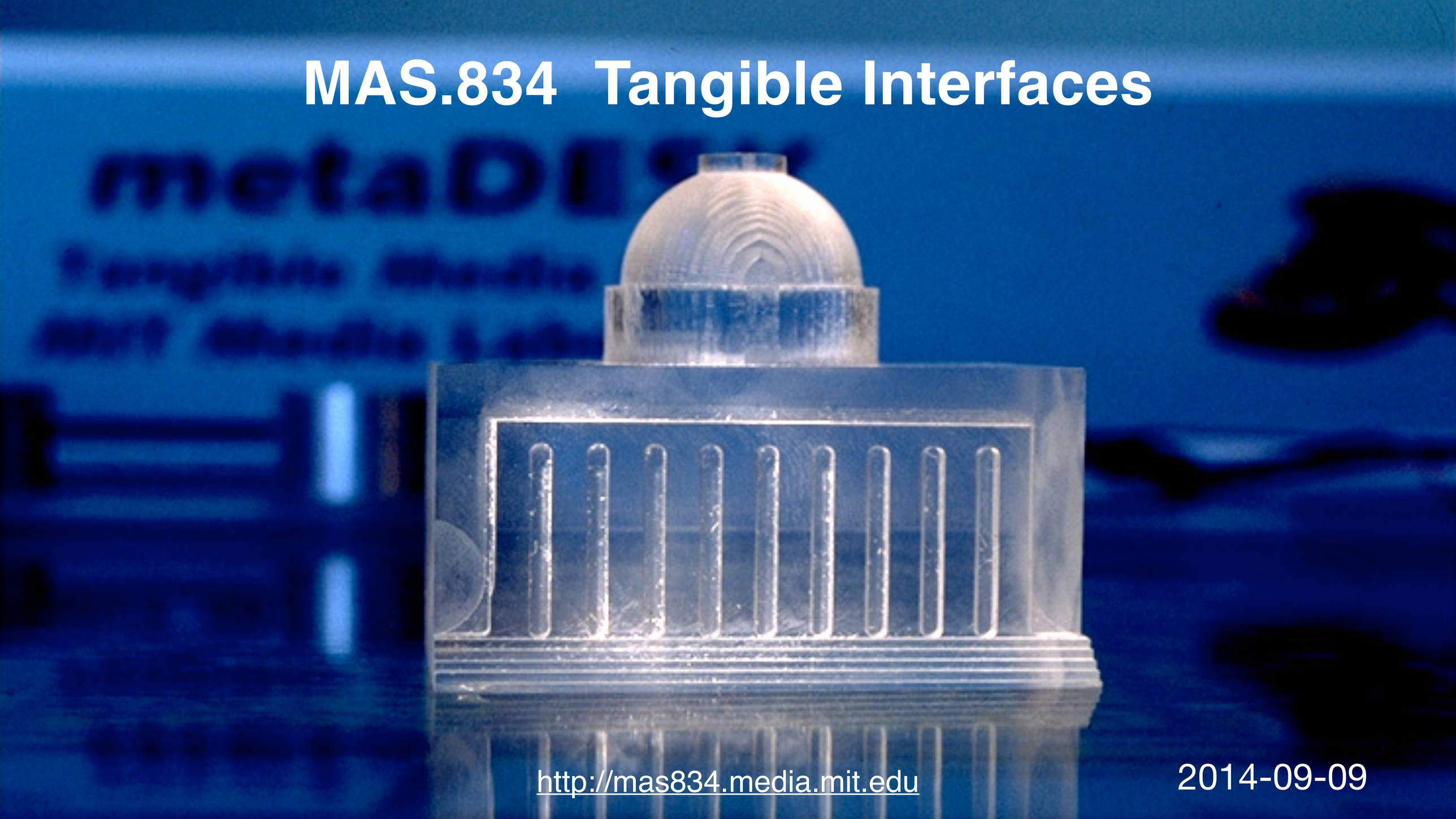
MAS.834 Tangible Interfaces



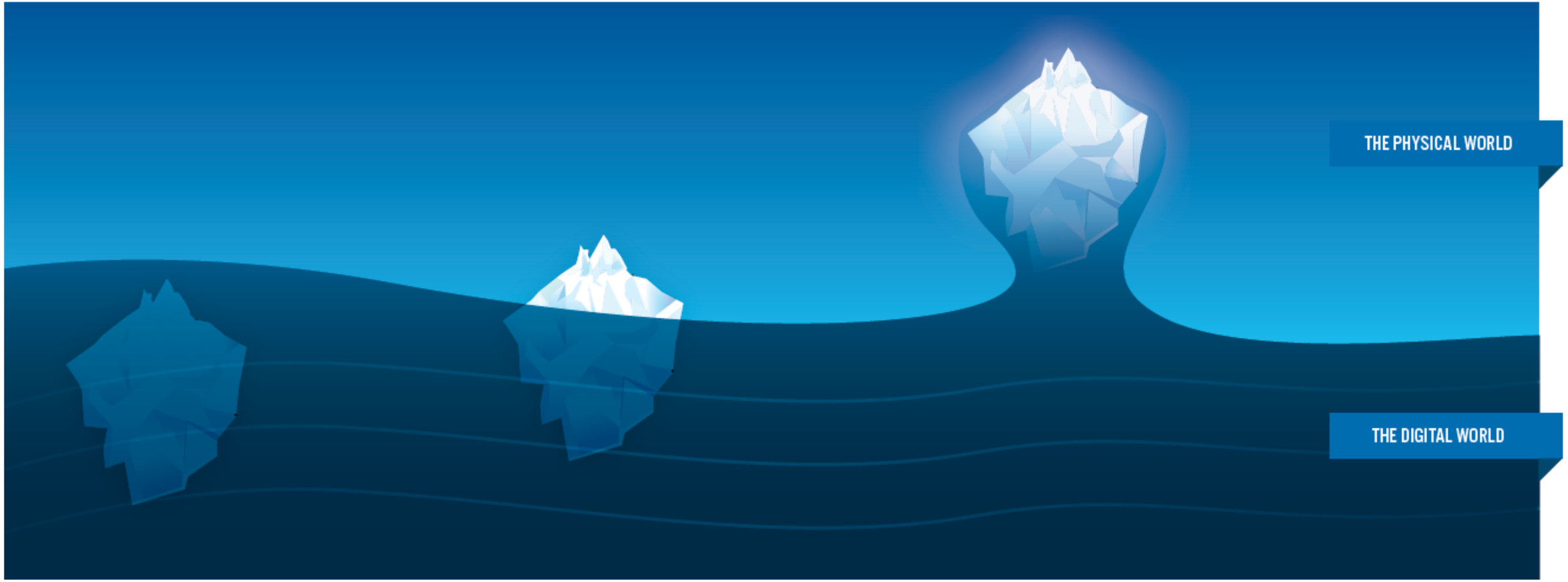
http://mas834.media.mit.edu

2014-09-09

GUI PAINTED BITS

TUI TANGIBLE BITS

RADICAL ATOMS



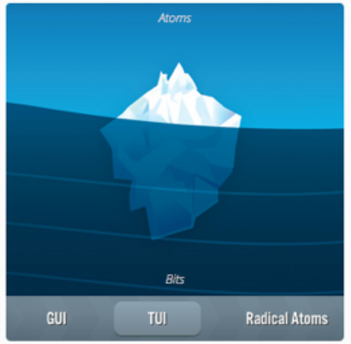
http://tangible.media.mit.edu/vision/
http://mas834.media.mit.edu

MIT Media Lab

Tangible Media Group

The Tangible Media Group, led by Professor Hiroshi Ishii, explores the Tangible Bits & Radical Atoms visions to seamlessly couple the dual world of bits and atoms by giving dynamic physical form to digital information and computation.

http://tangible.media.mit.edu/vision/



*A **tangible user interface** is like an iceberg: there is a portion of the digital that emerges beyond the surface of the water—into the physical realm—so that we may interact directly with it.*

TANGIBLE BITS

In 1997, we presented our vision of "Tangible Bits" at the CHI '97 conference. We proposed the concept of Tangible User Interface (TUI) that is based on physical embodiment of digital information & computation, in order to go beyond the current dominant paradigm of "Painted Bits" or Graphical User Interface (GUI). Humans have evolved a heightened ability to sense and manipulate the physical world, yet the GUI based on intangible pixels takes little advantage of this capacity. The TUI builds upon our dexterity by embodying digital information in physical space. TUIs expand the affordances of physical objects, surfaces, and spaces so they can support direct engagement with the digital world.

Through the design of a variety of TUIs, however, we have learned that TUIs are limited by the rigidity of "atoms" in comparison with the fluidity of "bits". TUIs have limited ability to change the form or properties of physical objects in real time. This constraint can make the physical state of TUIs inconsistent with the underlying digital models.

RADICAL ATOMS

To address this challenge, we presented our new vision, "Radical Atoms", in 2012. Radical Atoms takes a leap beyond Tangible Bits by assuming a hypothetical generation of materials that can change form and appearance dynamically, becoming as reconfigurable as pixels on a screen. Radical Atoms is a computationally transformable and reconfigurable material that is bidirectionally coupled with an underlying digital model (bits) so that dynamic changes of physical form can be reflected in digital states in real time, and vice versa.

Radical Atoms is the future material that can transform their shape, conform to constraints, and inform the users of their affordances. Radical Atoms is a vision for the future of human-material interaction, in which all digital information has a physical manifestation so that we can interact directly with it. We no longer think of designing the interface, but rather of the interface itself as material. We may call it "Material User Interface (MUI)."

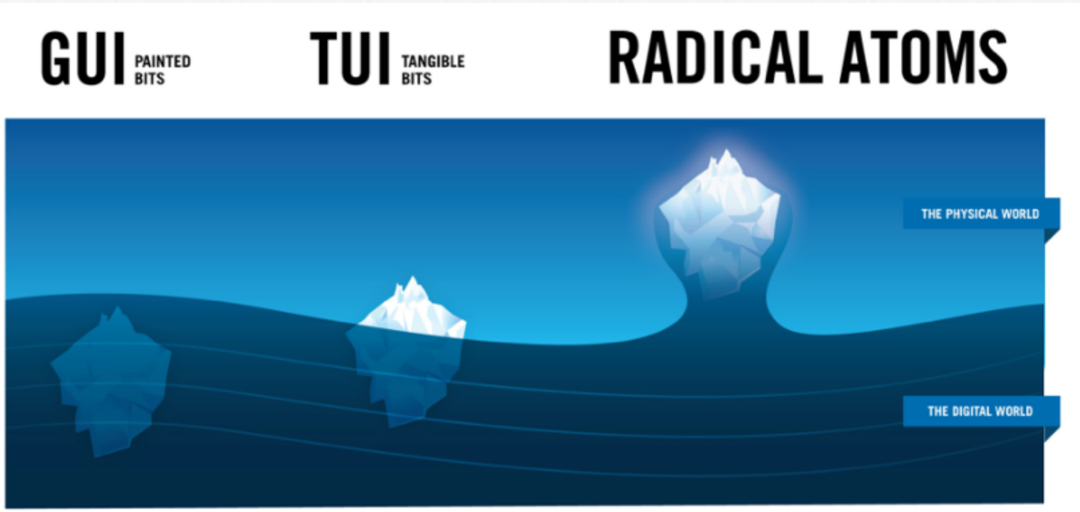
VISION–DRIVEN DESIGN

Looking back through the history of HCI, we see that quantum leaps have rarely resulted from studies on user needs or market research; they have come from the passion and dreams of visionaries such as Douglas Engelbart. We believe that vision-driven design is critical in fostering quantum leaps, and it complements needs-driven and technology-driven design by looking beyond current-day limits. Tangible Bits is an early example of our vision-driven research. With Radical Atoms we seek new guiding principles and concepts so that we see the world of bits and atoms with new eyes to trail blaze a new realm in interaction design.

There are three approaches in design research: technology-driven, needs-driven, and vision-driven. The reason why we focus on the vision-driven approach is its lifespan. We know technologies become obsolete in ~1 year, and user needs change quickly and applications become obsolete in ~10 years. However, we believe that strong visions can last beyond our lifespan. Even though we may need to wait decades before atom hackers (material scientists, self-organizing nano-robot engineers, etc.) can invent the enabling technologies for Radical Atoms, we believe the exploration of interaction design techniques can begin today.

TANGIBLE INTERFACES

MAS.834



"Radical Atoms" is our vision of human interactions with the future dynamic physical materials that are transformable, conformable, and informable.

