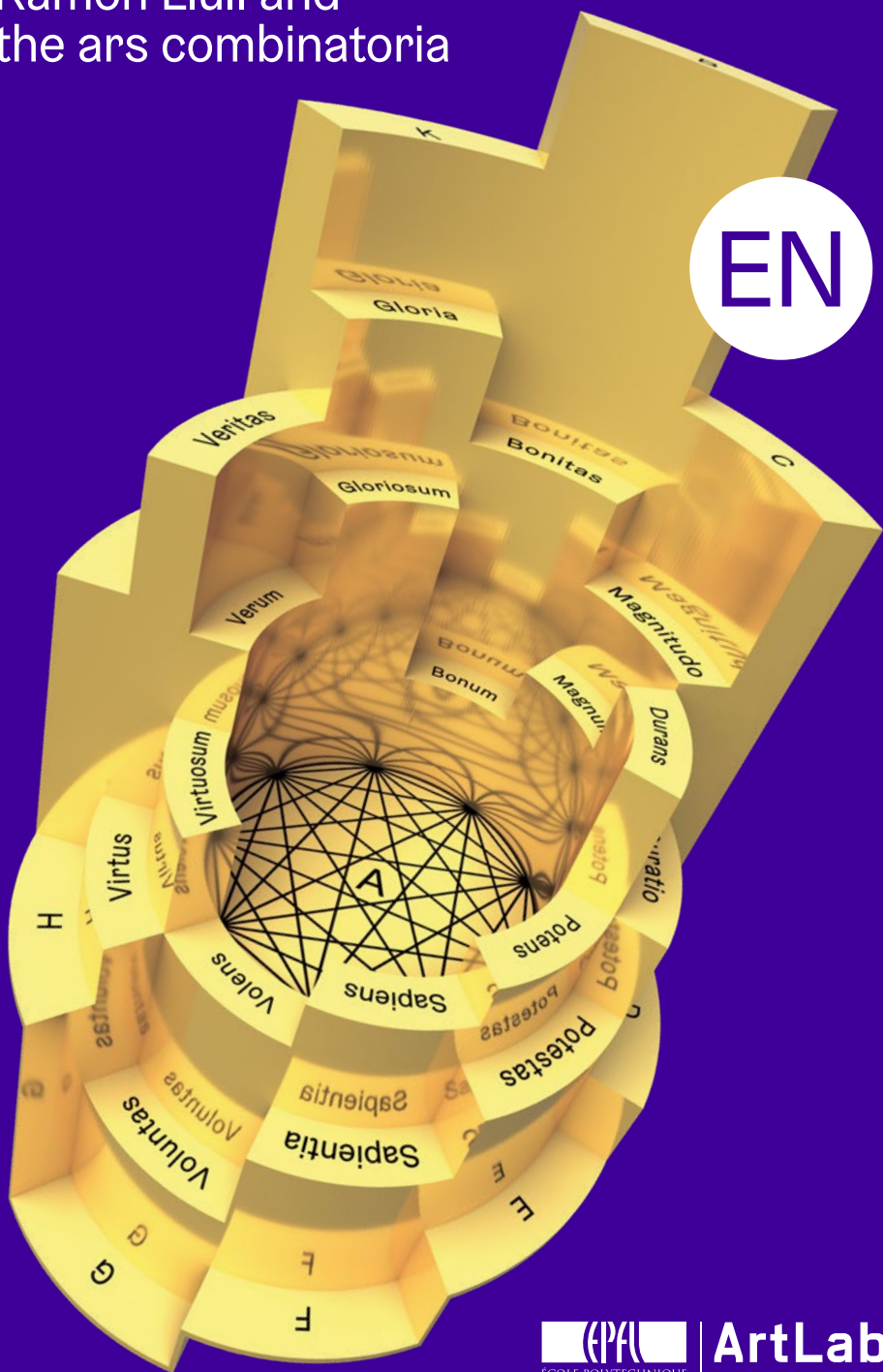


03.11.2018 –
10.03.2019

Thinking Machines

Ramon Lull and
the ars combinatoria

EN



Thinking Machines. Ramon Llull and the ars combinatoria

03.11.2018 – 10.03.2019

EPFL ArtLab's *Thinking Machines. Ramon Llull and the ars combinatoria*, is a bold exhibition that draws together scholarly, scientific and artistic modes of enquiry. Through it, we reread the late Middle Ages in the works of the outstanding Catalan philosopher and theologian, to explore the ramifications of his thinking in the realms of modern and contemporary art, and computation. The reverberations of Llullian thought on technology, art and culture find their present-day corollary in a pedagogical revolution which has 'computational thinking' at its core.

This four-month exhibition proposes fresh perspectives on contemporary technologies and their development through the ages under the influence of both art and science. The exhibition offers a space in which visitors can reflect on the significance of Llullian *combinatorics* for generative and algorithmic principles which are now developed in advanced technologies. *Thinking Machines* likewise raises ethical questions on the accumulation and transfer of knowledge through intelligent systems.

The exhibition is organized by the ZKM | Center for Art and Media Karlsruhe, in collaboration with the Centre de Cultura Contemporània de Barcelona – CCCB and the École polytechnique fédérale de Lausanne (EPFL). Curated by three internationally acclaimed artists and scholars, Prof. Dr. Amador Vega (Universitat Pompeu Fabra, Barcelona), Prof. Dr. h. c. mult. Peter Weibel (ZKM | Karlsruhe), and Prof. Dr. Siegfried Zielinski (UdK, Berlin University of the Arts), *Thinking Machines* is realized at EPFL under the leadership of ArtLab director Professor Sarah Kenderdine.

Specifically designed to be encountered through either of its two opposite entrances in the Pavilion B of EPFL's ArtLab, *Thinking Machines* offers visitors a non-linear curatorial assemblage that can be approached bidirectionally.

The four primary themes of this exhibition are: Inside Thinking Machines, Variantology, Poetics of Knowledge, and Towards Computational Thinking.

Participating artists / thinkers

Abraham Abulafia, Petrus Apianus, Ralf Baecker, Manuel Barbadillo, Berlin Society for Nontrivial Pursuits (S4NTP), Michael Bielicky, H  l  ne Binet, John Cage, Juan Eduardo Cirlot, Salvador Dal  , M  rton Fernezelyi, Philipp Goldbach, Matthias Gommel, Jean-Jacques Grandville, Sabine Groschup, Philipp Matth  us Hahn, Daniel Irrgang, Sarah Kenderdine, Yunchul Kim, Athanasius Kircher, Alexander von Kryha, Werner K  nzler, Pe Lang, Nikolaus Joachim Lehmann, Gottfried Wilhelm Leibniz, Daniel Libeskind, David Link, Bernd Lintermann, Ramon Llull, Christian L  lkes, Josep Maria Mestres Quadreny, Stephan Michelspacher, Manfred Mohr, Thomas Le My  sier, Val  re Novarina, Jos   Pal Latorre, Perejaume, Mikl  s Petern  k, Giovanni Battista della Porta, Robert Preusse, Francesc Pujols, Raymond Queneau, Stefanie Rau, Sophie Reiser, Kamila B. Richter, Petrus Roselli, Arnold Sch  nberg, Jeffrey Shaw, Adam S  lowik, Josep Soler, Josep Maria Subirachs, Zolt  n Szegedy-Masz  k, Edwin Thumboo, Philipp T  gel, Tatjana Jo  lle van Vark, Peter Weibel, Iannis Xenakis, Jos   Mar  a Yturralde, Lazarus Zetzner

Inside Thinking Machines

The outstanding Catalan philosopher and theologian Ramon Llull (c. 1232–1316) from Majorca invites us to reexamine the late Middle Ages. Llull not only theoretically and linguistically invented a new method of knowledge acquisition. Like an engineer, he also mechanized it, and translated it into a machine. This device consisted of four diagrammatic figures, one of which is made from three concentric paper disks, two of them rotatable, bearing concepts or their symbolic substitutes as letters. By turning the disks, linguistic symbols, terms, and letters of the alphabet are correlated, and combined.

Presenting for the first time the scholastic hypothesis that the world could possess a logical structure, Llull attempted to shift the plane of signs and linguistic deductions to that of existence and mechanical argumentation. *Avant la lettre* he invented, a quasi-logical machine, which is able to implement the combinations of terms materially, in a 'paper computer.'

From the Lullian formalization of terms, the school of *ars combinatoria* originated, which has been influential for many thinkers and creators from Gottfried W. Leibniz up to the contemporary arts. Radically modernizing Llull, Leibniz assumes that symbols can be assigned to all terms, and that by combining them, formally and mechanically, new terms can be derived and generated. In this way, it would be possible to create an ideal language, many scientists and philosophers had dreamed about in the past, and still dream about today.

The method Llull invented was universal in its aspiration and, introduced a modern way of learning. It postulated the unity of the various disciplines of

knowledge of his day, and through deduction, argumentation, and dialogue was intended to lead to peace among the religions in states of enmity.

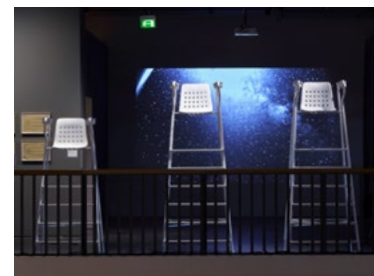
Over 700 years ago, with shameless modernity, Ramon Llull challenged a culture of religion and knowledge that succumbed to the misunderstanding it could only develop its power by isolating itself from others. For this intellectual wanderer between the worlds of North Africa, the Middle East, and the heterogenous identities in southern Europe, to resolve conflicts and develop new, future-oriented options between different world views and religions—there was only one possibility, with an infinite number of variables: Language as a poetic event, as theory and practice of dialogue and successful communication, which we refer to as *Diálogos*, that is “Effective education is based on effective communication.” On the basis of this simple insight, Arthur A. Lumsdaine developed his concept of ‘teaching machines’ in the early 1960s.

