D buildings and design the buildings' interiors (See Case Studies). Innovations in CAD software and 3D printers, together with the whole movement of open hardware the likes of Arduino and Raspberry Pi (see Case Studies), will enable more people to become makers. The global 3D market is expected to reach $2.99 billion by 2018[4]; as these tools grow in popularity, makers will be able to create anything from a small gadget to a house or even a spaceship (see Case Studies). Makers are motivated by the possibility of creating personalised objects that don't require a large economy of scale to be made. As a result, the makers' objects often come with slight imperfections or variability. Indeed, variability will become part of the design process and makers will show a newfound appreciation for craftsmanship. The Japanese refer to this as Wabi-Sabi: an aesthetic centred on the acceptance of transience and imperfection (See Additional Insights). We can imagine in the future that manufacturing will move from a standardised, large-scale process to smaller quantities of highly personalised artefacts. These highly personalised objects will be increasingly connected objects that are appealing to people because they are made to their own specifications: they fit the unique profile of the user and are able to

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connect with a whole ecosystem of devices.

Makers will engage in social manufacturing through online maker communities that offer 3D printing and other production services such as quick prototyping. They will set up instant labs where they can reinvent new objects and use crowdsourcing to fund their production. Fab labs, small-scale fabrication laboratories offering personal digital fabrication, will grow in popularity (See Additional Insights). This is a real revolution in terms of manufacturing. As the maker movement takes more traction, it will encourage and revive local production. Makers will become entrepreneurs who can prototype, manufacture, sell, and test their ideas quickly and cheaply before potentially scaling them up. Because people will increasingly be able to make things for themselves, the number of people directly employed in making things will decline and the cost of labour as a proportion of the total cost of production will diminish. This will encourage makers to move some of the work back to rich countries, not least because new manufacturing techniques make it cheaper and faster to respond to changing local tastes and enable "mass customisation" (see Additional Insights). It will create a new complementary production ecosystem and potentially revive some local economies. This is a real transformative change whereby industries are democratised and are handed over to regular people, the Makers.

The challenge of this new trend will be the economy of scale of the digital world, and ensuring that these new makers exploit online power to tap into the needs of niche communities, thereby participating in the long tail of objects and making sizable profits from it.

REINVENTING TECHNOLOGY SO THAT IT FEELS MORE TANGIBLE AND BETTER FOR PEOPLE.

Everyone who has noticed a small child's interaction with screens will recall that the first reaction is to touch it. For the children of the "iPad generation", digital technology is seamlessly embedded into the everyday, and they want to be able to manipulate, touch, and feel it. According to cyborg anthropologist Andrew Warner, every generation of computing becomes more tactile[5]. The first interfaces were awkward keyboards and terminals, then the mouse (which required the whole arm to move), then the touchpad (which we lovingly stroke with our fingertips), and then the touchscreen (which integrated display and touch). Warner believes that the next generation of technology will bring new ways for people to get similar tactile experiences: to be able to touch objects or materials. Indeed, people are not satisfied anymore with static and passive interactions. They prefer to engage with more kinetic and active technology (see Additional Insights). We can already notice the growing availability and popularity of gestural interfaces that involve body interaction. The Wii, for example, has sold 96.56 million units worldwide[6]. More innovations should leverage the idea that, as humans are sensual beings, the body is often indeed the best and most natural interface to use.

ACCORDING TO CYBORG ANTHROPOLOGIST ANDREW WARNER, EVERY GENERATION OF COMPUTING BECOMES MORE TACTILE.