Tangible Media Group
MIT Media Lab

Course Overview

http://mas834.media.mit.edu

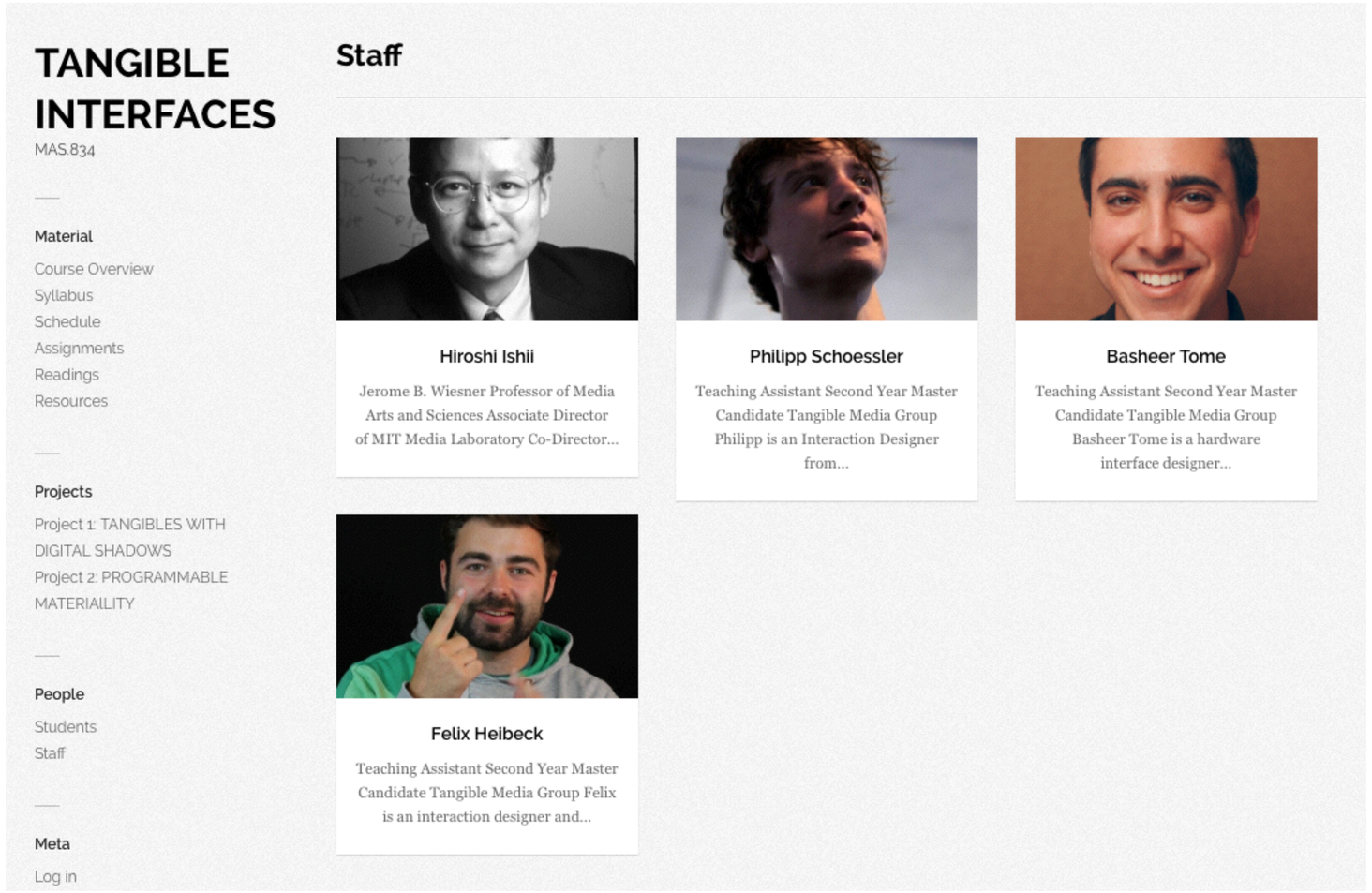
The first Fall 2014 class meets on September 9th (Tuesday) at 1-4pm in E15-341

This HCI (Human-Computer Interactions) course will explore the design space of Tangible Bits and Radical Atoms by giving dynamic physical form to digital information and computation. Our goal is to broaden the bandwidth of interaction between people and digital information & computation through "dynamic tangibles" that help people design, learn, and communicate using the full range of human senses and skills. We will pursue the interfaces that are not only practical, but also aesthetically pleasing and inspiring.

This is a project-based course centered around hands-on technological tutorials for prototyping, material design workshops, and students' projects, as well as lectures on HCI, CSCW (Computer-Supported Cooperative Work), Interaction Design, and Interactive Arts. Course enrollment is limited to keep a design studio atmosphere.

Students will design/develop experimental user interfaces, applications, enabling technologies, and/or theories, using sketches, posters, physical mockups, and working prototypes to solicit studio discussion. Studio discussions of ideas using tangible representations will be a vital way to refine designs collaboratively.

MAS 834 Team Fall 2014



Staff Team <mas834_2014_staff@media.mit.edu>

Students <mas834_2014_students@media.mit.edu>

Research Framework

Human-Computer Interactions (HCI) & Remote Collaboration (CSCW)

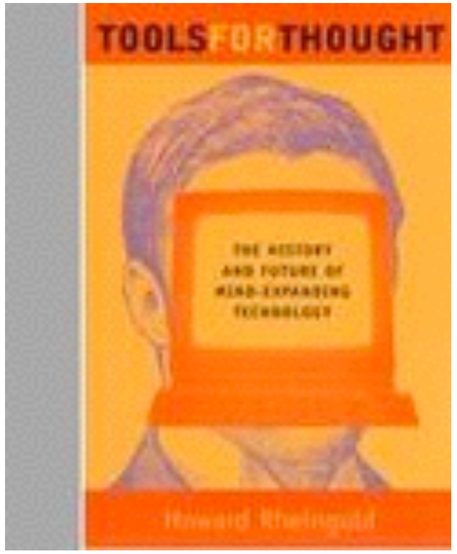
	HCI: Human-Computer Interaction	CSCW: Human-Human Collaboration
Human Interaction	**Interact** GUI: Graphical User Interfaces AR/MR: Augmented/Mixed Reality **TUI: Tangible User Interfaces**	**Collaborate** Telepresence / Remote Collaboration IPS: Inter-Personal Space + SWS: Shared Work Space
Information	**Represent** 2D ▶ 3D Painted Bits (GUI Pixels) ▶ **Tangible Bits ▶ Radical Atoms**	**Share** Distributed Shared Information Space Synchronization of Representations

Tools for Thought

Howard Rheingold, MIT Press

The History and Future of Mind-Expanding Technology

http://www.rheingold.com/texts/tft/




Ideas Colliding
Opportunities Emerging
Disciplines Transcending
NATIONAL GEOGRAPHIC
Photograph by Kara Swanson, My Shot
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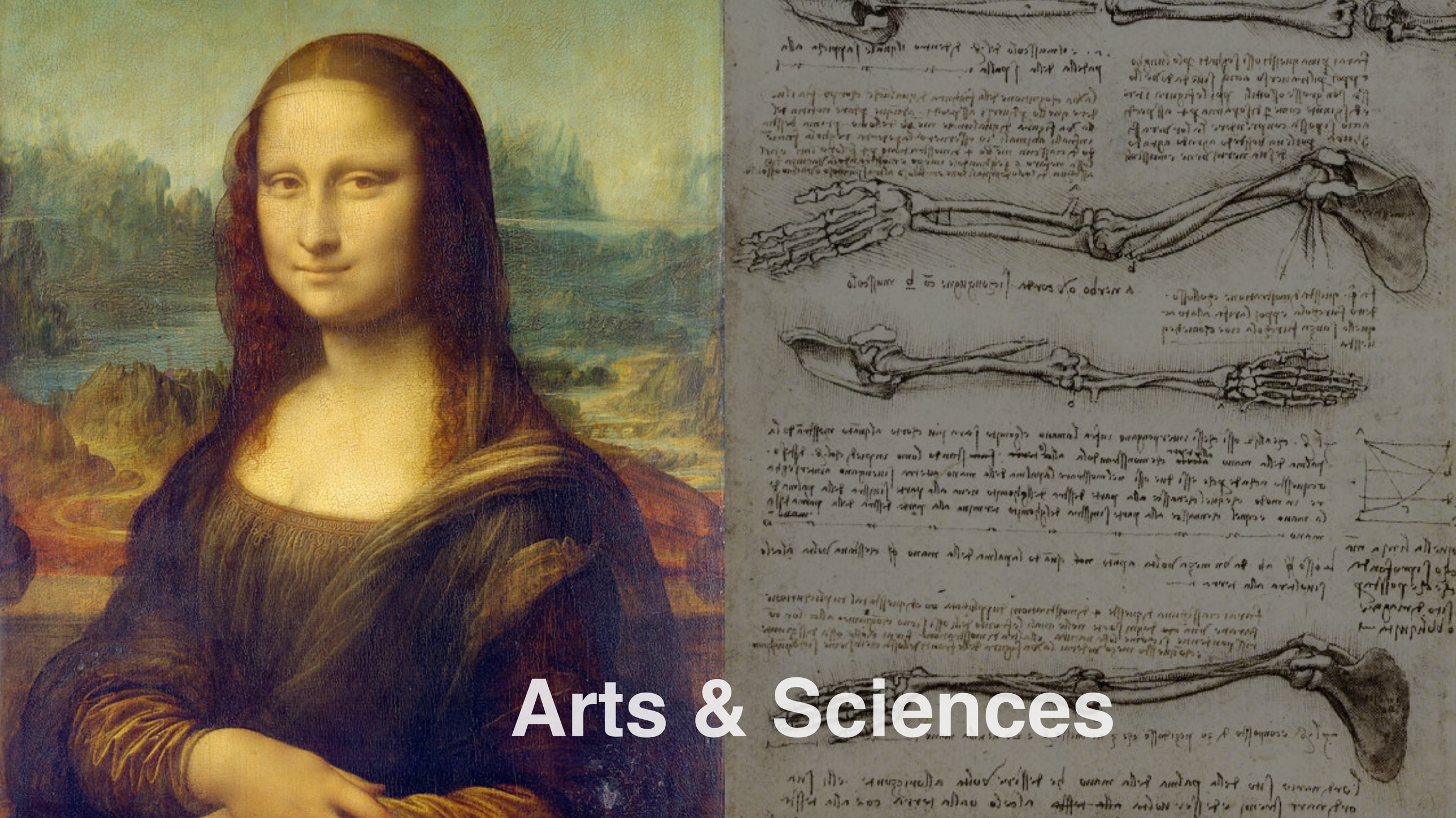

Arts & Sciences

Music & Technology

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MirrorFugue III Xiao Xiao
MIT
Media
Lab

Milano
Design Week

LEXUS DESIGN AMAZING 2014 MILAN
April 8-13, 2014

Tangible Media Group
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TRANSFORM

Tangible Media

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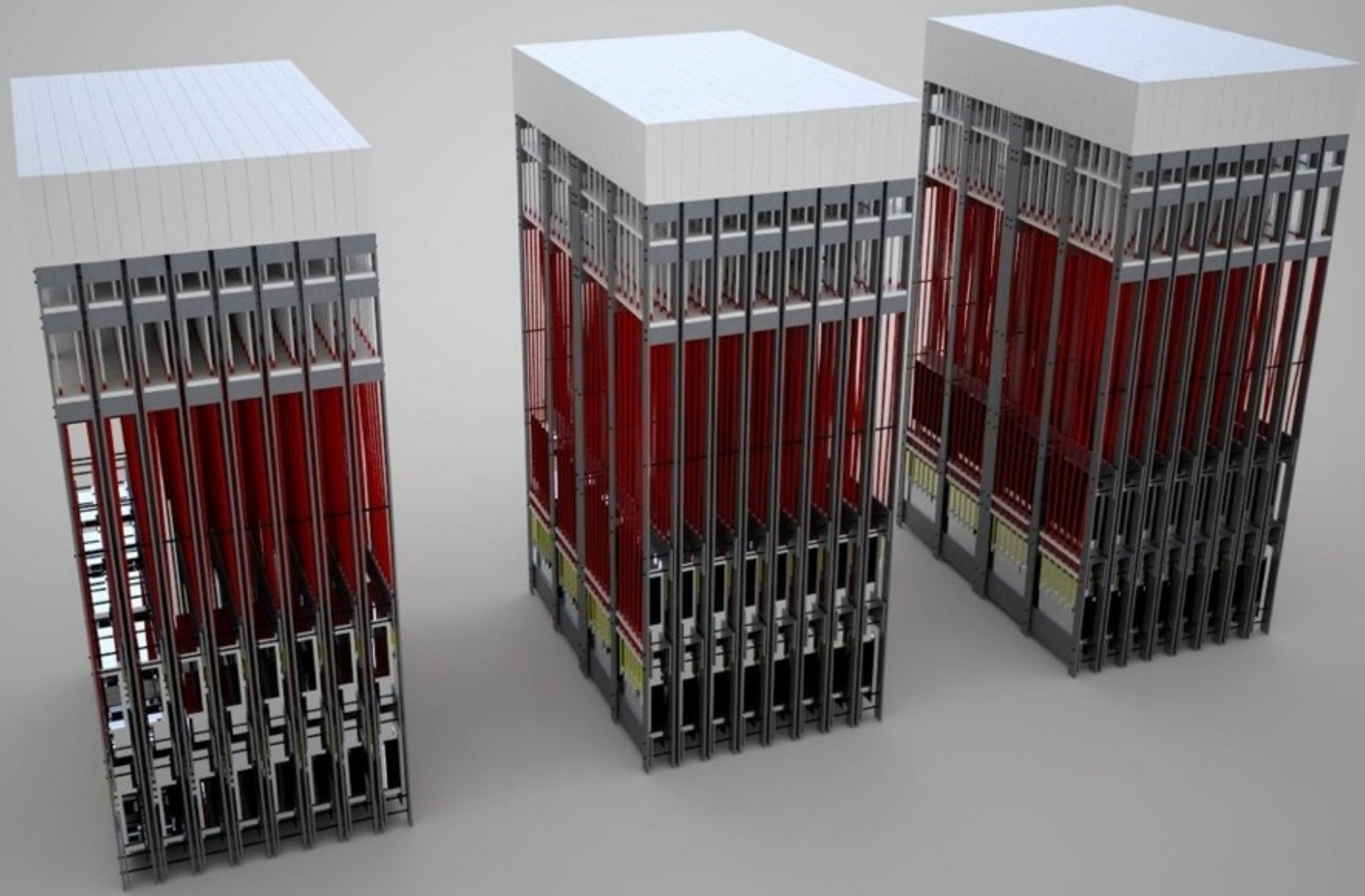
inFORM ENGINES