In *Thinking Machines. Ramon Llull and the ars combinatoria*, contemporary artists and thinkers are in interactive dialogue with the great work of Ramon Llull. He was a nomad moving extensively across the world around the Mediterranean Sea, in the same way as his ideas were to travel, be rediscovered and echoed across time.

1 Listening Chair 2002/2009

Matthias Gommel
*1970, Leonberg, DE

Steel, plastic, loudspeaker,
audioplayer, 240×120×140 cm.
ZKM | Center for Art and
Media Karlsruhe. Permanent loan
from the LUBW Karlsruhe.



The three tennis umpire chairs are part of the sound installation *12 Movies* (2002/2009) by artist and designer Matthias Gommel (*1970). Special exciter (vibrating) loudspeakers are built into the armrests of the chairs. If you rest your elbows on them and put the palms of your hands over your ears, you will hear the sound source that is connected to the chair because the sound-waves travel across the body through your skeleton.

1.1 Cantavan los aucells a l'auba [...]

The birds were singing at dawn

Based on a verse by Ramon Llull from the *Llibre d'Amic e Amat* (*Book of the Friend and the Beloved*)

Performed by the vocal group Auditexaudi, 06/01/2016

Josep Soler

*1935, Vilafranca del Penedès, ES

Sound recording, 4:00 Min.

Production: Centre de Cultura Contemporània de Barcelona – CCCB

1.2 Orient – Occident 1960

Iannis Xenakis

*1922, Brăila, GR

† 2001, Paris, FR

Electroacoustic composition, 7:02 Min.

Salabert, Paris

1.3 Response Impulses 2018

Aether Ore

(Liz Allbee, Alberto de Campo, Hannes Hoelzl)

Liz Allbee

* 1976, Berlin, Vermont, US

Alberto de Campo

* 1964, Graz, AT

Hannes Hoelzl

* 1974, Bolzano, IT

Sound recording, 8:00 Min.

Response impulses is a recorded spontaneous composition of 8 minutes with no prior discussion of strategies.

2 Audiovisual animation based on the twelve illuminations in the *Breviculum ex artibus Raimundi Lulli* by Thomas Le Myésier, after 1321



Directed by: Universitat Pompeu Fabra (UPF) and RenderArea, 2016

11-channel video installation, color, sound, 8:31 Min. Production: Centre de Cultura Contemporània de Barcelona – CCCB and Universitat Pompeu Fabra, Barcelona

The *Breviculum ex artibus Raimundi Lulli electum* is the best known manuscript about Ramon Llull. It contains the shortest of three compilations of his basic ideas, and was written by his pupil Thomas Le Myésier (?–1336), who presented it to Joan of Burgundy, Queen of France. The *Breviculum* is best known for its twelve large miniatures depicting scenes from the life of Ramon Llull. As this illustrated manuscript must have been produced shortly after Llull's death under the close supervision of his pupil, Le Myésier, in northern France, it is reasonable to assume that the depictions of Llull are fair.

The manuscript possesses an eventful history. It began its journey in Paris, after which, it travelled to Poitiers, in western France, where it could be found in the early-sixteenth century in the ownership of the canon of St. Pierre Cathedral. He left the *Breviculum* to his nephew in 1582. What happened to the manuscript after that date is uncertain. It resurfaced again in 1736, when it was bought by Ulrich Bürgi, the abbot of the Benedictine monastery St. Peter's Abbey in the Black Forest, from the Freiburg lawyer, Joseph Anton Weigel. When the monastery was secularized in 1806/7, Le Myésier's illuminated manuscript—and many of the other treasures of the monastery library—became part of the collection of the library of the Grand Duke of Baden in Karlsruhe, Germany. Today, these manuscripts are held by the Baden State Library, the direct successor of the Duke's library.

3.1 Ramon Llull, *Ars compendiosa inueniendi ueritatem*, [in Latin] France (or Spain?), 14th cent., manuscript on parchment.

Cologne, Foundation Martin Bodmer, MS Bodmer 109, fols. 3v-4r.



Ramon Llull, *Sincah basītah* [*Ars brevis* in Arabic]. Aleppo (?), c. 1682, manuscript reproduction.

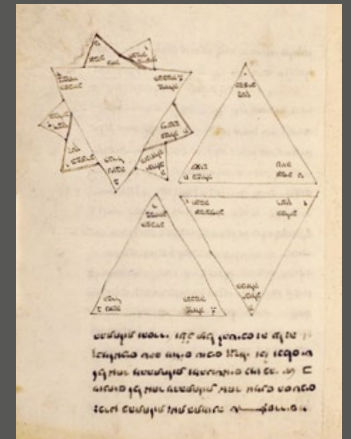
Aleppo, Maronite Archbishopric Library, MS 127, fols. 3v-4r.



Ramon Llull, *Melakhah ketsarah* [*Ars brevis*, in Hebrew].

Senigallia, Italy, 1476, manuscript reproduction.

New York, Jewish Theological Seminary, MS 2312, fols. 2v-3r.



Ramon Llull's *Ars compendiosa inueniendi ueritatem* [Concise Art of Finding the Truth] (Majorca, c. 1274) is the first formulation of what was later to be reworked as the *Ars brevis* [The Short Art] (Pisa, 1308). In this text, Llull uses geometrical figures and algebraic notation (letters) to demonstrate the basics of his combinatory methods of absolute and relative principles. Written in Latin, the work enjoyed wide circulation. Widely known are also a Hebrew (1476) and an Arabic version (1682) of the *Ars brevis*, which demonstrate the reception of Llull's thought across religious and cultural boundaries. In our times, in which religious tensions are again on the rise, it is a gesture both significant and symbolic to exhibit these manuscripts together, each written in one of the three languages of the Abrahamic religions. They remind us of Llull's utopia to acknowledge and engage others through dialogue. He was convinced that understanding between Jews, Christians, and Muslims could not be based on their holy books (Torah, Bible, and the Koran), but instead had to be rooted in a universal grammar of the names of God, which, as the common foundation of the three religions, forms the rational principles of an *ars combinatoria*.

An Arabic translation of Ramon Llull's *Ars brevis* (*Sincah basītah*, MS 127), produced in the seventeenth century, is housed in the library of the Maronite Archeparchy in Aleppo, Syria. The eventful history of the library stretches back to the early-eighteenth century when Gabriel Germanos Farhat, later bishop of the Maronite Church of Aleppo, laid its foundation. With its collection of over 1700 manuscripts, it is considered one of the most important libraries in the Middle East, and is a cultural center of the Maronite Church. From 2012 until the Syrian War began, the manuscripts were catalogued and digitized. Although the war has caused devastating damage in Aleppo, the library's collection of manuscripts was saved — and thus also this rare copy of Llull's *Ars brevis* in Arabic translation. However, because of the current situation in Syria it was not possible to bring the original manuscript to Switzerland. We would like to thank the Archbishop of the Maronite Church in Aleppo, Fr. Joseph Tobji, the director of the library, Fr. Elie Tobji, and the archivist, Mr. Macarios Jabbour, for their outstanding commitment and for sharing this digital reproduction of transcultural dialogue despite the library's difficult circumstances.

3.2 Mashallah ibn Athari, *De compositione astrolabii* (in Latin, trans. Iohanne Hispalensi). Basel (?), 13th-14th cent, manuscript.

Basel, Universitätsbibliothek, MS F III 25, fols. 28v-29r.



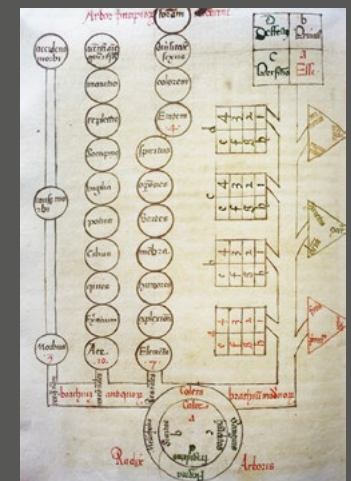
Peter Apian, *Cosmographia, sive, descriptio uniuersi orbis* [...] (Antwerp, 1584).

Printed book.
Lausanne, École polytechnique fédérale de Lausanne Library, AXB 1, pp. 64-65.



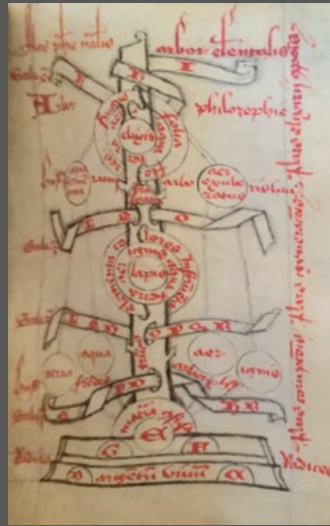
Ramon Llull, *Ars compendiosa medicinae*, Naples (?), c. 1520, manuscript.

St. Gallen, Kantonsbibliothek, Vadianische Sammlung MS 393, fols. 15v-16r. Owner: Ortsbürgergemeinde, St. Gallen.