By combining new digital technology with physical interaction, we can create playful and intuitive experiences. For example, Tangible User Interfaces (TUI) let a person interacts with digital information through the physical environment. TUI takes advantage of our haptic sense, the process of recognising objects through touch (see Additional Insights) to make information directly malleable and intuitively perceived. One of the pioneers in TUI is Hiroshi Ishii, a professor at the MIT Media Laboratory who heads the Tangible Media Group. His particular vision for tangible UIs, called Tangible Bits, is to give physical form to digital information, so that bits can be directly manipulated and perceived. The Tangible Media Group is developing a pure vision of interaction that does not yet exist, but that may be invented in the next 100 years by atom hackers (material scientists, self-organising nano-robot engineers, etc.). Their vision speculates about new interaction techniques and applications that would be enabled by the Radical Atoms (see Additional Insights). We are witnessing more examples of bridging the digital and physical worlds by giving a tangible presence to virtual elements. For example, Tangible Textural Interface (TTI) is a new sound system that embeds a tactile surface. TTI has flexibility that enables people to physically touch and feel the response through the controls and physical morph of the surface (see Case Studies). This can be especially helpful in enabling people to understand complex information because it makes it more "real" for them.

Makers will embrace such technology and participate in its development in order to turn their pixel dreams into physical realities, in a way that feels more connected and aligned with the fundamentals of human interaction.

1. http://www.nytimes.com/2012/11/30/opinion/global/maria-popova-evgeny-morozov-susan-greenfield-are-we-becoming-cyborgs.html?pagewanted=all&utm_medium=referral&utm_source=pulsenews

2. http://www.nytimes.com/2011/10/25/us/screen-time-higher-than-ever-for-children-study-finds.html

3. The Long Tail, Wired Magazine, October 2004

4. “3D Printing: A Global Strategic Business Report” by Global Industry Analysts, Inc. (http://www.strategyr.com/3D_Printing_Market_Report.asp)

5. http://techcrunch.com/2012/11/04/5-perspectives-on-the-future-of-the-human-interface/http://www.nintendo.co.jp/ir/en/sales/hard_soft/index.html

ADDITIONAL INSIGHTS

"Everything in the factories of the future will be run by smarter software. Digitisation in manufacturing will have a disruptive effect every bit as big as in other industries that have gone digital, such as office equipment, telecoms, photography, music, publishing and films. And the effects will not be confined to large manufacturers; indeed, they will need to watch out because much of what is coming will empower small and medium-sized firms and individual entrepreneurs. Launching novel products will become easier and cheaper. Communities offering 3D printing and other production services that are a bit like Facebook are already forming online—a new phenomenon which might be called social manufacturing."

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MASS CUSTOMISATION refers to the use of flexible computer-aided manufacturing systems in marketing, manufacturing, call centres, and management to produce custom output. Those systems combine the low unit costs of mass production processes with the flexibility of individual customisation. Mass customisation is the new frontier in business competition for both manufacturing and service industries. At its core is a tremendous increase in variety and customisation without a corresponding increase in costs. At its limit, it is the mass production of individually customised goods and services. At its best, it provides strategic advantage and economic value. Mass customisation is the method of "effectively postponing the task of differentiating a product for a specific customer until the latest possible point in the supply network."

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FAB LABS (fabrication laboratory) are small-scale workshops offering personal digital fabrication. A fab lab is generally equipped with an array of flexible computer-controlled tools that cover several different length scales and various materials, with the aim to make "almost anything". This includes technology-enabled products generally perceived as limited to mass production. While fab labs have yet to compete with mass production and its associated economies of scale in fabricating widely distributed products, they have already shown the potential to empower individuals to create smart devices for themselves. These devices can be tailored to local or personal needs in ways that are not practical or economical using mass production.

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THE CENTER FOR BITS AND ATOMS (CBA) was established in 2001 in the MIT Media Lab. The cross-disciplinary centre broadly looks at the intersection of information to its physical representation. MIT's Center for Bits and Atoms is an ambitious interdisciplinary initiative that is looking beyond the end of the Digital Revolution to ask how a functional description of a system can be embodied in, and abstracted from, a physical form. Researchers explore new ways to turn digital information (bits) into physical objects (atoms) and vice-versa. "One of the core themes is the idea of digitising fabrication," says Neil Gershenfeld, CBA's director. "That's not only computers controlling tools; it's also about putting programs into materials themselves." To that end, Gershenfeld and his colleagues have programmed self-assembling strings of robotic modules and are now using biological proteins to create self-assembling nanostructures. The CBA is home to an impressive collection of machines. In fact, it's the ultimate workshop, and it's freely available to researchers and students. "The freedom of access means they get used in a very different way from conventional settings," says Gershenfeld. "People get to play around more, which encourages speculative work."