Designed by Daniel Leithinger & Sean Follmer, and Rendered by Amit Zoran



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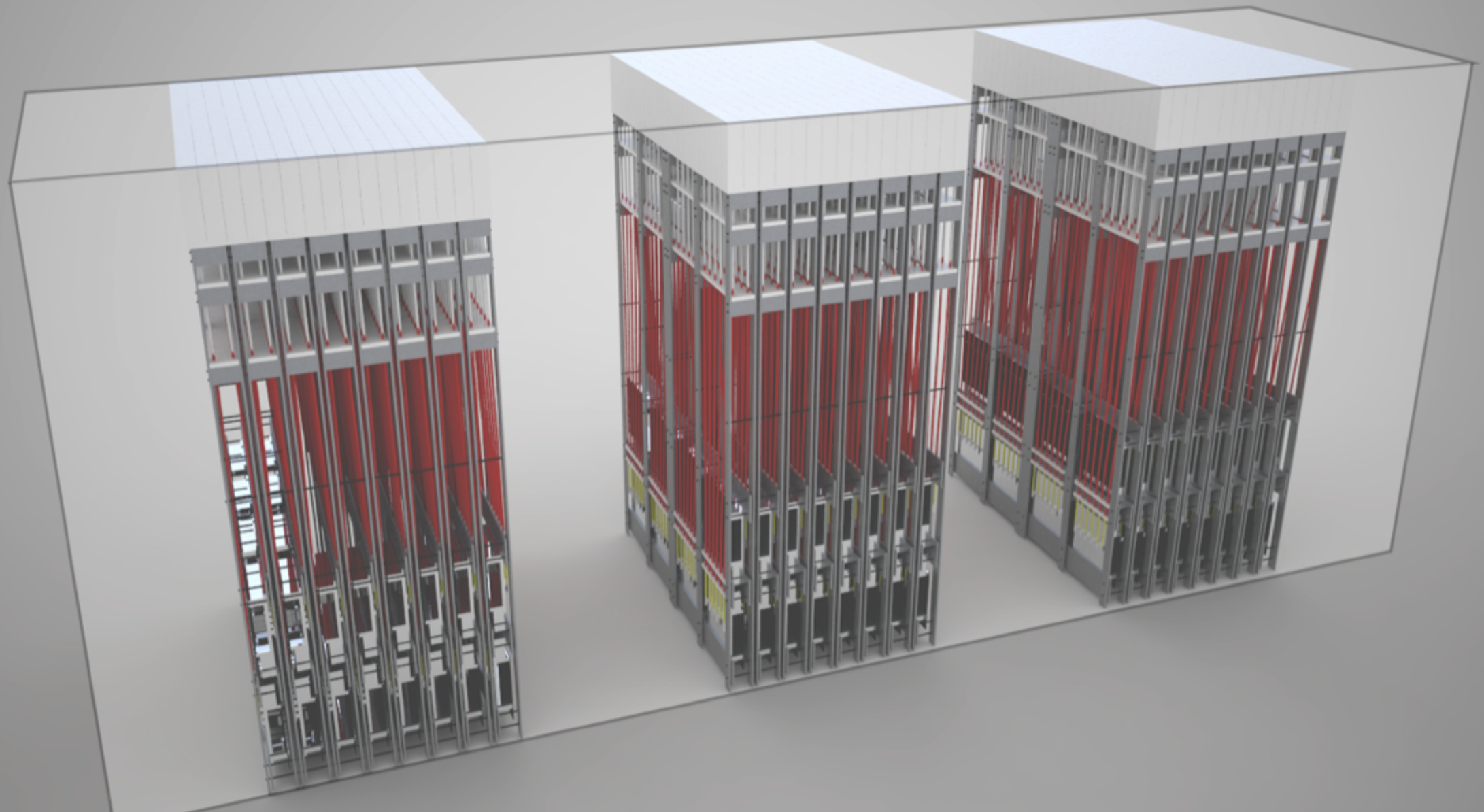
inFORM ENGINES

Designed by Daniel Leithinger & Sean Follmer, and Rendered by Amit Zoran



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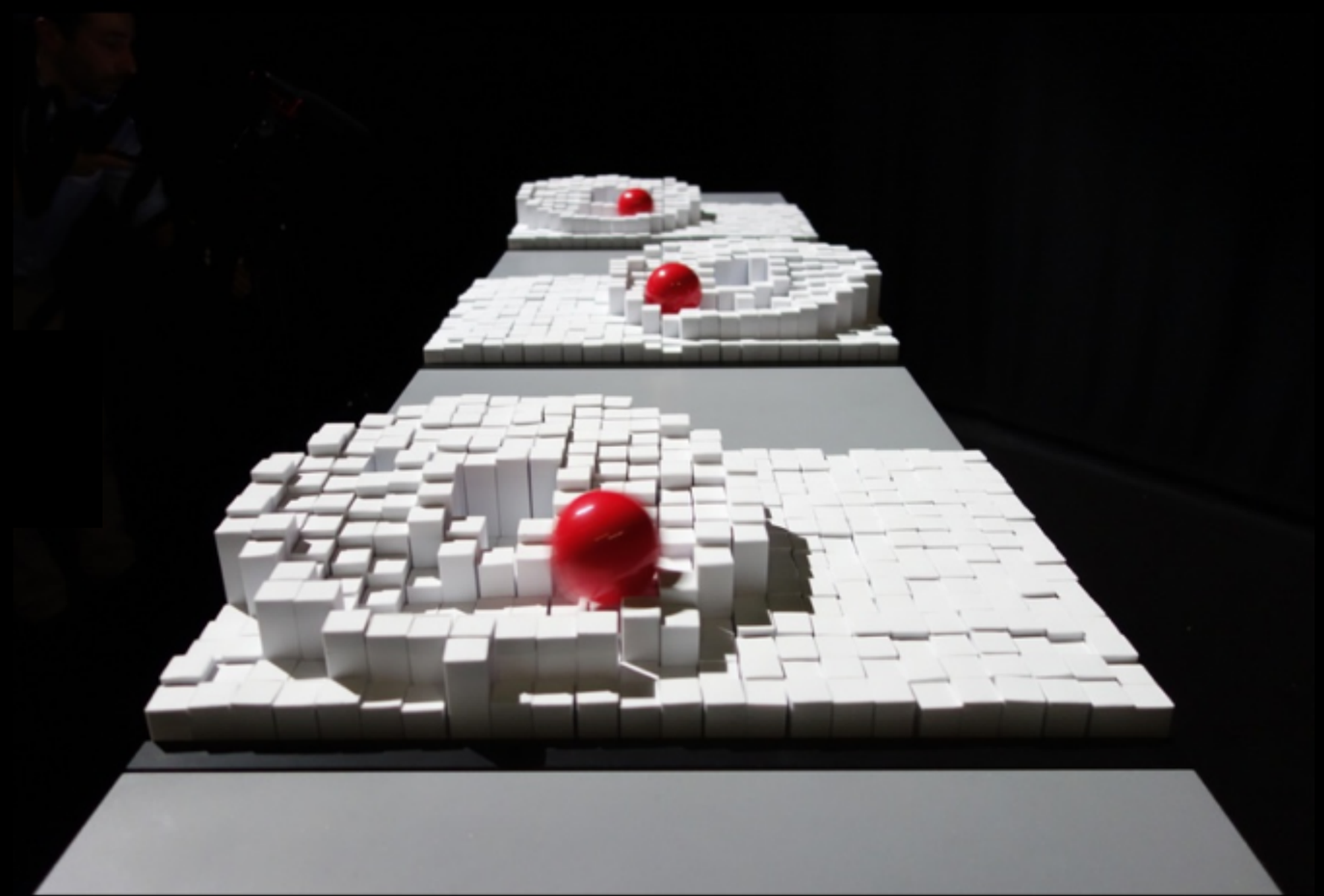
Design vs Technology



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“TRANS - Disciplinary”

Finding opportunity in conflict between disciplines

Breaking down old paradigms to create new archetypes

“auf-heben”

http://www.talkingcranes.com/blog/poles-must-engage

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vision
Photo courtesy of Nobukazu Kuriki
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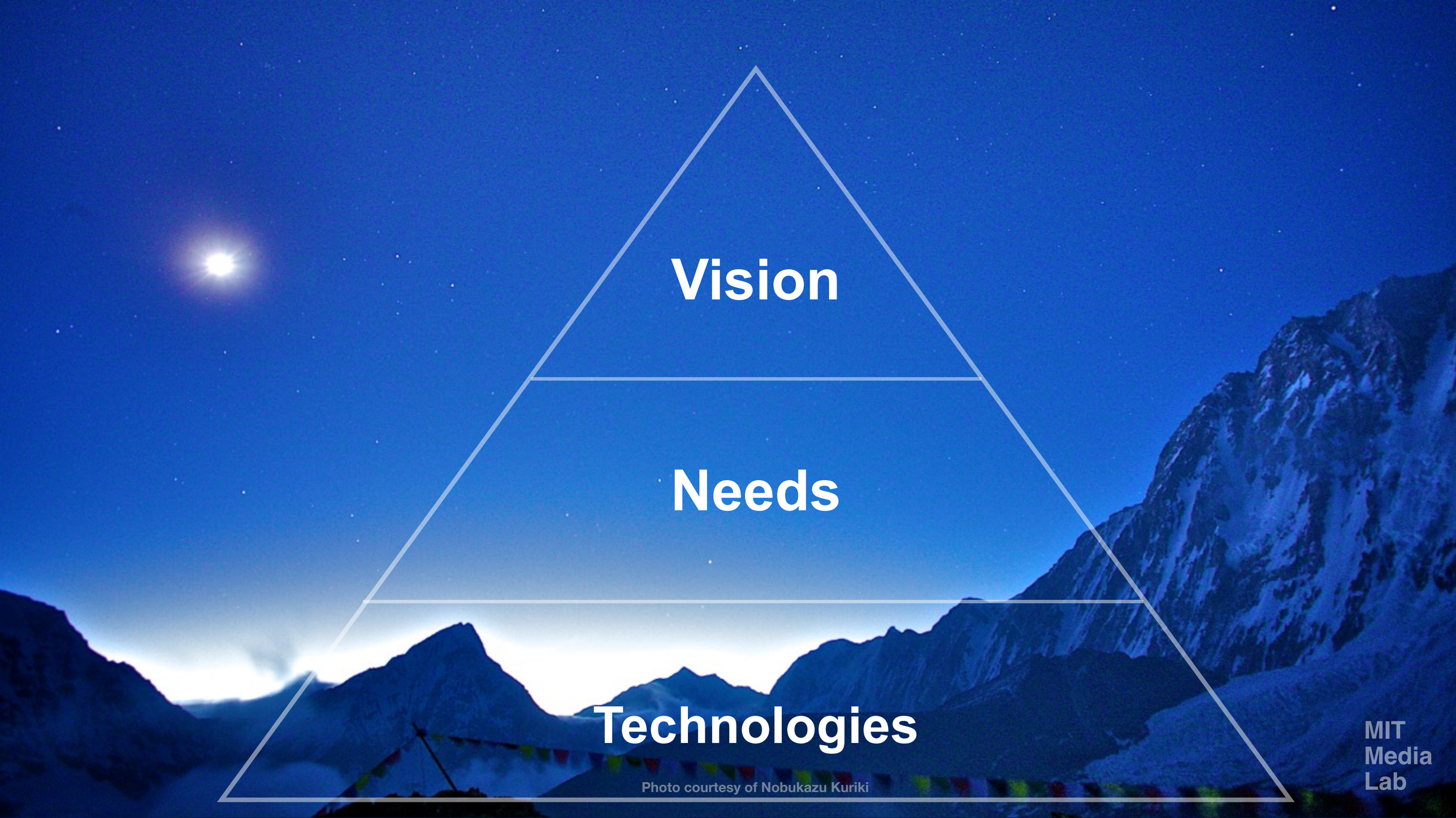
Vision
Needs
Technologies
Photo courtesy of Nobukazu Kuriki
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Lifespan