Ramon Llull, *Opuscula chymica*,
15th cent., manuscript.

Bern, Burgerbibliothek, MS A 78,
fols. 168v-169r. / fols. 189v-190r.



Thomas Le Myésier, *Breviculum
ex artibus Raimundi Lulli
electum*, Northern France (?),
after 1321, manuscript facsimile
(Valencia, 1993) print.

After original in Karlsruhe, Badische
Landesbibliothek, MS St. Peter perg. 92.
Private collection, Barcelona.



The origins of Ramon Llull's art of combination can be characterized epistemologically by two poles. On the one hand, they are informed by the traditions of mystic thought, such as the Jewish Kabbalah with its combinatorial hermeneutics and Christian mysticism. On the other hand, Llull's art belongs to the tradition of scientific rationalism of explaining the world, for example, astronomy. Llull's paper machines rely on the concept of the medieval volvelle, a construction of overlaid paper disks revolving on a string, which allow readers to make calculations. Appearing as early as c.1000 AD, these paper machines were used for calendars, zodiacs and in astronomy.

The mathematician, Peter Bennewitz (Latinized: Petrus Apianus, aka Peter Apian, 1495–1552), from Ingolstadt, Germany whose studies in astronomy were conducted mainly in Vienna, published his *Cosmographia* in 1524. This treatise of astronomy, cartography and navigation contains the finest examples of printed paper astrolabes. The astrolabe originated in ancient Greece and was developed further in Arab-Islamic culture into beautifully crafted instruments, circulating widely by the 9th century. For some, the astrolabe represented

a model of the cosmos; for others it was an instrument of measuring time, or simply a navigational tool; in a broad sense, it could also be seen as an analog computing device.

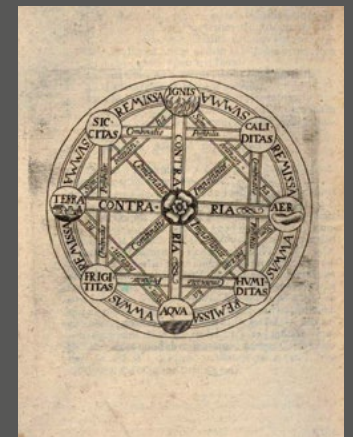
Ramon Llull spent many years of his life in Montpellier, France, one of the three capitals of the Kingdom of Majorca (together with Palma and Perpignan), and the location of the most famous school of medicine in 13th century Europe. There, Llull was able to acquire knowledge in the fields of medicine and astronomy, and came into contact with the ideas of medieval physicians such as Avicenna (980–1037) and Constantine the African (d. before 1098/9).

In the *Ars compendiosa medicinae* [Concise Art of Medicine] (Montpellier (?), 1285-1287), Llull applies the principles and methods of his *Ars magna* [Great Art] to medical science and, at the same time, makes use of medical theory as a paradigm for his analog thinking in philosophy and theology. In this book, the theory of the four elements (earth, air, fire and water) plays an important role, alongside the use of herbs, in the treatment of illness. This text features Llull's first use of the expression "algorithmic figures" in his diagrammatic depiction of the relations between elemental qualities (heat, dryness, humidity and coldness).

Llull's scientific works had a significant impact on alchemical traditions of the 15th and 16th centuries, texts labeled today as pseudo-Llullian.

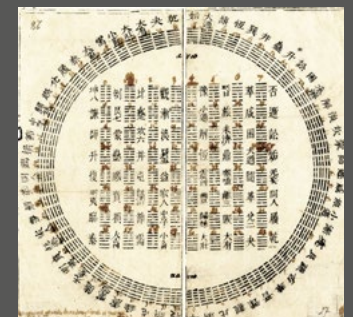
3.3 Gottfried Wilhelm Leibniz, *Dissertatio de arte combinatoria* [...] (Leipzig, 1666).

Printed book reproduction. Hannover,
Gottfried Wilhelm Leibniz Bibliothek,
Niedersächsische Landesbibliothek,
Nm-A 836.



I Ching / I Ging hexagrams
owned and annotated
by Gottfried Wilhelm Leibniz,
1701.

Reproduction of print and ink on paper.
Hannover, Gottfried Wilhelm Leibniz
Bibliothek, Niedersächsische Landes-
bibliothek, LK-MOW Bouvet 10, Bl. 27–28.



Ramon Llull, *Raymundi Lullii Opera ea quae ad adinventam [...]* (Lazarus Zetzner: Argentorati [Strasbourg], 1617).

Printed book. Zürich, Zentralbibliothek, NM 474, pp. 842–3.



The search for a universal language based upon the principles of rationality and logic, which would enable dialog beyond cultures and religions, absorbed Gottfried Wilhelm Leibniz (1646–1716) his entire life. When he was just 20 years old, he published his *Dissertatio de arte combinatoria*, inspired by, but also diverging from, Ramon Llull's *Ars magna*. In contrast to Llull, Leibniz's interest was not in generating true statements using combinatory principles; instead he sought to unravel the mathematical basis of a logic that allows as many combinations as possible. This idea of developing a universal language through the combination of simple elements, ultimately led Leibniz to the binary system of numerals. This binary arithmetic is today the foundation of all computer technologies. Leibniz also saw traces of this universal mathematical language in logograms, or Chinese characters. Leibniz corresponded extensively with Father Joachim Bouvet (1656–1730), who worked for the Chinese royal household. Bouvet pointed out the parallels between Leibniz's binary system and the hexagrams of the *I Ching*.

In that era, the *I Ching* [Book of Changes] was considered to be the oldest Chinese book; originating in the years between 1100–1000 BCE. It is a divination text, which offers guidance for actions in the real world. The statements are organized in 64 hexagrams, each consisting of continuous and interrupted lines. To consult it, hexagrams are constructed using random processes, leading to corresponding readings. Bouvet and Leibniz, however, were less interested in the uses of the *I Ching* than in its combinatory structure — as had also been the case with Leibniz's interest in Llull's *Ars magna*.

The diagram exhibited here (in reproduction), was sent by Bouvet to Leibniz on November 4, 1701. To this, Leibniz added what were, in his opinion, corresponding Arabic numerals. Although the *I Ching* is not a book about mathematical principles, Leibniz saw in this text, whose diagrams he interpreted as the primeval form of Chinese characters, proof of the transcultural universality of his binary system.

3.4 Athanasius Kircher, *Ars Magna Sciendi [...]* (Amsterdam, 1669), vol. 1.

Printed book. Lausanne, École polytechnique fédérale de Lausanne Library, AXC 34:1, frontispiece.



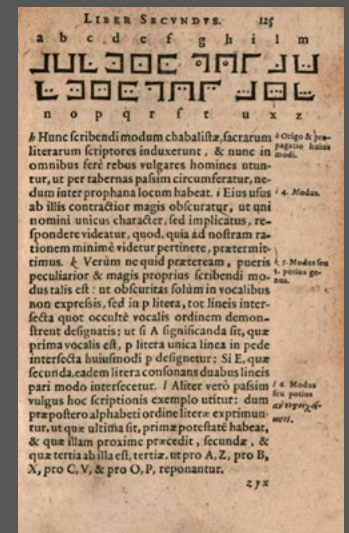
Stephan Michelspacher, *Cabala, speculum artis et naturae, in alchymia [...]* (Augsburg, 1654).

Printed book. Zürich, Zentralbibliothek, K Bro 1932, plate 3.



Giovanni Battista della Porta, *De Occultis Literarum Notis [...]* (Strasbourg, 1603), pp. 124–5.

Printed book
Private collection, Berlin.



In the early modern era, the *Ars combinatoria* developed into much more than a method for generating knowledge. In the Lullist tradition of the sixteenth and seventeenth centuries, it can be understood as a key element in the history of thought of explaining the world. The German Jesuit, Athanasius Kircher, modeled the ontological basis of his work closely on Lull's ideas. The internal principles of the production and construction of being are generated by one combining God. Almost every page of Kircher's *Ars magna sciendi* (1669), divided into twelve books, testifies to his attempt to understand the art of combination within the unity of interpreting and producing the world.

The frontispiece of the *Ars magna sciendi* shows the Divine Eye presiding over all the fields of knowledge that can be grasped through combinatorics. The small text bubbles contain the disciplines. The Allegory of Wisdom holds in its left hand a tablet, on which the "alphabet of the art" is written. In three columns, each containing nine terms, all knowledge is listed — a concept which hails back to Lull's combinatorics. Beginning at the top, the left column lists goodness, greatness, duration, power and wisdom, will, strength, truth, and fame. The middle column contains predicates and relations (difference, consensus, dichotomy, incipience, and so on). The right-hand column, in the tradition of the *scala rerum*, ladder or scale of things, lists God at the top, followed by the angels, creatures and descending down to the minerals and to Aristotle's categories (predicaments), aiming to encompass all existence. The letters and abbreviations in front of the terms are the symbolic elements, which over the course of Kircher's hypertext are repeatedly combined with each other. The Greek phrase on the pedestal of the throne echoes the ultimate aim of the *Ars magna sciendi*: "There is nothing more beautiful than knowing everything."

4 The Movements of Ramon Llull & the Lullist Network — A Chronotopological Cartogram 2018



Robert Preusse, Stefanie Rau, Daniel Irrgang, Amador Vega, Sophie Reiser, Siegfried Zielinski

Digital animation.
ZKM | Center for Art and Media Karlsruhe and
Staatliche Hochschule für Gestaltung Karlsruhe (HfG)

5 Portolan chart of the Mediterranean and the Black Sea 1449



Petrus Roselli

Reproduction of map on parchment
Karlsruhe, Badische Landesbibliothek, S 6.