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FABCENTRAL is a site that supports the digital fabrication facility and global network of fab labs managed by MIT's Center for Bits and Atoms (http://fab.cba.mit.edu/).

In Spain, there are six fab labs spread throughout Asturias, Barcelona, Bermeo, Leon, Seville, and Valldaura.

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FAB ACADEMY is the distributed educational platform of the worldwide network of fab labs. The Fab Academy is a Digital Fabrication Program directed by Neil Gershenfeld of MIT's Center For Bits and Atoms. It is based on MIT's rapid prototyping course, MAS 863: How to Make (Almost) Anything. The Fab Academy began as an outreach project rom the CBA, and has since spread to fab labs around the world. The program provides advanced digital fabrication instruction for students through a unique, hands-on curriculum and access to technological tools and resources. Furthermore, Fab Academy is evolving to a Master's program through the development of applied research projects and thesis, as well as exploring expanded training programs related with specific conditions of labs and communities.

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MAKERSPACES, or shared production facilities, now number 1000 around the world, and they are growing at the astounding rate. Recognising the power of the Maker Movement, in early 2012 the Obama administration launched a program to bring makerspaces into one thousand American schools over the next four years. They include complete digital fabricant tools such as 3D printers and laser cutters. In a sense, it is a return of the traditional workshop class, but upgraded for the Web Age. And this time it is not designed to train workers for low-paying, blue-collar jobs. Instead, it is founded on the government's advanced manufacturing initiative aimed at creating a new generation of system designers and production innovators.

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MENTOR MAKERSPACE introduces high schools to small-scale, distributed digital design and manufacturing technologies in order to help their students realise the creative potential of cutting-edge hardware and software tools. The goal is to show students that they can have an idea, design it on a computer, and make it into a real object. This goal is supported by designing low-cost tools (software and hardware) with interfaces that are powerful, yet intuitive.

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OPEN SOURCE ECOLOGY is a network of farmers, engineers, and supporters that has spent the last two years creating the Global Village Construction Set, an open-source, low-cost, high-performance technological platform that allows for the easy, DIY fabrication of the 50 different Industrial Machines that it takes to build a sustainable civilisation with modern comforts. The GVCS lowers the barriers to entry into farming, building, and manufacturing, and can be seen

as a life-size Lego set of modular tools for creating entire economies. The tools are designed to be useful whether in rural Missouri – where the project was founded – in urban redevelopment, or in the developing world.
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"The digital natives are starting to hunger for life beyond the screen. Making something that starts virtual but quickly becomes tactile and usable in everyday world is satisfying in a way that pure pixels are not. The quest for 'reality' ends up with making real things."
(Anderson, Chris, Makers: The New Industrial Revolution, 2012)

"We never perceive by vision alone; in fact, perceive means 'to grasp'. We have many expressions about 'knowing' that invoke touch, such as wanting a 'hands on' experience. Especially in our relation to 'things', we desire to know them through closeness and the mediation of our touch. (...) We get to know objects, things in the world, through touch. We engage with the world proximally through touch, rather than merely encounter it in distanced, abstracted vision alone."
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KINAESTHESIA is the sensation of movement of body and limbs relating to sensations originating in muscles, tendons and joints.
(Paterson, Mark, The Senses of Touch: Haptics, Affects and Technologies, 2007)