Photo courtesy of Nobukazu Kuriki

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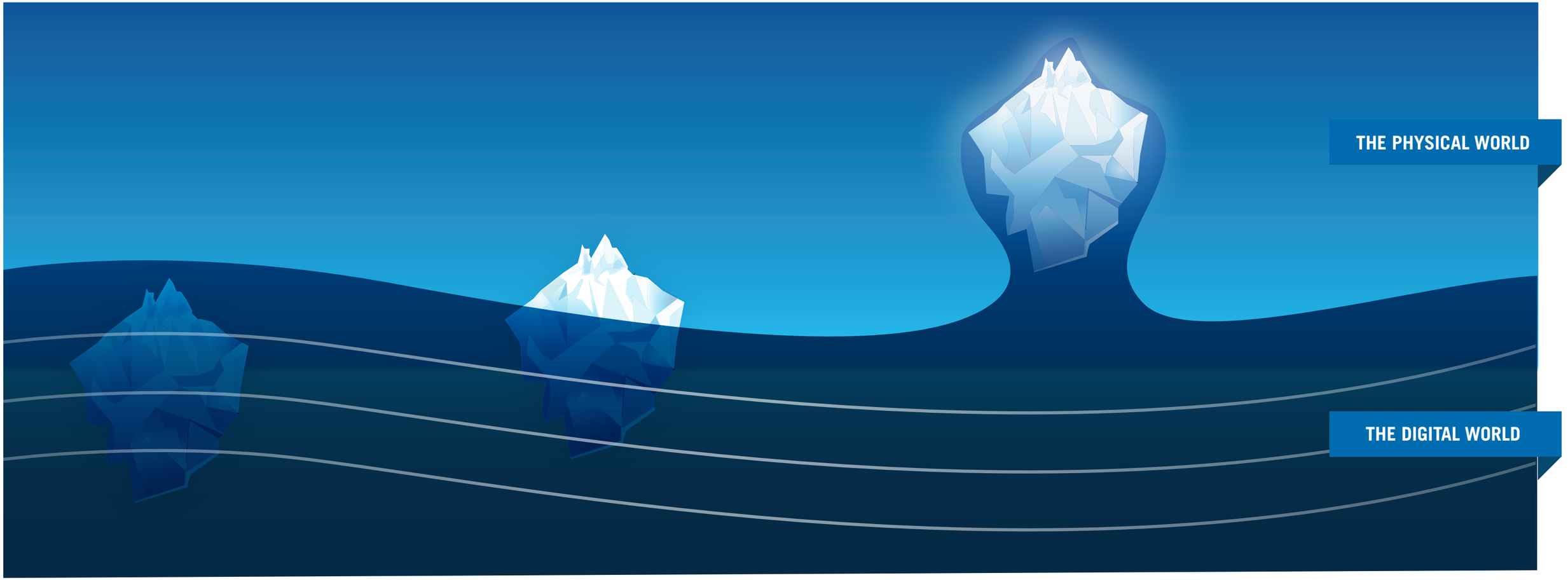
GUI PAINTED BITS

TUI TANGIBLE BITS

RADICAL ATOMS



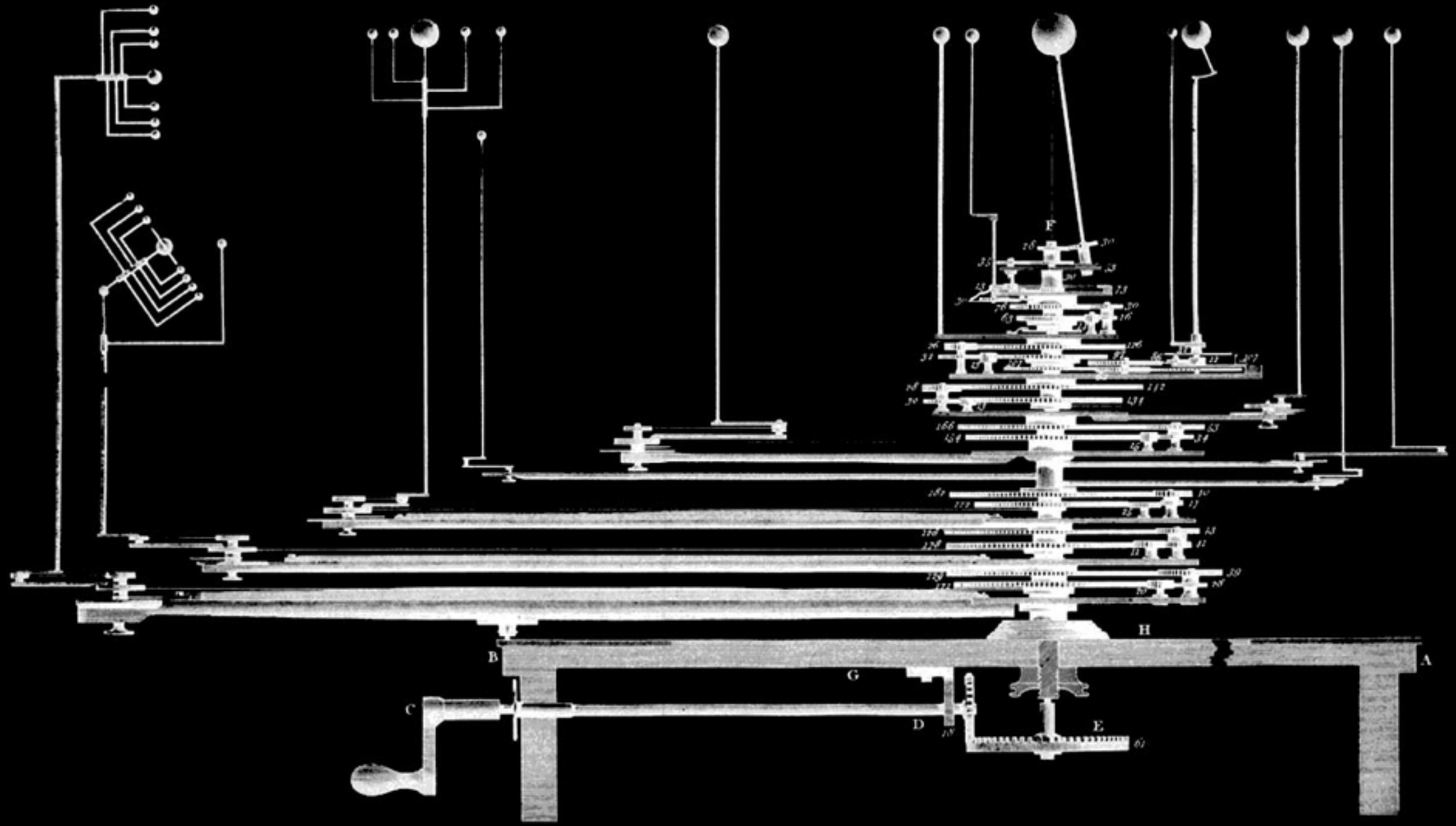
A Graphical User Interfaces only let users see digital information through a screen, as if looking through a surface of the water. We interact with the forms below through remote controls such as a mouse, a keyboard or a touch screen.

A Tangible User Interface is like an iceberg: there is a portion of the digital that emerges beyond the surface of the water - into the physical realm - that acts as physical manifestations of computation, allowing us to directly interact with the 'tip of the iceberg.'

Radical Atoms is our vision for the future of interaction with hypothetical dynamic materials, in which all digital information has physical manifestation so that we can interact directly with it - as if the iceberg had risen from the depths to reveal its sunken mass.