Portolan charts began to be produced around the time in which Ramon Llull was gradually developing his variations of the *Ars combinatoria*. Tuscan cartographers started to create these charts in the last third of the thirteenth century. As modern techniques of navigation, they quickly spread and circulated in major ports, including Genoa and Venice, cities which were trade network hubs. From there, the charts quickly reached Majorca and Catalonia. Portolan charts did not typically serve religious or political interests. Known as "portolanos" — pilot or navigational manuals — they were exceptionally useful for seafarers. The network of lines emanating from windroses gave sailors information about directions and distances that were important for steering ships. This very precise example of a Portolan chart of the Mediterranean and the Black Sea was produced in 1449 by Petrus Roselli, a cartographer living in Majorca. The original, created on parchment, is part of the collection of the Baden State Library in Karlsruhe, Germany.

Abraham Abulafia, *Hayyei ha-Olam ha-Ba* [Life of the World to Come, in Hebrew]

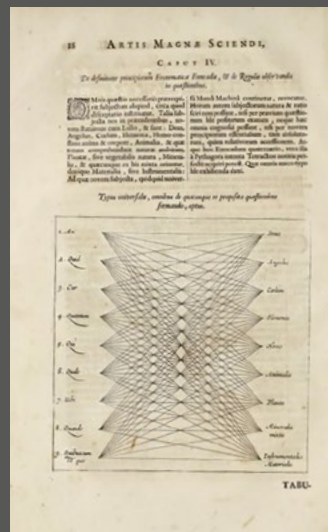
Italy, 14th–15th cent., manuscript reproduction. Zürich, Braginsky Collection, MS B 251. Courtesy of the Braginsky Collection, Zürich. Photography by Ardon Bar-Hama, Ra'anana, Israel.



The Jewish mystic Abraham Abulafia (1240 – after 1291), was a contemporary of Lull, who also lived in Spain. He devised a new, prophetic, school of Kabbalah, a mystical religious tradition of Judaism. Abulafia's method focused on inner transformation, personal experience, and the attainment of spiritual ecstasy, which he thought was key to mystical and prophetic experiences. His book *Chaye Ha-Olam Ha-Ba* [Life in the World to Come] (1280) contains 138 concentric circles which are to be used as aids in meditation. Concentration on these circles serves to focus the mind. The system centers on the 72 Names of God which can be derived in a combinatorial way by combining the numerical values of the letters in the names of the twelve tribes of Israel, the Patriarchs, and the nine letters of the words *shivtei yisra'el* (the tribes of Israel). Initially beginning by contemplating the physical images, in higher levels of the practice one proceeds to imagine these circles and rotate them in the mind.

Athanasius Kircher, *Ars Magna Sciendi* [...] (Amsterdam, 1669), vol. 1.

Printed book reproduction. Lausanne, École polytechnique fédérale de Lausanne Library, AXC 34:1.



Ramon Llull, *Ars compendiosa inueniendi ueritatem*

France (or Spain ?), 14th cent., manuscript reproduction. Coligny, Fondation Martin Bodmer, MS Bodmer 109. Courtesy of the Bodmer Foundation and e-codices Virtual Manuscript Library of Switzerland.



Pseudo-Ramon Llull

Various texts. c. 1520, manuscript reproduction. St. Gallen, Kantonsbibliothek, Vadianische Sammlung MS 391. Owner: Ortsbürgergemeinde, St. Gallen.



Variantology

Llull's *ars combinatoria* was a method based on divine intuition for generating truths by means of a logical algebraic language. The basic ideas were both simple and complex: all three Abrahamic religions are variants of one religion based on texts. They build upon the axiom that in the beginning of existence there was the word, and, therefore, being and word can only be conceived as inextricably interwoven. This means that both within the systems of each of the religions and in their interactions there must exist processes, which are now designated communication. That was the great discovery of Ramon Llull 700 years ago: If he could succeed in formulating a code that would be comprehensible in all languages that constituted the basis of the religions of the word, one would possess an instrument which could be applied to all monotheistic views of the world. To invent such a universal machine, at least three media steps are necessary, which all technology-based forms of communication must pass through:

- 1) Condensing the multiplicity of the messages to be transmitted into a manageable number of elemental truths – the prerequisite for breaking down mental activity into basic operational steps.
- 2) Reducing the complexity of the spoken and written languages in which the messages are formulated to a few symbolic elements.
- 3) Rendering the symbolic signs and their combinatory possibilities material in hardware, which physically enables the logical game with constant repetition to produce different meanings.

7 Ars Generalis Ultima
(R. Lullus)

Ars Signorum
(G. Dalgarno)

Lettre à Marin Mersenne
(R. Descartes)

Polygraphia nova et
universalis ex
combinatoria arte
detecta (A. Kircher)

2016

From the series
Read Only Memory

Philipp Goldbach
*1978, Cologne, DE

Four-part, double-sided copper-coated epoxy resin, glass fabric laminate, electrical components, lead solder
108,5 × 108,5 × 1 cm.
Courtesy the artist



Philipp Goldbach's *Read Only Memory* (ROM) thematizes some of the requirements of digital storage technology: practical, material, theoretical, and historical. The electric conductivity of metals, the process of binary encoding through positive and negative charge states, and the theory of artificial ideal languages, are brought together in his series of entirely hand-made circuit boards. On each one Goldbach etched a grid of conductive tracks on double sided copper-plated boards, drilled through them at the intersection points, and connected them to 8000–9000 diodes soldered on both sides. In this way, bit by bit, in switching states of 0 and 1, Goldbach encoded passages from historical texts that develop ideas and approaches for a *lingua universalis*. The intense debates in the seventeenth century about a universal or international auxiliary language that would put an end to the Babylonian plethora of languages, reconcile peoples, and convert non-believers were formulated in mathematical and logical terms and can be seen as the conceptual predecessors of digital machine languages. Llull's *Ars generalis ultima* is the earliest text that Goldbach has included in his series of boards. This work was especially productive for thinkers in the Baroque era and also for today's computer technology, because Llull's 'logical machine' provided for the first time 'hardware' and 'software'.

8 **Self_portrait.jpg**
2005

Yunchul Kim
*1970, Seoul, KR

Ink on paper, 248 × 160 × 5 cm.
Courtesy the artist



At first glance, *Self_portrait.jpg* violates all expectations of media art. On a 270 × 150 cm white sheet of finest traditional Japanese paper, bizarre-looking symbols have been meticulously drawn in ink. A closer examination reveals that they are from the character set of the ASCII code. If one were to count the discrete character elements, the total would be 58806 characters, which Yunchul Kim painted on the paper during a meditation exercise that lasted three and a half months. If the characters are entered into a computer capable of reading them and then sent to a printer, one gets a portrait of the artist. However, that is only a second level on which the work exists and can be perceived. *Self_portrait.jpg* succeeds beyond any technological *dispositif*, for its material and physical existence goes far beyond such technical aspects.

9 **Meditationes**
2016

David Link
*1971, Düsseldorf, DE

Mixed media installation
Production: David Link, Köln
and Centre de Cultura Contemporània de
Barcelona – CCCB. Courtesy the artist



This work, produced especially for this exhibition, is the creation of an artist who is deeply familiar with Ramon Llull's works. David Link's research on generative systems and computer-generated texts finds its expression in the form of art installations. *Meditationes* — a title alluding to René Descartes (1596–1650) and his critique of Llull — is an animated e-book which is being continuously written. While one is reading the two pages that are open, the next two are generated. *Meditationes* presents ongoing observations on the central ideas of Llull's *Ars magna*, for example, the "absolute principles" (Figure A) and the "relative principles" (Figure T), as well as on the lists of the virtues and vices. Additionally, the work's underlying software constantly searches the Internet for these concepts, revealing how contemporary society engages with these ideas. Throughout the flow of texts, there are no repetitions, and new shades of meaning arise continuously. The result is that the concepts become increasingly empty of context and that the meaning of each random concept can appear to be nullified at any given point.

10 **Llull**
1988

Josep Maria Subirachs
*1927, Barcelona, ES
†2014, Barcelona, ES

Lithography
Printed on Japan paper / 7 plates.
Limited print edition of 45 samples,
signed and numbered by the artist.
Framed lithography: 68 × 53 cm.
ESPAI SUBIRACHS, Barcelona



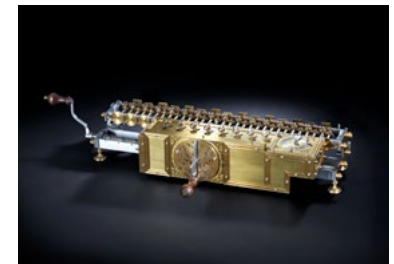
The stairway is one of the most important symbols in Llull's thought, where it stands for the unification of two divided worlds. Analogously to the state of the path that the intellect has to follow, according to Christian beliefs, the ladder describes in ascending and descending order the degrees of existence and the diversity of all creatures and entities of Creation: minerals, plants, animals, humans, elements of the cosmos, heaven, angels, and God. The symbol of the stairway inspired the Catalan philosopher Francesc Pujols, who was very close to Salvador Dalí, to write his book *Hiparxiologi o Ritual de la Religión Catalana* [*Hiparxiologi or Ritual of the Catalan religion*]. The stairway as a mystic symbol is a motif that is highly notable in the work of artist Josep Maria Subirachs, who created some of the sculptures of the Sagrada Família by Antoni Gaudí in Barcelona.