HAPTIC PERCEPTION is the process of recognising objects through touch. It involves a combination of somatosensory perception of patterns on the skin surface (e.g., edges, curvature, and texture) and proprioception of hand position and conformation. People can rapidly and accurately identify three-dimensional objects by touch. They do so through the use of exploratory procedures, such as moving the fingers over the outer surface of the object or holding the entire object in the hand. Gibson in The senses considered as perceptual systems (1966) defined the haptic system as "The sensibility of the individual to the world adjacent to his body by use of his body". Gibson and others emphasised the close link between haptic perception and body movement: haptic perception is active exploration. The concept of haptic perception is related to the concept of extended physiological proprioception according to which, when using a tool such as a stick, perceptual experience is transparently transferred to the end of the tool. Haptic perception relies on the forces experienced during touch. This research allows the creation of "virtual", illusory haptic shapes with different perceived qualities, which has clear application in haptic technology. Loss of the sense of touch is a catastrophic deficit that can impair walking and other skilled actions such as holding objects or using tools.
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TANGIBLE USER INTERFACE (TUI) is a user interface in which a person interacts with digital information through the physical environment. One of the pioneers in tangible user interfaces is Hiroshi Ishii, a professor in the MIT Media Laboratory who heads the Tangible Media Group. In the last two decades, TANGIBLE USER INTERFACES (TUIs) have emerged as a new type of interface that interlinks the digital and physical worlds. Drawing upon users' knowledge and skills of interaction with the real, non-digital world, TUIs show potential to enhance the way people interact with and leverage digital information. TUIs are an emerging post-WIMP interface type concerned with providing tangible representations to digital information and controls, allowing users to quite literally grasp data with their hands. Interaction with TUIs is therefore not limited to the visual and audio senses, but also relies on the sense of touch.
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RADICAL ATOMS is Hiroshi Ishii and Tangible Media Group's vision for the future of human-material interactions, in which all digital information has a physical manifestation that allows us to interact directly with it.
Radical Atoms was created to overcome the fundamental limitations of its precursor, the Tangible Bits vision. Tangible Bits – the physical embodiment of digital information and computation – was constrained by the rigidity of atoms in comparison with the fluidity of bits. This makes it difficult to represent fluid digital information in traditionally rigid physical objects, and inhibits dynamic tangible interfaces from being able to control or represent computational inputs and outputs.
In order to augment vocabulary of Tangible User Interfaces, Radical Atoms uses dynamic representations such as co-located projections or "digital shadows". However, the physical objects on the tabletop stay static and rigid. To overcome these limitations, Tangible Media Group began to experiment with a variety of actuated and kinetic tangibles, which can transform their physical positions or shapes into an additional output modality beyond the traditional manual input mode of TUIs.
Radical Atoms is based on new, vision-driven design research into interactions with Dynamic Physical Material that can:

1. Conform to structural constraints
2. Transform structure and behaviour
3. Inform new abilities

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NANOTECHNOLOGY (sometimes shortened to "nanotech") is the manipulation of matter on an atomic and molecular scale. The vision of Radical Atoms requires actuation nanoscale (NEMS) and individual addressing of elements in the system (quantum computing). Material property changes at the molecular level can manifest themselves as drastic property changes at the macroscopic level (optical, mechanical, electric, etc.). Nanosciences aim to scale down technology to the atomic level. Commonplace technology, including inkjet printers, already makes use of microscopic-scale micro-electromechanical systems (MEMS).

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MECHATRONICS, in relation with robotics, is one of the most vibrant fields related to dynamic matter, self-reconfigurable robots, and assemblies. Adaptronics, by Janocha, summarises the sensor and actuator technologies to build systems that adapt to their environments. Self-reconfigurable materials were shown by the Claytronics project, which aims to explore how modular systems made up of nodes could be built. Large-scale prototypes have been built to explore the "ensemble effect", in which multiple nodes interact with each other. To scale down design, the number of nodes has to be increased dramatically. In order to scale proportionally, assembly may become problematic. Kinematic self-replicating machines can create nodes and establish a hierarchy internally between them, thus solving assembly problems.