Orrery

Tangible Representation of Knowledge



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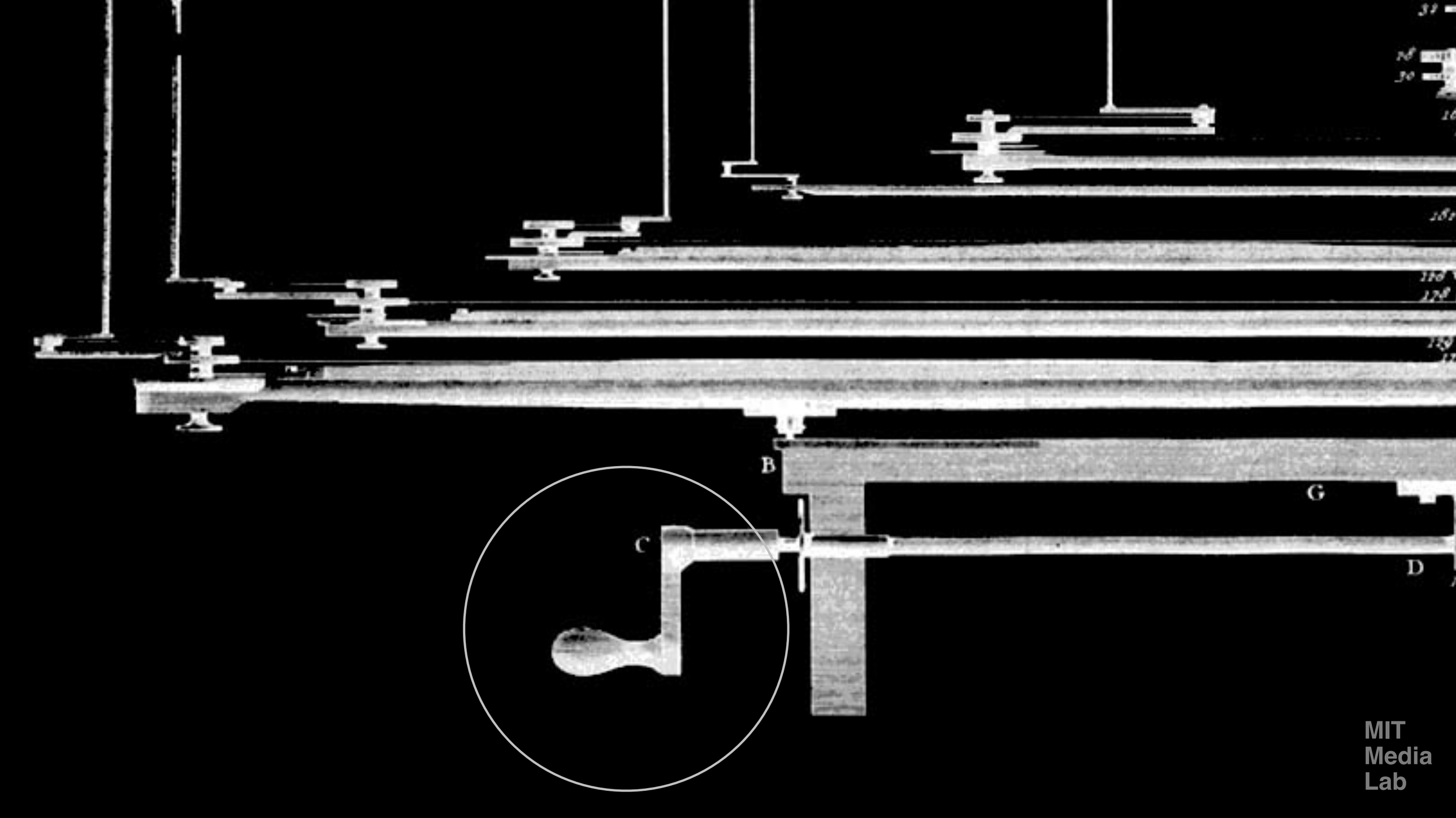
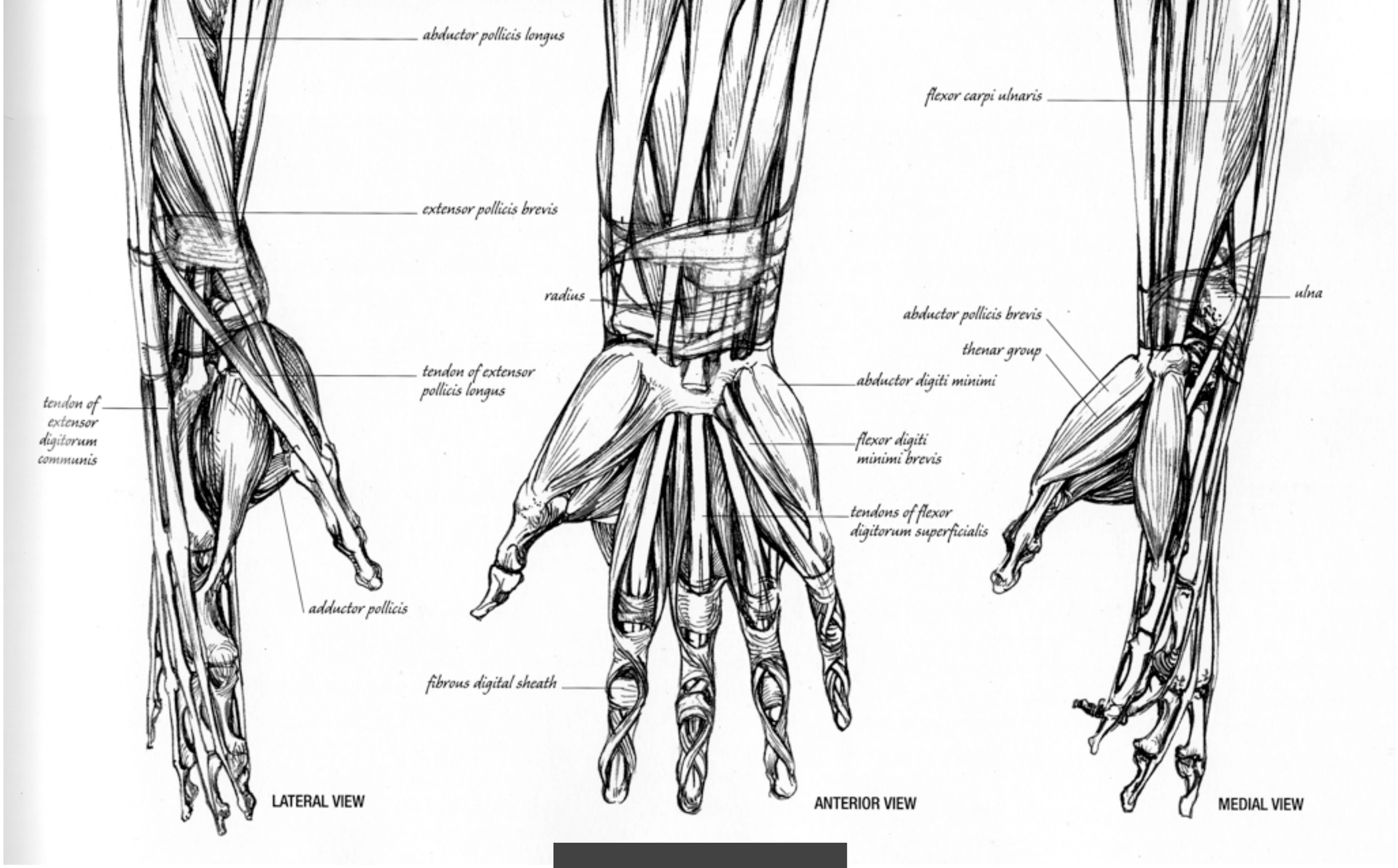
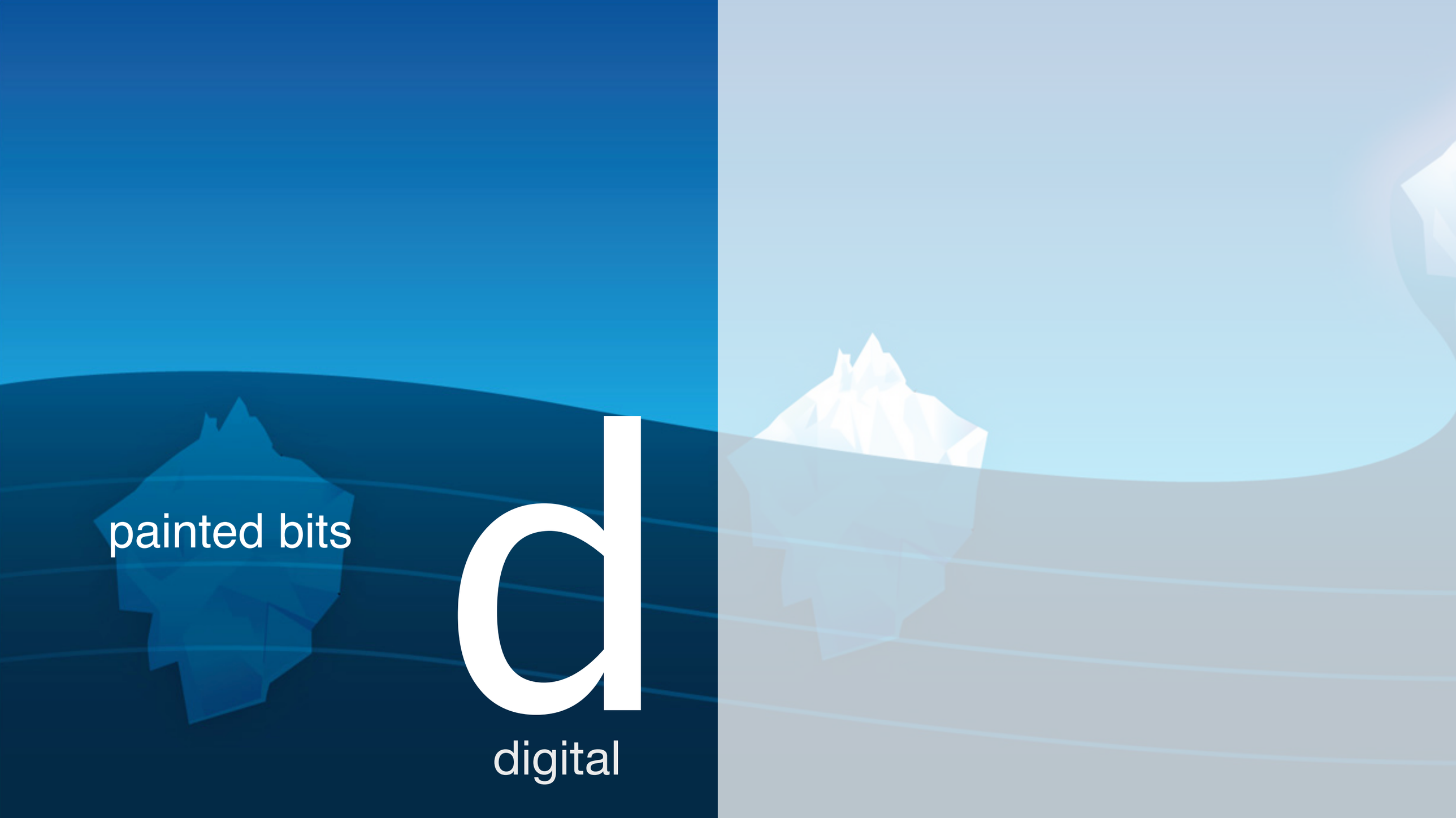
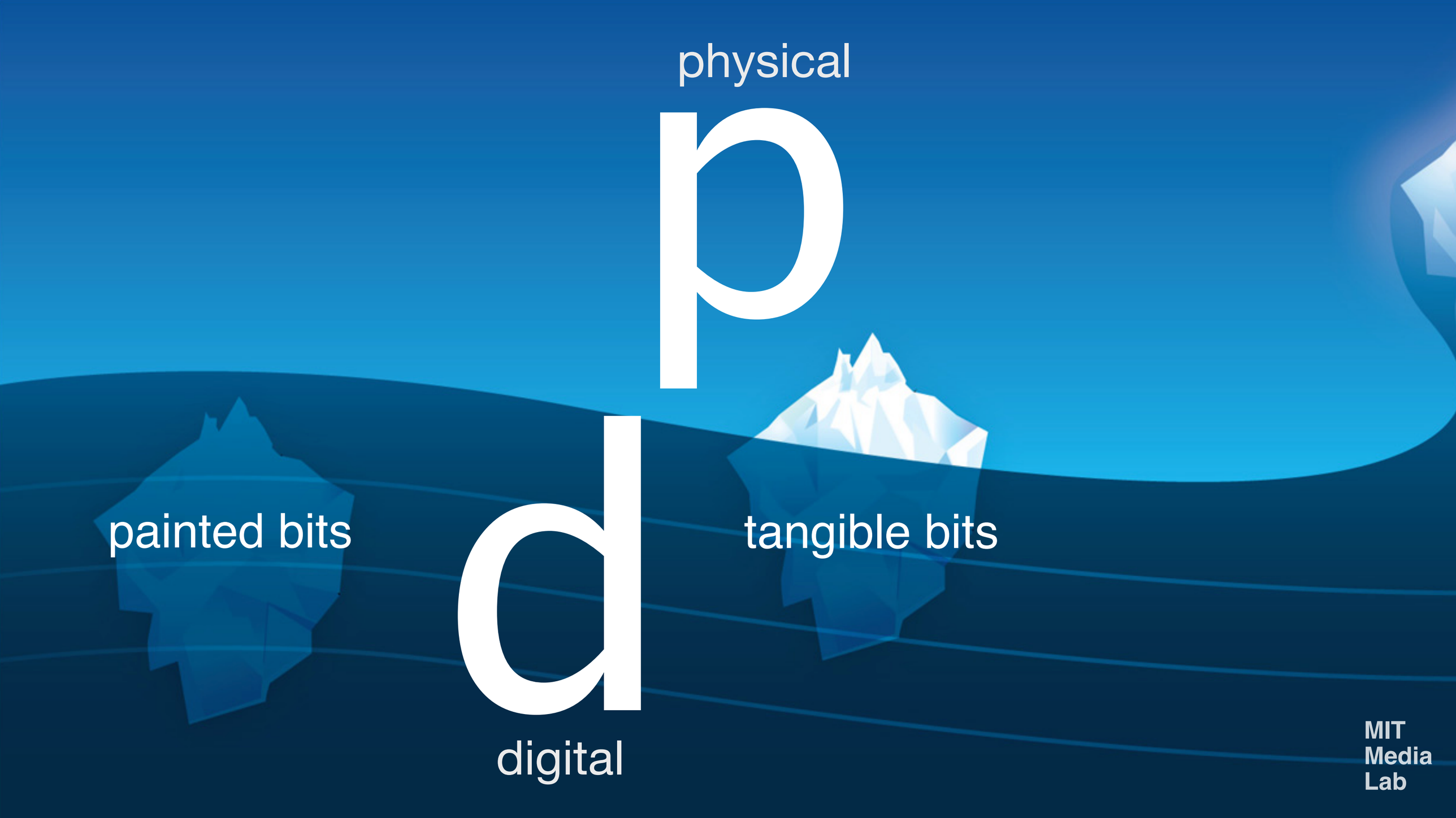



abductor pollicis longus
extensor pollicis brevis
tendon of extensor pollicis longus
tendon of extensor digitorum communis
adductor pollicis
LATERAL VIEW
radius
fibrous digital sheath
abductor digiti minimi
flexor digiti minimi brevis
tendons of flexor digitorum superficialis
ANTERIOR VIEW
flexor carpi ulnaris
ulna
abductor pollicis brevis
thenar group
MEDIAL VIEW