In other compositions dedicated to Llull, like in this lithography, Subirachs also incorporated one of the circular figures of the *Ars magna generalis ultima*, also called *Ars magna*, summarizing the *Ars Lulliana* in six characteristic elements, in which letters symbolize the absolute and relative principles, as well as the interrogative subjects and rules. In order to approach Llull's conception of the world, the rationality of the forms created by the artist was merged with an implicit spirituality, so that Llull's thought is evoked by Subirachs as a metaphor of philosophy, mysticism and knowledge.

11 **Leibniz' calculating machine from 1690–1720 (replica)**
1995

Nikolaus Joachim Lehmann
*1921, Camina, DE
†1998, Dresden, DE

Brass, wood
16,75 kg; 15 × 70 × 21 cm.
Heinz Nixdorf Museums Forum (HNF),
Paderborn



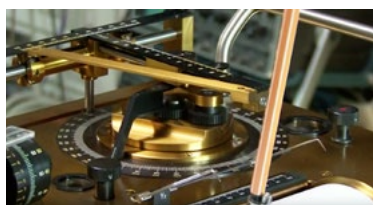
In 1666, the German philosopher and mathematician Gottfried Wilhelm Leibniz (1646–1716) wrote the treatise *Dissertatio de arte combinatoria*, which engages systematically with Lull's Ars. In the context of his idea of a universal science for everything learnable, and a lingua universalis, from 1672 onward, Leibniz worked on developing a calculating machine, which for the first time was able to perform automatically the four fundamental arithmetical operations (addition, subtraction, multiplication, and division). Leibniz' calculating machine is considered a milestone in the history of mechanical calculating devices. The operating mechanism that Leibniz developed, which is also known as the stepped drum or "Leibniz Wheel", could perform multiplication mechanically. For over two hundred years, this remained an indispensable component of mechanical calculating machines. The piece shown here is a fully functioning replica of the only original machine that has survived, which is now in the State Library of Lower Saxony in Hanover, Germany. The replica was built according to plans by Joachim Lehmann.

12 Mythe van een Magistra

2013
Myth of a Magistra

Tatjana Joëlle van Vark
* 1944, Nijkerk, NL

Video by: JIPFILM for NWD Freudenthal Institute, University of Utrecht
color, sound, 14:05 Min.



13a Bolton cipher wheel from c. 1800–1806 (replica)

2013
Brass
Diameter: 7 cm.
Heinz Nixdorf MuseumsForum (HNF), Paderborn



Caesar encryption (also referred to as Caesar cipher, Caesar algorithm, Caesar shift, shift cipher or Simple Caesar) is a simple symmetric encryption technique based on monographic and monoalphabetic substitution. As one of the simplest and most insecure methods, today it serves mainly to illustrate basic principles of cryptography.

13b Kryha Liliput

~ 1926

Cipher machine in pocket watch shape
2,5 × 7 cm.
Metal
Heinz Nixdorf MuseumsForum (HNF), Paderborn

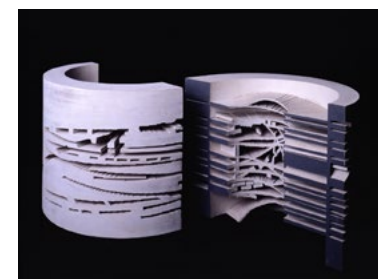


The engineer Alexander von Kryha was born in Ukraine and probably died in Baden-Baden, Germany. The miniature encryption device in pocket-watch format that bears his name was constructed in the 1920s and sold predominantly on the open market. The device with rotating disks showing numbers and letters of code was not particularly secure and the cipher was easy to break. However, it shared a significant characteristic with Lullian wheels that were seen in publications books. The *Kryha Liliput* had an elegant design and became a popular object amongst enthusiasts of encryption and decryption.

14 Virtual House

1997
Daniel Libeskind
* 1946, Łódź, PL

Two-part, chipboard, sandpaper, glued
Each 30 × 43 × 22 cm.
Courtesy the artist



In his design for a *Virtual House* (1997), the architect and artist Daniel Libeskind did not present a technologically upgraded dwelling of the future that followed notions of "new media" cyberspace and virtual reality of that time. The term virtuality was understood by Libeskind in a much broader sense; namely, as a sphere of what is possible. Consequently, his design does not present any kind of static form, but a dynamic configuration, which focuses on experience in a particular moment. Although the physical model of the house, as a material object, captures a certain moment in time, Libeskind makes it plain that, "the model represents what one can see at a certain moment, but there is no certain moment. [...] There cannot be a singular virtual house. The single case is only a token in the actual of the virtual." Familiar with the writings of Ramon Lull and Giordano Bruno (1548–1600), an Italian astronomer and philosopher who assumed the universe to be infinite and eternal, Libeskind presented a combinatory open principle as the structural foundation of the *Virtual House*. Its cylindrical mechanism would consist of 365 kinetic rings, referring to the 365 days of the year which permanently rotate on their own axis in both directions – each day opening possibilities for new

decisions. In total, the combinatory possibilities of the rings represent every possible form, every possible configuration of the house, without ever materializing them.

15 Photograph of the
Reading Machine
by Daniel Libeskind
from 1985

2018

Photograph by: H el ene Binet

Lightbox, UV print on blended fabric
80 x 80 cm.

Courtesy Daniel Libeskind
  H el ene Binet



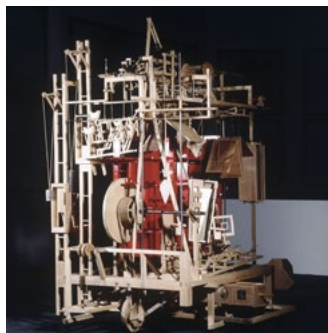
Photograph of the
Memory Machine
by Daniel Libeskind
from 1985

2018

Photograph by: H el ene Binet

Lightbox, UV print on blended fabric
80 x 80 cm.

Courtesy Daniel Libeskind
  H el ene Binet



Photograph of the
Writing Machine
by Daniel Libeskind
from 1985

2018

Photograph by: H el ene Binet

Lightbox, UV print on blended fabric
80 x 80 cm.

Courtesy Daniel Libeskind
  H el ene Binet



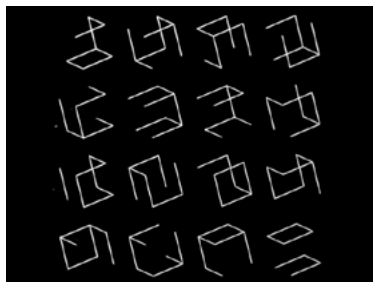
16 Cubic Limit
1973-1974

Manfred Mohr

*1938, Pforzheim, DE

16 mm film, digitized, b/w, no sound
4:01 Min.

Courtesy the artist



17 Random Access Memory
2016

Ralf Baecker

*1977, D usseldorf, DE

Aluminium profiles, custom pick and
place mechanism, microscope camera,
computer and electronics
60 x 60 x 150 cm. Courtesy the artist



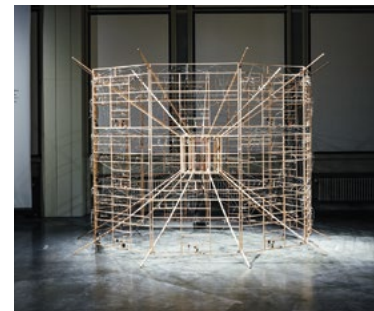
Random Access Memory is a digital memory device that operates with geological material (approx. 1.5 mm grains of sand). The individual bits in the memory can be read, written, and deleted using a pick and place mechanism. Read errors, bouncing grains of sand, and other particles make the mechanism prone to errors. A software runs a program on the device, which is based on a two-dimensional Turing Machine, and is equivalent to the approach used by contemporary computers. Geological material as a medium references the old Arab divinatory technique of geomancy, which has its origins in "ilm al-raml", the Arabic science of sand. Geomancy defines a set of rules and instructions, with the aid of which knowledge about the future can be formed and condensed through recursive operations on geological material. *Random Access Memory* is a hybrid in which concepts, material, and technology developed across two millennia come together.

18 Rechnender Raum /
Computing Space
2007

Ralf Baecker

*1977, D usseldorf, DE

Lightweight sculpture, strip of
beechwood, string, lever,
weights, electronics, servomotor,
250 x 300 x 300 cm.
Courtesy the artist

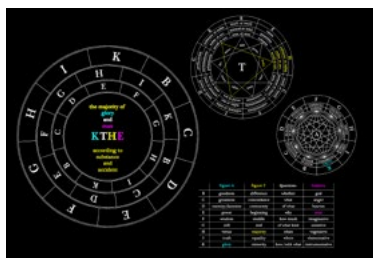


Rechnender Raum leads us into a structure, which could be a calculating machine; into a labyrinthine space with many branches, the components of which are arranged both with symmetry and balance according to concrete principles of order. The construction, which consists of wooden slats, chains, and lead weights, is conceived as a 'reverse' machine, which is turned inside out. In its functional way, it copies the logic of neural networks. Through its geometric structure, into which one can peer from all sides, the work appears to blur the line between inside and outside. However, the inner logic according to which the machine operates remains hidden and so the illusion of openness and penetrability is frustrated yet again.