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MATERIAL COMPUTATION SCIENCE has been exploring novel intelligent materials that could potentially assist in the actuation of shape. These materials could augment computational actuation through material logic by interpolating between actuated points. Today's TUIs are designed in a heterogeneous manner: actuation (structure) and cover (skin) are designed and implemented separately. The Radical Atoms project needed new material-design principles, which treat objects as homogeneous entities with the ability to change their properties. A number of materials experience a shape-memory effect under external stimuli due to their molecular structures. Shape memory alloys (SMAs) return to a preprogramed shape when heat is applied, and magnetic shape-memory alloys experience a memory effect under strong magnetic fields. SMAs inspired the imaginary material Perfect Red, around which Radical Atoms explored the interaction techniques for form-giving. Other materials can be actuated by driving electric current through them: electroactive polymers and polymer gels change their size, shape, and optical properties when exposed to high currents. Optical properties of objects can change rapidly through certain stimuli. Thermochromic materials change their colour in response to heat, while halochromic materials change their colour in response to acidity levels.

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EMBODIED INTERACTION THEORY, proposed by Paul Dourish in 2001 in his book Where the Action Is, provides a broad view of how our interaction with computers is intertwined with the psychical world. The author gives a wealth of examples of innovations in computer technologies, along with a deep grounding in the philosophical, psychological, and sociological issues and theories. As Donald Norman said: "As Dourish so cogently explains, design should not be about tasks and their requirements, or applications, or computing – design is really about interaction with a focus on ubiquity, tangibility, and most of all, shared awareness, intimacy and emotions."

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PHYSICAL ACTIVITY can have psychological benefits. Studies show that exercise can increase the amounts of neurotransmitters dopamine and serotonin in the brain. The increased levels of neurotransmitters can help treat disorders, such as Parkinson's disease and depression, as well as help people to feel more energetic overall.

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THE THEORY OF AFFORDANCE is a term originally introduced by psychologist James J. Gibson in his 1977 article The Theory of Affordances and explored more fully in his book The Ecological Approach to Visual Perception in 1979. In 1988, Donald Norman appropriated the term "affordances" in the context of human-machine interaction to refer to just those action possibilities that are readily perceivable by an actor. Through his book The Design of Everyday Things, this interpretation was popularised within the fields of HCI and interaction design. According to Norman's definition, the term affordance "refers to the perceived and actual properties of the thing, primarily those fundamental that determinate just how the thing could possibly be used."

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THE RETURN OF ANALOGUE: Local independent record label Woodsist – home to such acts as Ganglians, Blank Dogs, and Psychedelic Horseshit – releases vinyls and CDs and has a cassette-only arm called Fuck It Tapes. The Woodsist sound often includes the terms "lo-fi", "noise pop", and "shit gaze". The label is dominating the DIY-music conversation in Brooklyn. G. Lucas Crane, Woodsist's "tape manipulator" – the guy responsible for the undulating ambient drone at the label's live shows) – adds that the artists also share a determined aversion to trendiness.

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INCREASE IN CONSUMERS' PASSION FOR LIVE MUSIC: A growing number of American consumers are expected to attend concerts in 2013, according to a survey by live event intelligence company LiveAnalytics. Nearly 40% of consumers taking part in the survey said they would attend more concerts this year. Just 9% said they would attend fewer concerts in 2013 and 53% said the number of concerts they will attend would remain the same. In 2012, more than 36 million concert tickets were sold in North America, up 5% from the previous year, according to data from concert industry tracking company Pollstar, grossing more than $4.3 billion (€3.2bn, £2.6bn). According to LiveAnalytics, North American consumers of all ages attended more concerts in 2012 than in 2011. The increase was most evident among consumers aged 25–34 and 45–54. Of the 10 highest-grossing tours in North America, six had an average ticket price of more than $100 (€75, £62). It is no surprise, therefore, that people earning $125k (€94k, £78k) or more attended the highest number of concerts in 2012.

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