hands


painted bits
d
digital


physical
p
painted bits
d
tangible bits
digital
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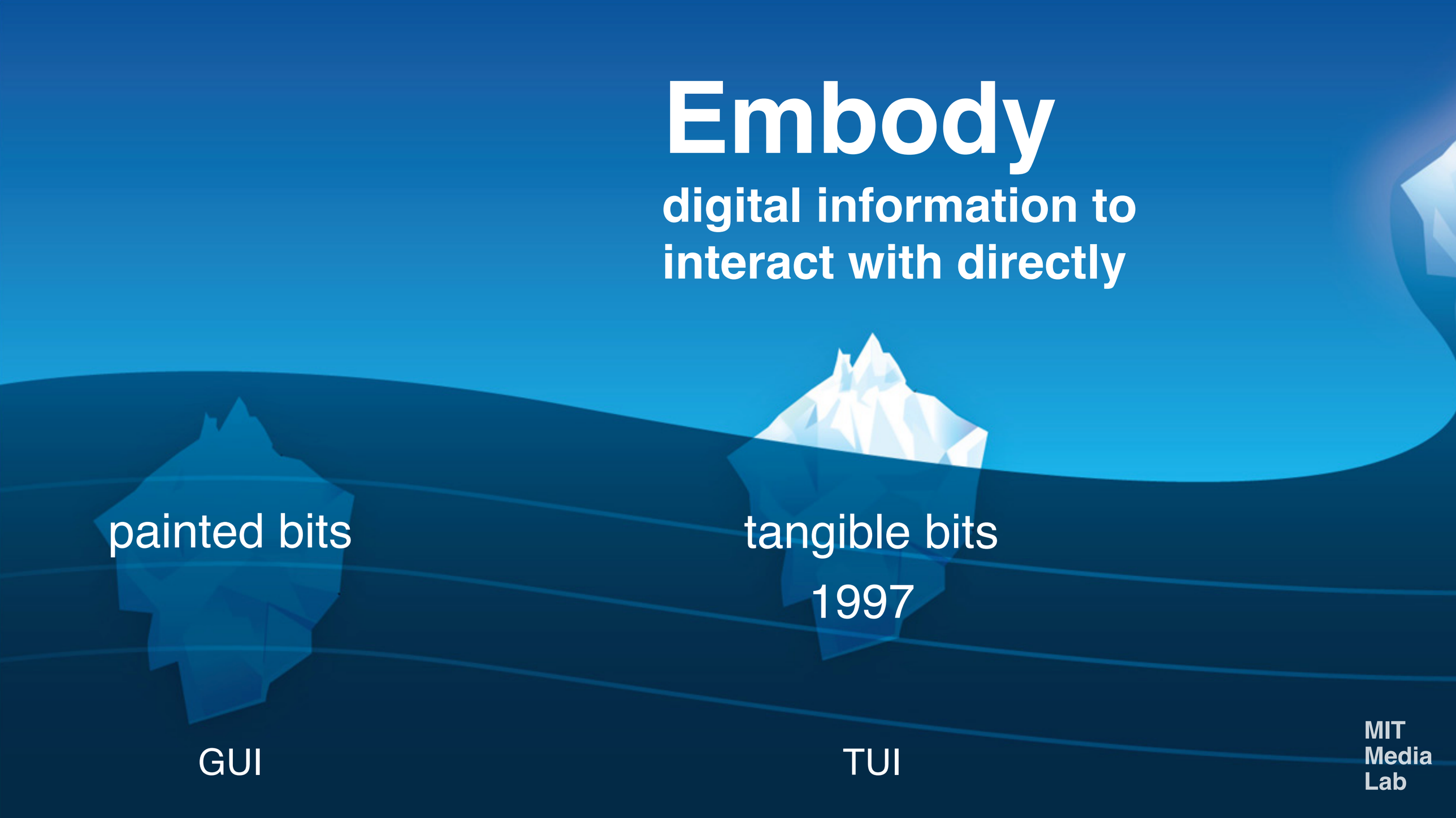
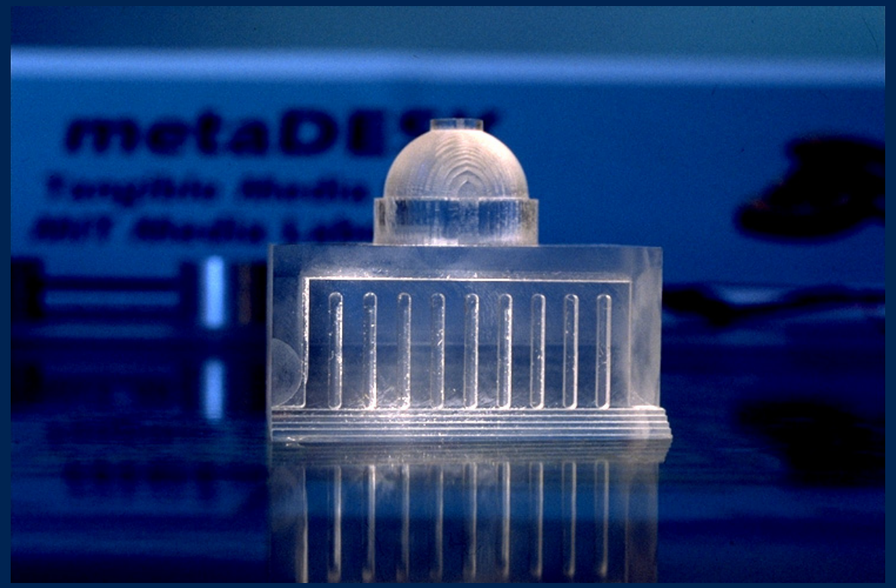
Embody

digital information to interact with directly



Tangible Bits



March 1997

“Tangible Bits” paper presented at CHI ‘97 in Atlanta

Published in the Proceedings of CHI '97, March 22-27, 1997, © 1997 ACM

Tangible Bits: Towards Seamless Interfaces between People, Bits and Atoms

Hiroshi Ishii and Brygg Ullmer
MIT Media Laboratory
Tangible Media Group
20 Ames Street, Cambridge, MA 02139-4307 USA
{ishii, ullmer}@media.mit.edu

ABSTRACT
This paper presents our vision of Human Computer Interaction (HCI): "Tangible Bits." Tangible Bits allows users to "grasp & manipulate" bits in the center of users' attention by coupling the bits with everyday physical objects and architectural surfaces. Tangible Bits also enables users to be aware of background bits at the periphery of human perception using ambient display media such as light, sound, airflow, and water movement in an augmented space. The goal of Tangible Bits is to bridge the gaps between both cyberspace and the physical environment, as well as the foreground and background of human activities.

This paper describes three key concepts of Tangible Bits: interactive surfaces; the coupling of bits with graspable physical objects; and ambient media for background awareness. We illustrate these concepts with three prototype systems – the metaDESK, transBOARD and ambientROOM – to identify underlying research issues.

Keywords
tangible user interface, ambient media, graspable user interface, augmented reality, ubiquitous computing, center and periphery, foreground and background

INTRODUCTION: FROM THE MUSEUM
Long before the invention of personal computers, our ancestors developed a variety of specialized physical artifacts to measure the passage of time, to predict the movement of planets, to draw geometric shapes, and to compute [10]. We can find these beautiful artifacts made of oak and brass in museums such as the Collection of Historic Scientific Instruments at Harvard University (Fig. 1).

We were inspired by the aesthetics and rich affordances of these historical scientific instruments, most of which have disappeared from schools, laboratories, and design studios and have been replaced with the most general of appliances: personal computers. Through grasping and manipulating these instruments, users of the past must have developed rich languages and cultures which valued haptic interaction with real physical objects. Alas, much of this richness has been lost to the rapid flood of digital technologies.

We began our investigation of "looking to the future of HCI" at this museum by looking for what we have lost with the advent of personal computers. Our intention was to rejoin the richness of the physical world in HCI.

BITS & ATOMS
We live between two realms: our physical environment and cyberspace. Despite our dual citizenship, the absence of seamless couplings between these parallel existences leaves a great divide between the worlds of bits and atoms. At the present, we are torn between these parallel but disjoint spaces.

Figure 1 Sketches made at Collection of Historical Scientific Instruments at Harvard University

We are now almost constantly "wired" so that we can be here (physical space) and there (cyberspace) simultaneously [14]. Streams of bits leak out of cyberspace through a myriad of rectangular screens into the physical world as photon beams. However, the interactions between people and cyberspace are now largely confined to traditional GUI (Graphical User Interface)-based boxes sitting on desktops or laptops. The interactions with these GUIs are separated from the ordinary physical environment within which we live and interact.

Although we have developed various skills and work practices for processing information through haptic interactions with physical objects (e.g., scribbling messages on Post-It™ notes and spatially manipulating them on a wall) as well as peripheral senses (e.g., being aware of a change in weather through ambient light), most of these practices are neglected in current HCI design because of the lack of diversity of input/output media, and too much bias towards graphical output at the expense of input from the real world [3].

Outline of This Paper
To look towards the future of HCI, this paper will present our vision of Tangible Bits and introduce design projects including the metaDESK, transBOARD and ambientROOM systems to illustrate our key concepts. This paper is not intended to propose a solution to any one single problem. Rather, we will propose a new view of interface and raise a set of new research questions to go beyond GUI.

FROM DESKTOP TO PHYSICAL ENVIRONMENT
In 1981, the Xerox Star workstation set the stage for the first generation of GUI [16], establishing a "desktop metaphor" which simulates a desktop on a bit-mapped


bottles

musicBottles (classical)

Origin: Weather Bottle

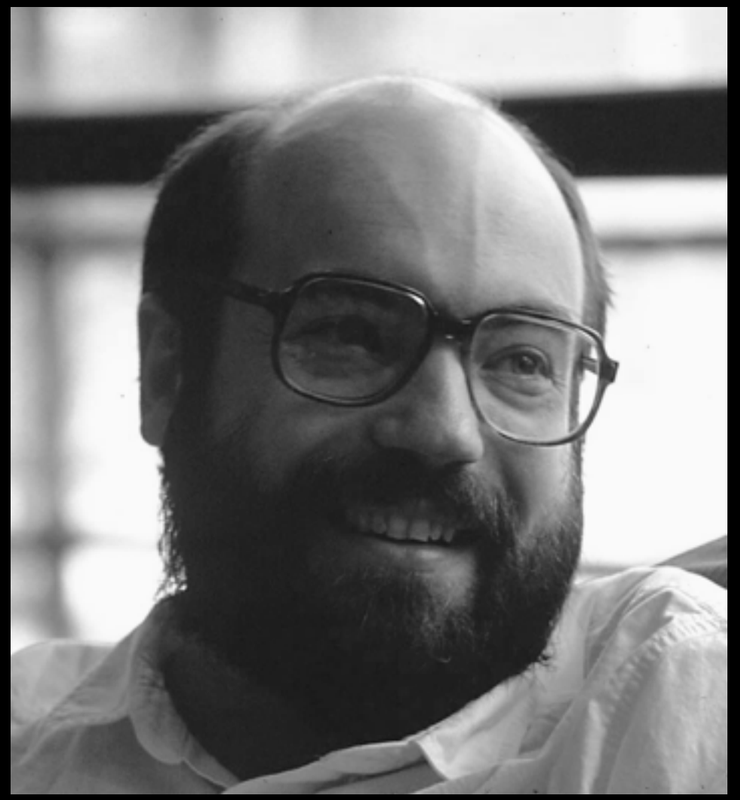
present for my mother

soy sauce bottle
in her kitchen

石井 和子

Kazuko ISHII

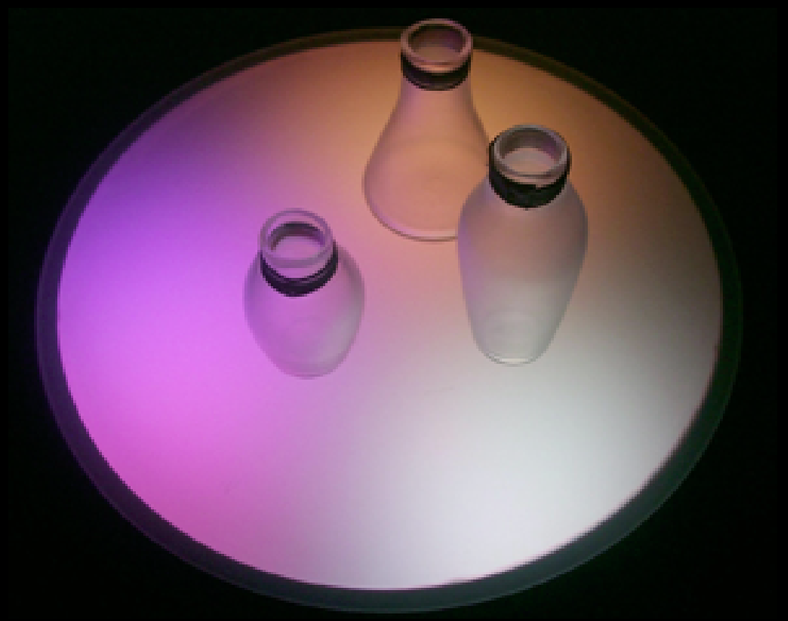
1926 - 1998



Mark Weiser
1952 – 1999

Bottles: A Transparent Interface as a Tribute to Mark Weiser

IEICE TRANS. INF. & SYST., VOL.E87–D, NO.6 JUNE 2004



INVITED PAPER *Special Section on Human Communication I*

Bottles: A Transparent Interface as a Tribute to Mark Weiser

Hiroshi ISHII[†a)], ***Nonmember***

SUMMARY This paper first discusses the misinterpretation of the concept of "ubiquitous computing" that Mark Weiser originally proposed in 1991. Weiser's main message was not the ubiquity of computers, but the *transparency* of interface that determines users' perception of digital technologies embedded in our physical environment seamlessly. To explore Weiser's philosophy of transparency in interfaces, this paper presents the design of an interface that uses glass bottles as "containers" and "controls" for digital information. The metaphor is a perfume bottle: Instead of scent, the *bottles* have been filled with music — classical, jazz, and techno music. Opening each bottle releases the sound of a specific instrument accompanied by dynamic colored light. Physical manipulation of the bottles — opening and closing — is the primary mode of interaction for controlling their musical contents. The *bottles* illustrates Mark Weiser's vision of the *transparent* (or *invisible*) interface that weaves itself into the fabric of everyday life. The *bottles* also exploits the emotional aspects of glass bottles that are tangible and visual, and evoke the smell of perfume and the taste of exotic beverages. This paper describes the design goals of the bottle interface, the arrangement of musical content, the implementation of the wireless electromagnetic tag technology, and the feedback from users who have played with the system.

key words: *Mark Weiser, ubiquitous computing, pervasive computing, invisible computing, transparent interface, tangible interface, tangible bits, bottles, musicBottles, weather bottle*

1. Introduction

"Ubiquitous" has become a popular buzzword used by virtually every media in Japan today. Unfortunately, however, Mark Weiser's original concept of "ubiquitous computing" [19] was not well understood, and was often misused as a label for the old idea such as "anytime & anyplace computing" or as an acronym of "mobile/wireless broadband services."