19 Re-Interpretation
of the *Ars
Generalis Ultima*
2018

Philipp Tögel
*1982, Nuremberg, DE

Interactive, javascript (paper.js)
based installation. Courtesy the artist



Transformation of the combinatory paper machine into computer software. Ramon Llull's art of combination basically consists of three elements. The first is a vocabulary of 'absolute principles,' represented by the letters B through K. They function as a comprehensive collection of ideas, which are assumed to be common to all mankind. In addition, there is the logic that connects the principles and their levels of meaning. Through this permutative grammar, they can be combined to form statements and questions. A last step completes the combinatorics: the combinations of letters generated by the rules are read and interpreted as questions or statements by the user.

The 'four figures' that make up Lullian combinatorics show the repertoire of terms and the rules of combination to which they refer, but only in part. It is the user who has to form statements and questions from the chains of letters. The conversion into software, which Werner Künzel already created in 1991, goes beyond the original concept of Llull in that it transforms the series of symbols into language fragments.

The updated version of Werner Künzel's software by artist and programmer Philipp Tögel (2017/2018) now attempts to connect the visual imagery of Llull's figures and charts with the possibilities offered by the expanded interfaces of the *Ars generalis ultima*. The new software seeks to approximate the Lullian algorithm in both its function and graphic depiction.

20 moving objects |
no. 1755–1899
2016

From the series *Modular*

Pe Lang
*1974, Sursee, CH

Actuators, cables, silicon,
various mechanical parts
200 × 200 × 8 cm.
Courtesy the artist



Poetics of Knowledge

Ramon Llull started out as a writer of love poetry in the style of Provençal singers of the Middle Ages, the troubadours. In their quest to find the perfect combination of "motz el son" ("word and sound") the troubadours invoked the *inventio* of classical rhetoric and developed complex composition techniques. After his religious epiphany, Llull dedicated his complex verse technique to the service of God. The systematic methods of thought acquired when he wrote poetry, he expanded into a language of logic, and transferred the mechanisms of poetry to thought processes. The skills, which he had learned through studying the complex relationships of phonetic repetitions and variations in his art of poetry, he applied to terminology in general. It can be assumed that Llull, with his combinatorics based on numbers, his tables and disks of permutations, wanted to find the earliest, primeval book, just as later Stéphane Mallarmé would invent a cosmic text architecture in his *Le Livre* (1957) that would reveal nothing less than "all existing relations between everything". The poem *Cent mille milliards de poèmes* [A Hundred Thousand Billion Poems] by Raymond Queneau in 1961, which consisted of thousands of cut-up lines, realized this idea of Mallarmé's in a reduced form. Thus, Llull's *ars combinatoria* can be viewed as a universal method of poetic inspiration and a poetics of knowledge.

21 Collage I
1969

Collage, silkscreen on paper
50 × 68 cm.
ZKM | Center for Art and Media
Karlsruhe

Collage II
1969

Collage, silkscreen on paper
50 × 68 cm.
ZKM | Center for Art and Media
Karlsruhe

Adfera
1972

Silkscreen on laid paper
50 × 66 cm.
ZKM | Center for Art and Media
Karlsruhe

No title
1972

Silkscreen on laid paper
45 × 61 cm.
ZKM | Center for Art and Media
Karlsruhe

Manuel Barbadillo
*1929, Cazalla de la Sierra, ES
†2003, Málaga, ES

22 Impossible Figure
(Grey Cubes)

1973

Impossible Figure
(Grey Prism)

1973

Impossible Figure
1973

José María Yturralde
*1942, Cuenca, ES

Serigraphy on cardboard, 81 × 61 cm.
ZKM | Center for Art and Media Karlsruhe



23 Recombinatorial
Poetry Wheel
2015 / 2018

Sarah Kenderdine
Jeffrey Shaw
Edwin Thumboo

Interactive video projection
Courtesy the artists



In the tradition of the *OuLiPo* — *workshop of potential literature*, this interactive installation gives visitors the opportunity to recombine the poetic ensemble of the preeminent Singaporean poet Edwin Thumboo. Twenty-seven of his best-known poems are redefined as polyvocal readings that de- and reconstruct his original oeuvre, creating a live performance with continuously emergent vectors of meaning.

The 200 cm-diameter, round wall-projected image shows a clock-like circle of twenty-seven figures of the poet. The visitor uses a circular knob to rotate a white dot around the edge of the circle to choose one of the figures and thereby trigger his reading of a particular poem that will continue until another figure is chosen. By moving the marker from one figure to another the viewer interrupts the ongoing reading and jump-cuts to a different poem and reading. The resulting indeterminate machination of Thumboo's poetry readings, shown also as printed texts across the center of the screen, constructs an infinitely recombinatory new poetic entity out of his oeuvre.

24 Fesonomia divinatória
de Francesc Pujols
si hagués viscut a l'època
de l'Emperador Traja
1974

Divine Physiognomy of
Francesc Pujols As If
He Had Lived In The Period
of Emperor Trajan

Salvador Dalí
*1904, Figueres, ES
†1989, Figueres, ES

Lithograph on paper
94,7 × 67 × 2,5 cm.
Fundació Francesc Pujols, Martorell,
Barcelona



25 Pujols–Dalí
1956

Josep Pal-LaTorre

Video, digitized, b/w, no sound
11:08 Min.
Fundació Francesc Pujols,
Martorell Barcelona



Salvador Dalí (1904–1989) corresponded with Francesc Pujols (1882–1962), with whom he shared a deep admiration for Antoni Gaudí's (1852–1926) artistic genius. When Pujols returned from his exile in France, following the Spanish Civil War (1936–1939), the two met at Torre de les Hores, the philosopher's house at Martorell near Barcelona. The meeting was documented by journalist Josep Pal-LaTorre.

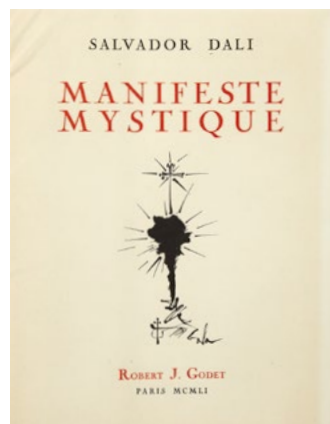
26 Ospite di Roma.
Salvador Dalí
In the news reel
La Settimana Incom,
14.05.1954

Video, digitized, b/w, sound,
English subtitles, 1:30 Min.
Archivio Storico Istituto Luce, Rome



27 Manifiesto Místico
Paris 1951

Salvador Dalí
*1904, Figueres, ES
†1989, Figueres, ES



Around 1948, after returning to Europe from his stay in the U.S.A., Salvador Dalí formulated his project for the renewal of religious art. Inspired in part by Renaissance artists (Raphael and Leonardo), it served as the basis for his *Manifeste mystique* (1951). In this work, which consists of drawings and a text in French and Latin, Dalí dissociated himself from the ideals of the French Surrealism movement, especially from André Breton (1896–1966). Instead, Dalí's sought to create a

new art, whose mystic-ecstatic foundation were inspired by Ramon Llull (1232–1315), as well as the scholar and theologian Raymond of Sabunde (c. 1385–1436), the Spanish mystic Juan de la Cruz (1542–1591) to whom he dedicated various paintings, architect of El Escorial monastery and royal palace Juan de Herrera (1533–1597), the architect Antoni Gaudí (1852–1926), and the Catalan philosopher Francesc Pujols (1882–1962).

28 Lilith

Barcelona 1949

Juan Eduardo Cirlot
*1916, Barcelona, ES
†1973, Barcelona, ES

Print
E. Granell Collection, Barcelona
© Antoni Tàpies, VEGAP, Barcelona, 2016



Cuaderno de Alquimia
beginning of the 1950s
Notebook of Alchemy

Juan Eduardo Cirlot
*1916, Barcelona, ES
†1973, Barcelona, ES

Ring notebook, handwritten
and personally illustrated
Courtesy Lourdes Cirlot, Barcelona



Structural Functions of
Harmony (ASSV 2.2.2.)
Chart of Regions
1939–1948

Arnold Schönberg
*1874, Vienna, AT
†1951, Los Angeles, CA, US

Pencil, ink and emulsion paint on paper
20,1×30,7 cm.
Arnold Schönberg Center, Vienna
© Belmont Music Publishers, Pacific Palisades



Zwölftonreihenscheiben
n. d.

Twelve-tone row disc

Arnold Schönberg
*1874, Vienna, AT
†1951, Los Angeles, CA, US

Ink and emulsion paint on hardboard
diameter 9 cm.
Arnold Schönberg Center, Vienna
© Belmont Music Publishers, Pacific Palisades

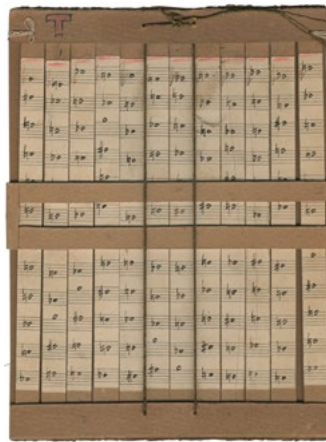


III. Streichquartett op. 30. Reihentafel 1927

III. String quartet op. 30.
Twelve-tone row chart

Arnold Schönberg
* 1874, Vienna, AT
† 1951, Los Angeles, CA, US

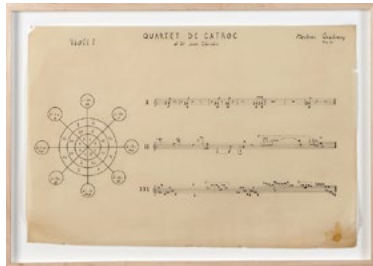
Cardboard, paper, string
18,9 × 14,2 cm.
Arnold Schönberg Center, Vienna
© Belmont Music Publishers,
Pacific Palisades



29 Quartet de Catroc 1962

Josep Maria Mestres
Quadreny
* 1929, Manresa, ES

Four-part, letraset and
printed ink on paper
Each 53,4 × 79,2 cm.
MACBA Collection.
MACBA Consortium.