This paper first discusses the core message of Weiser's "ubiquitous computing" vision based on my personal communication with him, and then presents "bottles" as a tribute to him. The *bottles* illustrates Weiser's vision of *profound technologies* that disappear by weaving themselves into the fabric of everyday life.

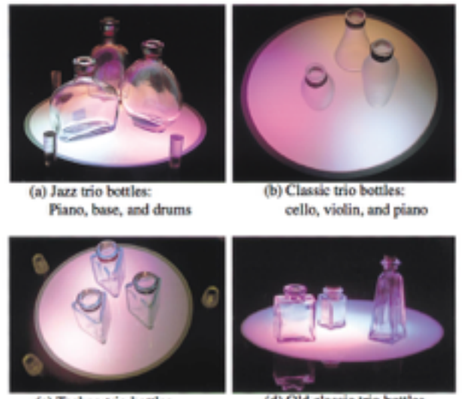
2. Ubiquitous

2.1 Anytime & Anyplace?

The word *ubiquitous*, meaning "omnipresent," is often interpreted as "anytime & anyplace." However, the concept of "anytime & anyplace" is nothing especially new. This

Manuscript received December 12, 2003.
Manuscript revised February 20, 2004.

[†]The author is with MIT Media Laboratory, E15-328, 20 Ames Street, Cambridge, MA 02139-4307 U.S.A.
a) E-mail: ishii@media.mit.edu

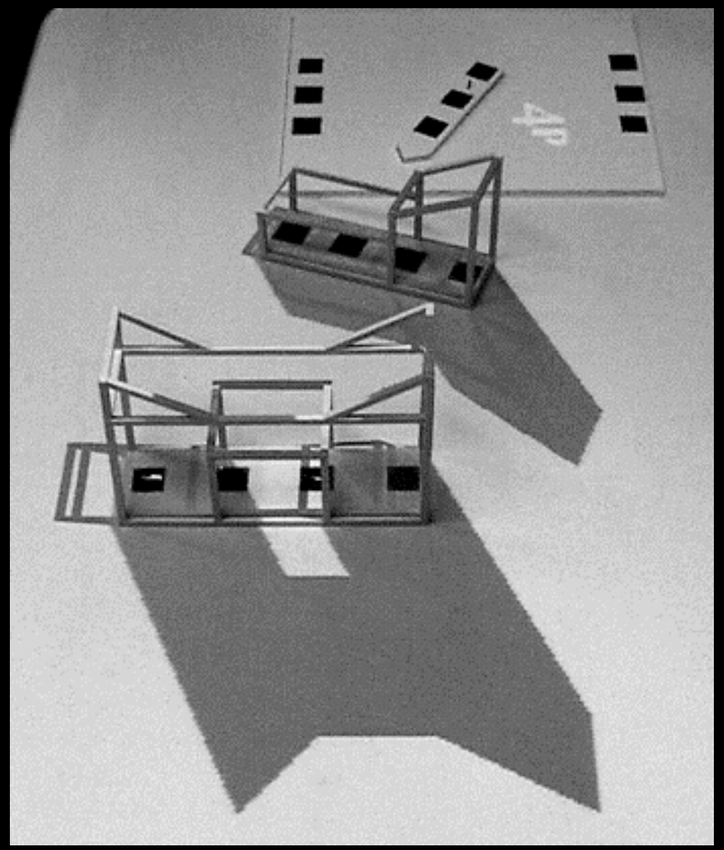


(a) Jazz trio bottles: Piano, base, and drums
(b) Classic trio bottles: cello, violin, and piano
(c) Techno trio bottles
(d) Old classic trio bottles (1st generation)

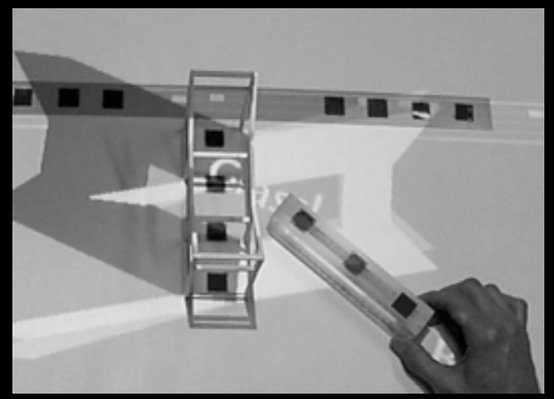
Fig. 5 musicBottles sampler.

Fig. 6 A weather bottle that contains the weather forecast of Sapporo-city.

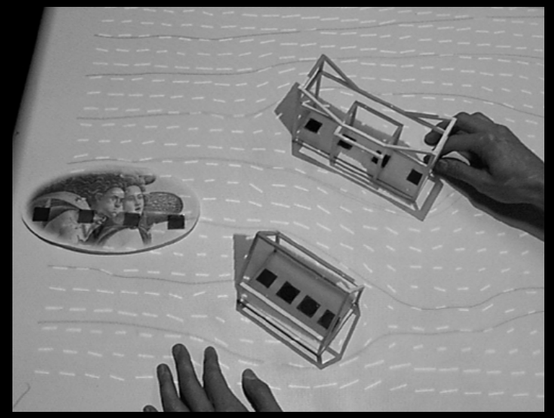
Urp:
Urban Planning Workbench
John Underkoffler and Hiroshi Ishii, 1997 - 1999