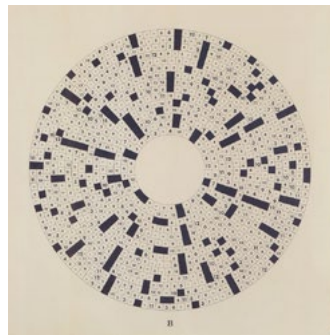


L'Estro aleatorio 1973–1978

The Random *Oestrus*

Josep Maria Mestres
Quadreny
* 1929, Manresa, ES

Ink, pencil and print on paper and
print on vegetal paper
48 × 95 × 2,5 cm
MACBA Collection.
MACBA Consortium.



30 Cent mille milliards de poèmes Paris 1961

One Hundred Thousand
Billion Poems

Raymond Queneau
* 1903, Le Havre, FR
† 1976, Neuilly, FR

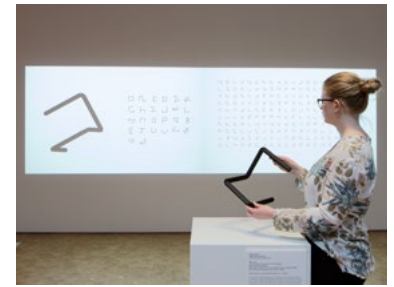
Print
ZKM | Center for Art and Media Karlsruhe



31 Alphabet Space 2017

Adam Słowik
* 1980, Mazovia, PL
Christian Lölkes
* 1990, White Plains, NY, US
Peter Weibel
* 1944, Odessa, UKR

Dynamically three-dimensional notation,
computer-based installation



In the analogue world, all notation was two-dimensional. Letters, images and notes were rigidly fixed onto two-dimensional surfaces. Here the possibility of displaying all 26 letters through a single three-dimensional sign arises from a three-dimensional object by Adam Słowik.

Leibniz reduced the ten digits 1–9 and 0, through which all numbers can be described, to the two digits 0 and 1. Something similar takes place here, with a single object able to represent 26 letters.

This alphabet has a basic geometry, and the individual letters and signs are described through parameters such as the rotation or the position of the base. Individual letters are defined through a quaternion. Number sequences and words can be represented as movement via multiple quaternions.

The viewer receives the current letter on the left screen via a projection of the base object. If the object stays still briefly, the letter is saved, it appears on the right screen, and the object can write a text sign by sign.

32 Calculating machine 1770–1774

Philipp Matthäus Hahn
* 1739, Scharnhausen, DE
† 1790, Echterdingen, DE

Two Prints Each 80 × 80 cm
KK rosa 84, Rechenmaschine P. M. Hahn
Photos: H. Zwietausch; Landesmuseum
Württemberg, Stuttgart



The Philipp Matthäus Hahn (1739–1790) of Württemberg originally came from Kornwestheim near Ludwigsburg. He was a priest, who devoted a great deal of effort to precision engineering. In his workshop he designed grand scale watches, so called world machines (*machinae mundi*), astronomical devices and calculating machines. Foremost he was fascinated by the possibilities of observing and calculating as precise as possible movements of stars and planets. After studying the calculating machines by Jakob Leupold (1674–1727), who in 1727 had published the first history of the calculating

machines in Leipzig, in the 1770s Hahn constructed intricate devices made of brass, which had two sets of 12 to 14 circular enamelled dials that operated with a central manual contactor. Together with Antonius Braun (1686–1728), who was also from Württemberg and who built similar machines, Hahn founded the precision engineering manufacture system whose equivalent today is the state's flourishing IT and software industry. Hahn's aesthetically pleasing and sophisticated artifacts were not actually intended to be primarily used by merchants or early statisticians. As God's machines of a special kind, their aspiration was to provide proof of the notion that the world functions like an enormous mechanical counter, like a clock.

33 arsmag1.c — Ars Magna oder Ars Generalis Ultima

Idea: Werner Künzel
Graphic design:
Udo Hartinger
1989

Werner Künzel
*1951, Duisburg, DE
Heiko Cornelius

COBOL program. Courtesy the artist



Ars Generalis Ultima des Raymundus Lullus Berlin 1987 [1986]

Werner Künzel
*1951, Duisburg, DE
Heiko Cornelius

Print. Courtesy the artist

34.1 Music of Changes 1951

John Cage
*1912, Los Angeles, CA, US
†1992, New York City, NY, US

Sound recording, digitized
44:01 Min.

The piece *Music of Changes*, composed for pianist David Tudor in 1951, by the artist, composer, and writer, John Cage, was one of the artist's first works deriving from chance operations. It was inspired by the *I Ching* [*The Book of Changes*], a divination manual, and the most ancient of the Chinese classical texts (dating to the first millennium BCE). Structuring the book are 64 hexagrams — which can be interpreted as a binary

system — each referring to oracular readings that were used by Cage as operators in the development of compositions, drawings, and texts governed by chance. In this way, artistic creation was freed from the artist's own intentions, the authority of the author, enabling the subjects to speak for themselves, for every viewer, listener, and reader. This retraction of one's ego and the turn toward the subjects themselves, which in their diversity constitute the openness of life, characterizes nearly all of Cage's artistic output after 1951. It arose out of his engagement with Zen Buddhism and Taoism, through which he also came to recognize the possibilities inherent in the *I Ching*. In the openness of life, chance remains the only constant. "I believe that chance operations constitute a thorough discipline, removing likes and dislikes of the ego and opening the music and the composer to the world around him, whether musical or not" (John Cage, 1970).

34.2 Jacob's Ladder. Oratio 1917–1922

Arnold Schönberg
*1874, Vienna, AT
†1951, Los Angeles, CA, US

Sound recording, digitized
44:00 Min.

34.3 L'Estro aleatorio. Series of six concerts for soloists and symphony orchestra 1973–1978

Josep Maria Mestres Quadreny
*1929, Manresa, ES

Sound recording, digitized.
69:11 min. Ars Harmonica.

35 La rel de l'arbre és una roda 2016

The root of the tree is
a wheel

Perejaume
*1957, Sant Pol de Mar, ES

Audiovisual installation



Scripted and directed by: Perejaume. Singers: Sebastià Bardolet, Pol Blancafort, Jaume Ayats and Josep Pieres. Selection of the texts by Ramon Llull: Perejaume. Musical adaption and arrangements: Jaume Ayats. Excerpts from: *Llibre de Gentil*, "Sant Gil"; *Començament de medicina*, "Misere d'Ànger"; *Arbre Exemplifical*, "Goigs de la Mare de Déu del Roser"; *Arbre de la Ciència*, Psalm "In exitu Israel". Recorded in the Abbot's Hall of Pedralbes Monastery and in a forest in Sant Iscle on 3/22/2016. Live sound recording by: Eric Arajol. Shooting and post-production: Wasabi Produccions S. L.
Multi-channel video installation, digitized, color, sound, 12:47 Min.
Production: Can Castellar and the Centre de Cultura Contemporània de Barcelona — CCCB.
Courtesy the artist.

The Catalan artist and poet Perejaume (*1957) developed a unique sensitivity to and vision of nature displayed in his important artistic oeuvres. In his essays, Perejaume attaches primary importance to the concept of place, which for him, is fundamentally connected to the Catalan landscape. His dialogue with the Catalan tradition includes, amongst other things, poems by Jacint Verdaguer (1845–1902), who wrote poetic versions of Lull's *Llibre d'amic e amat* [*The Book of the Lover and the Beloved*], and the paintings by Antoni Tàpies (1923–2012) and Joan Miró (1893–1983).

In his artistic interpretation of the figure of Ramon Llull, Perejaume created an audiovisual installation: *La rayl de l'arbre és una roda* (Barcelona 2016), a Mediterranean forest with rotating trees and traditional Catalan songs. The title of this installation derives from Ramon Llull's book, *Ars compendiosa medicinae* (Montpellier? 1285–1287), in which the philosopher uses the mechanism of the wheel to represent his characteristic combinatorial method, in this case in the context of natural symbols. The lyrics of the songs are taken from different philosophical and scientific works by Llull. The totality of the installation conveys the dynamics of nature and mechanical concepts that inspire Llull's *Ars*.

Ramon Llull, *Arbor principorum medicinae*.
Spain, mid-16th cent.

Manuscript reproduction. St. Gallen, Kantonsbibliothek, Vadianische Sammlung, MS 423.
Owner: Ortsbürgergemeinde, St. Gallen.



36 Combinatorial History of Images 2017–2018

Márton Fernezely
*1974, Budapest, HU
Miklós Peternák
*1956, Budapest, HU
Zoltán Szegedy-Maszák
*1969, Esztergom, HU

Interactive installation, custom made LED display, touchscreen
Production: ZKM | Center for Art and Media Karlsruhe
Courtesy the artists



“One million chimpanzees typing for one million years on one million typewriters will, of necessity, write the Divine Comedy by chance. Now, what did Dante do? He turned the accident around and he made something which was very improbable

necessary. And this is freedom. And this is the new idea of freedom as a turning around of chance, of accident, this is in the technical images.” – Vilém Flusser observed in a television interview conducted in 1991.