digital shadows

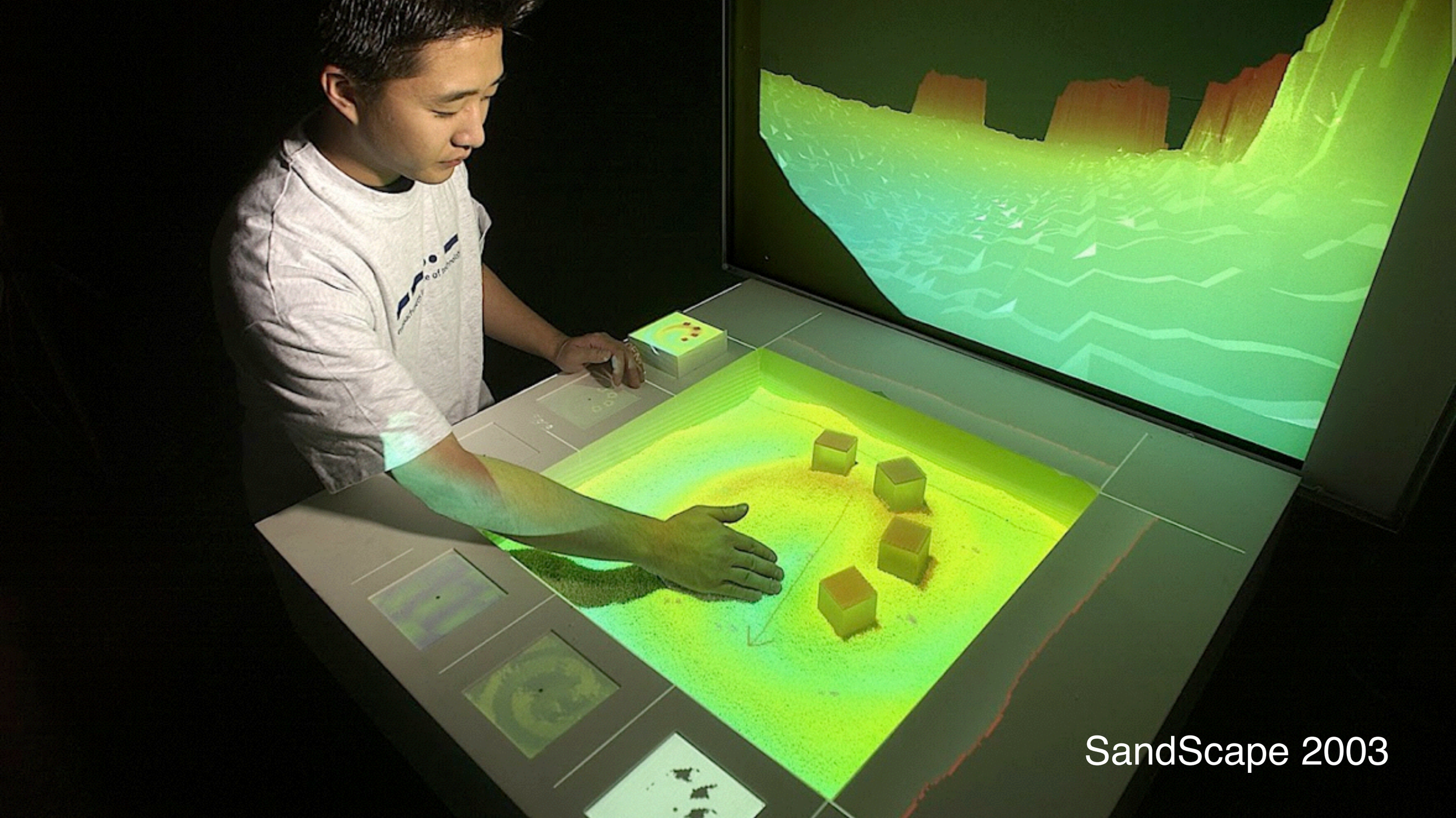


light reflections



wind


Clay & Sand



SandScape 2003

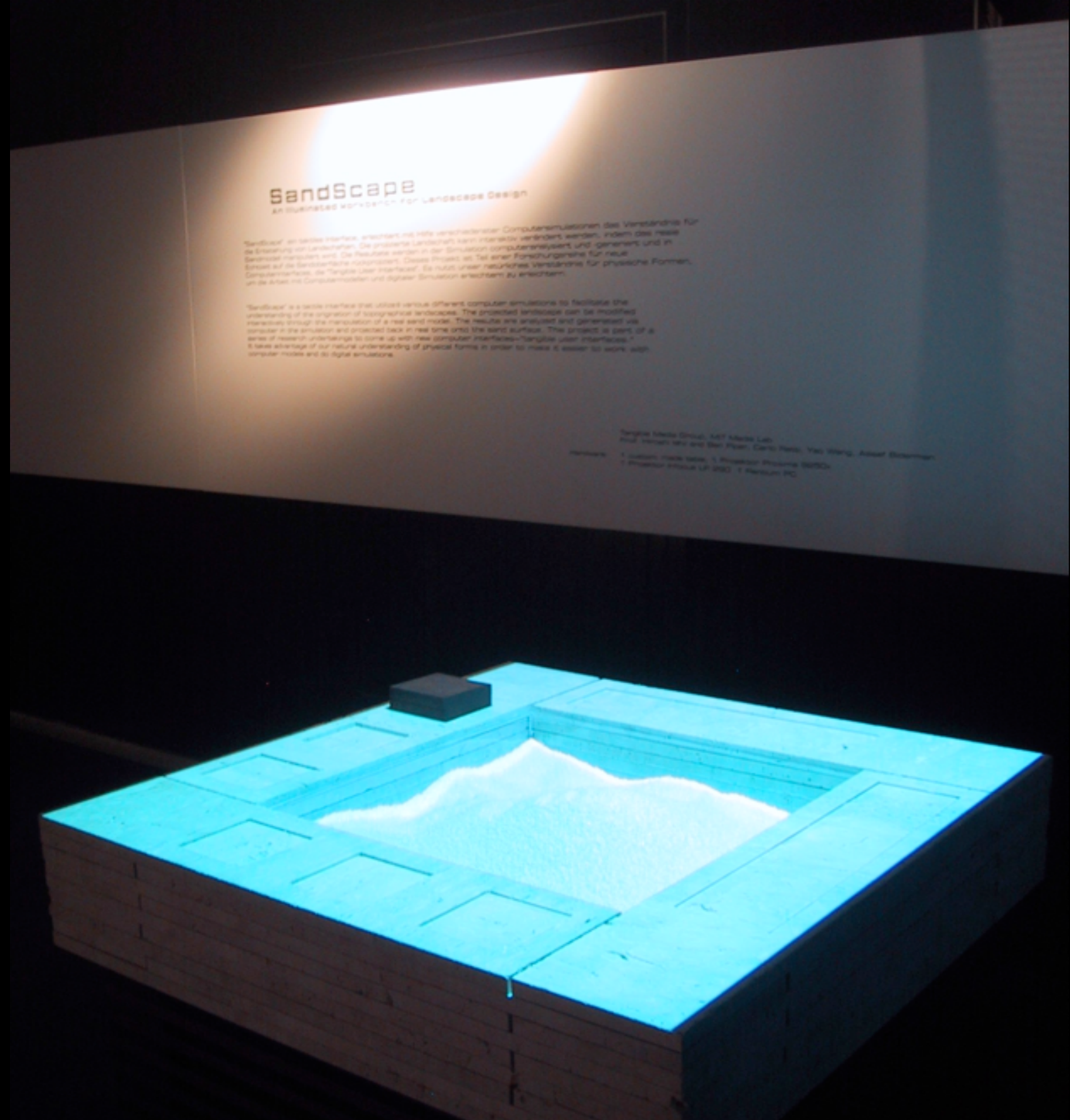
SandScape

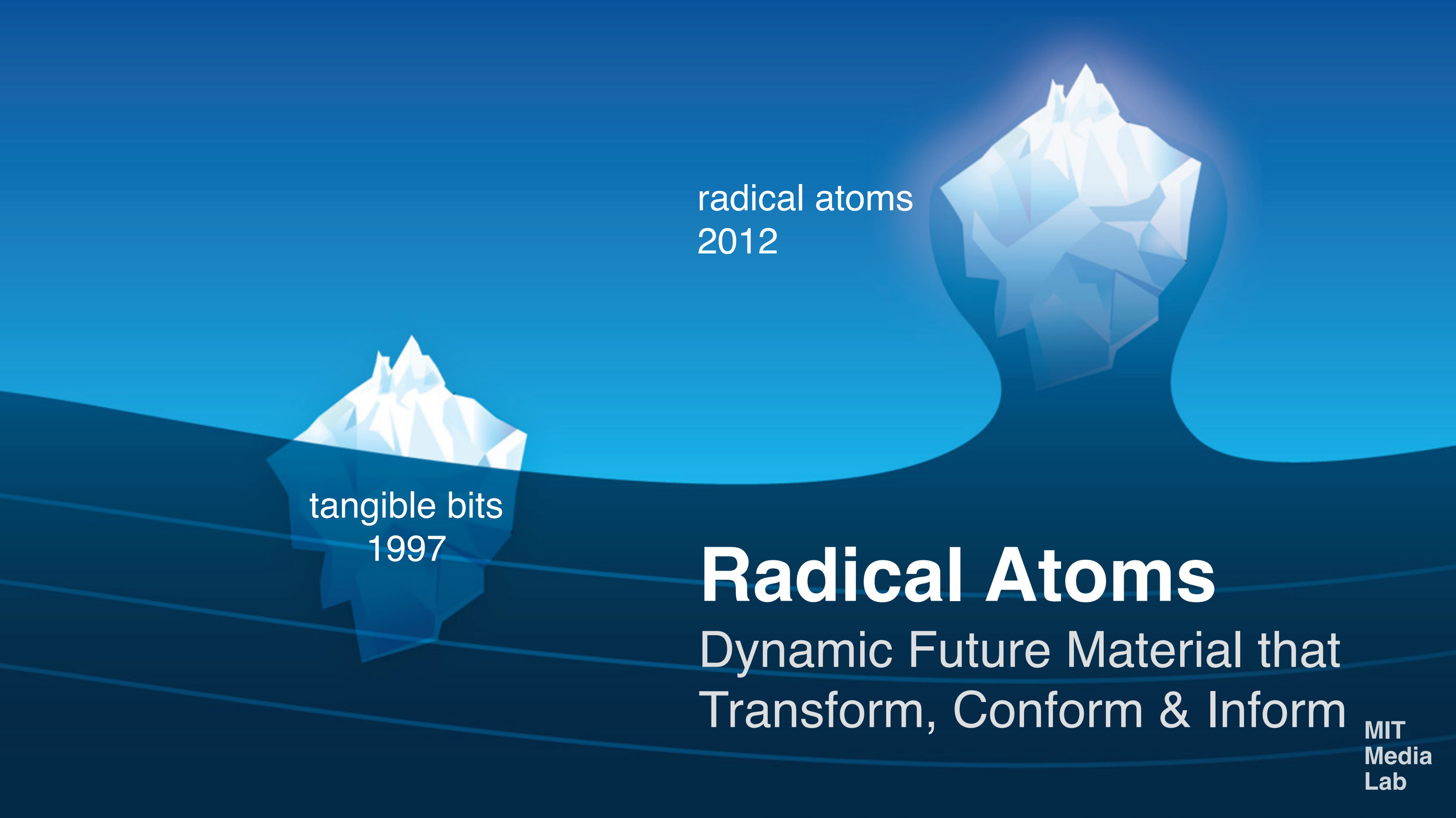
Ars Electronic Center

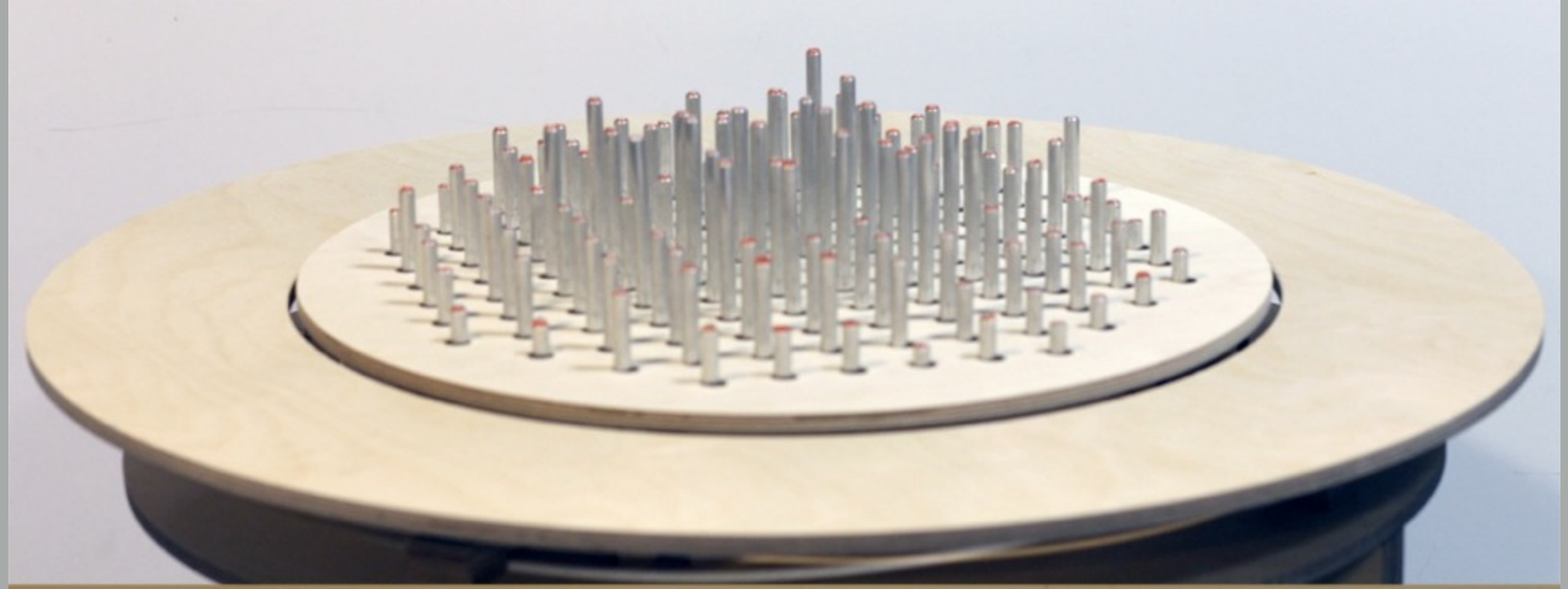
Hiroshi Ishii,
Carlo Ratti,
Ben Piper,
Yao Wang, and
Assaf Biderman

Tangible Media Group

MIT Media Laboratory




radical atoms
2012
tangible bits
1997
Radical Atoms
Dynamic Future Material that
Transform, Conform & Inform
MIT
Media
Lab

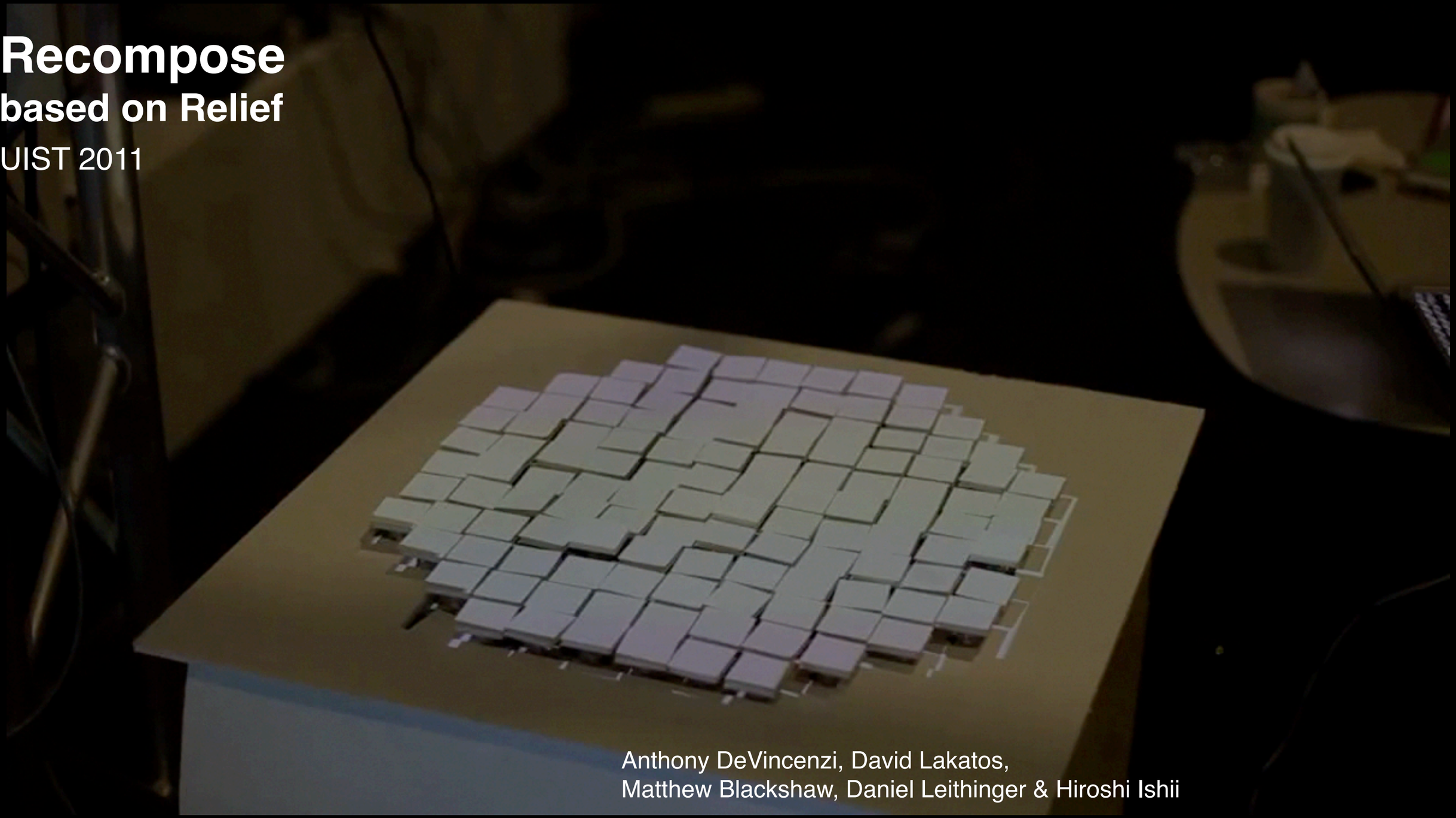


Relief: A 2.5D Shape Display

Daniel Leithinger & Hiroshi Ishii

Recompose
based on Relief

UIST 2011



Anthony DeVincenzi, David Lakatos,
Matthew Blackshaw, Daniel Leithinger & Hiroshi Ishii

TimeScape
based on Relief

Daniel Leithinger, Jinha Lee, Sean Follmer, Austin Lee, Matthew Chang & Hiroshi Ishii