Part of the uniqueness of digital visualization is that with any device of a given resolution the number of images is finite. Accordingly, all the possible images on a digital canvas can be rendered one by one by a combinatorial algorithm. Most of the variations will be little more than meaningless noise, but among them will be all the paintings, photographs and computer graphics ever possible to create, every frame from every motion picture, even every picture taken of every object from every possible viewpoint and lighting – rendered on the given resolution of the digital display.

In the installation two parallel histories of famous images are seen on the touchscreen: one of them shows the history of human talent – or in Flusser's words the defeat of entropy, freedom –, while the other shows the timeline of a combinatorial algorithm, how mechanical vision would arrive at the same exact results were it to try each of the pixel combinations on a monochrome 128 × 128 resolution display.

Both timelines can be moved horizontally on the touchscreen. When one selects an image, its place on the human and the algorithmic timeline will appear, together with its 128 × 128 monochrome reproduction on a LED wall.

37 (JC{639}) 2006 / 2012 Aleatory variation #1/89: Jozef Cseres

Sabine Groschup
*1959, Innsbruck, AT

Digital video, color, sound, OmeU
29:14 min (31:33 min).
Courtesy the artist and
John Cage Organ Foundation Halberstadt,
Edition Peters and John Cage Trust.



With a succinct visual aesthetic and sound design, the experimental film *(JC{639})* (A 2006 / 2012, 29'14"12) by the Austrian artist, filmmaker, and writer Sabine Groschup documents the extraordinary performance of John Cage's *ORGAN2/ASLSP* in the St. Burchardi Church in Halberstadt, Germany. Cage, who first wrote the piece in 1985 for piano, and then adapted it in 1987 for organ, with the title of the composition, *As SLOW as Possible*, poses the question of what “as slow as possible” means, and at the same time interrogates the basis of musical performance practice in general. The performance in Halberstadt takes up Cage's challenge in an impressive way, being planned for a period of 639 years. The film consists of 89 sequences, which are randomly recombined in ever new

variations. Thus, through the film's formal aesthetics Sabine Groschup also refers to John Cage's artistic work in which chance and randomness play a central role.

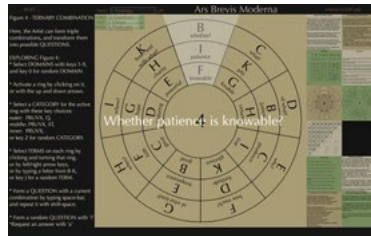
38 Ars Brevis Moderna 2018

Berlin Society for Nontrivial Pursuits (S4NTP)

Alberto de Campo, Hannes Hoelzl, Students of the Generative Art class, UdK Berlin

Special Thanks to Daniel Hromada.

Mac Mini, monitor, keyboard, trackpad
Courtesy the artist



39 Flare 2014

Yunchul Kim
*1970, Seoul, KR

Flare solution, motor, micro-controller,
double jacket reactor, aluminium
153 × 80 × 80 cm.
Courtesy the artist



Yunchul Kim combines material, electronic, and mathematical algorithmic aspects of our reality, and by doing so, he demonstrates contemporary alchemistic practice at the highest level. In recent years, Kim has built a series of complex artifacts in the pataphysical tradition, which combine heterogeneous materials such as liquids, paints, chemicals, and various metals in poetic dynamism. The title of the installation, *Flare*, refers to the Flare solution that can be seen moving in the glass reactor. In addition, the work also refers to the hidden, influential lobbying of the global oil and gas industry by *Flare Solutions Ltd*. The Korean artist is currently working at the University of Applied Arts in Vienna as an art researcher on the project *Liquid Things*.

Towards Computational Thinking

The reverberations of Lullian thought on technology, art and culture find their present-day corollary in a pedagogical revolution which has 'computational thinking' at its core. The drivers that brings this polymath, thinker, philosopher to the EPFL, demonstrate the extent to which Ramon Llull's investigations and prolific production are of profound relevance for our contemporaneity. Llull foresaw what would become the field of computer science and he was a pioneer in the theorization of multiple relevant concepts and ideas ranging from visualization diagrams to the notions of generative processes and systems. As an architect of computational thinking, Llull provides us with a prescient thematic currently at the forefront of teaching and learning at EPFL. This reasoning underwrites situating this exhibition on the campus.

In *Thinking Machines* the realms of poetry, literature and art meet those of humanities and scientific research. EPFL stages such an exhibition to give all who encounter it fresh optics on the gestations of contemporary science through the histories of art and science. The exhibition creates a platform to reflect on the significance of Lullian *combinatorics* for generative and algorithmic principles that are now developed in advanced technologies, while at the same time spawning topical ethical questions concerning the accumulation and transfer of knowledge through intelligent systems.

EPFL has recently embarked on an ambitious program of curriculum reform aimed at making computational thinking a key part of the foundational knowledge of all graduates, irrespective of their discipline. We know that as the ability of machines to

recognize patterns, to set up problems and to take decisions grows, many tasks that required human input can now be implemented efficiently and effectively by a computer. This prompts us to reexamine what kinds of decisions engineers and scientists should be educated to make. It is timely to turn to the ideas of the medieval polymath, Ramon Llull — hailed as one of the earliest proponents of computational thinking — and to look back at how these ideas informed and inspired new thought across cultural, spatial and temporal boundaries. In this effort, we harness these concepts in designing the educational curriculum of the future.

40 Logidules

Logidules are small plastic boxes containing one or more electronic elements. Their assembly allows students to design complex electronic configurations. Although the development started as early as 1968, the Logidules, standardized in 1974, were used at EPFL until 2010.

Courtesy Musée Bolo, EPFL

41 YOU:R:CODE 2017

Bernd Lintermann
*1967, Düsseldorf, DE

Interactive Installation
1 Mirror, 6 Monitors

Dimensions
Wall: 8,30 × 2,15 m

Idea: Peter Weibel. Concept, Realization: Bernd Lintermann. Audio design: Ludger Brümmer, Yannick Hofmann. Installation originally conceived for the exhibition *Open Codes* at the ZKM | Center for Art and Media Karlsruhe.



The title YOU:R:CODE can be read in two different ways: the reading of 'your code' indicates that the visitor experiences digital transformations of himself in different ways in the installation. While he/she still sees his/her own mirror image in the entrance — the most real virtual image we can imagine — the mirror image is increasingly transformed into a digital data body until the visitor is finally reduced to an industrially readable code. At the end, it is freed from the virtual representation and materialized via a flip dot display. The second reading, 'you are code', emphasizes that we ourselves consist of code that

manifests itself in for example genetic code, among others. The genetic code forms the algorithm of life and determines our actions from birth.

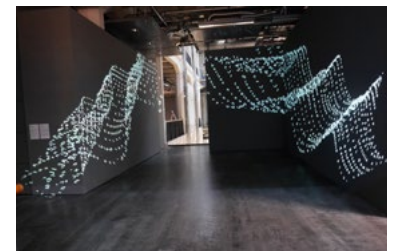
The first panel is a real optical mirror, following the laws of geometry and optics. The second panel superimposes the visitor's reflection with a digital simulation of a mirror and thus transforms the visitor into the digital space. In the third panel, the visitor sees him/herself captured in realtime by the computer as a dynamic 3D sculpture, rotating in the image plane. The fourth panel presents the visitor as an internet persona. His/her body is assembled by the icons of commonly known social media services and as a floating cloud of javascript code used to access social media data. The visitor's face is tracked and beside his face the visitor sees estimations of his height, age, gender and hair color. The fifth panel shows the visitor as the source code of his body: he is represented as a tile image of the letters C, T, A and G, which represent the four basic building blocks of DNA, the four bases adenine, cytosine, guanine and thymine. Genes which influence our dispositions for getting cancer or being emphatic are popping up on the body. The next panel fuses the biological with the digital code, referring to current research in using genes as long time digital storage. In the last panel, the visitor is shown as a silhouette showing an underlaid barcode and a simulated flip dot display. For decades, images composed of light — with televisions, monitors and projectors — determined communication with digital computers. Since the advent of the Internet of Things, the digital image has become detached from light and the objects themselves have become displays.

42 The Names 2018

Michael Bielicky
*1954, Prague, CZ
Kamila B. Richter
*1976, Olomouc, CZ

Programming: Wilhelm
Brodt, Andreas Hampp.
Sound arrangement:
Lorenz Schwarz.

Mini PC, projector, custom made program.
Produced by ZKM | Center for Art and Media Karlsruhe.
Courtesy the artists



43 Au dieu Inconnu 2005

To God the Unknown
Bible. Actes 17, 16–23
(Paul in Athen)

Valère Novarina
*1947, Chêne-Bougeries, CH

Excerpt from La Chair de l'homme,
P. O. L. Editions, 1995
Recitation: Laurence Mayor, Paris, 2005
59:20 Min. Courtesy the artist

“It is not a matter of performing, of orally disseminating a written text, but of practicing a mental experience of exhalation, like someone who finds himself constantly forced to feed on his own words. Respiratory rebirth. Inventing a breath for oneself. Becoming a practitioner of the breath.”

Valère Novarina

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Thinking Machines.
Ramon Llull and
the ars combinatoria
EPFL ArtLab
03.11.2018–10.03.2019

Curators

Amador Vega,
Peter Weibel,
Siegfried Zielinski

EPFL ArtLab Director
Sarah Kenderdine

Partners

ZKM | Center for Art
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Director
Sarah Kenderdine

Curatorial assistance
and project coordination
Giulia Bini

Manuscript specialist
Lisandra S. Costiner

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Exhibition graphic design
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Technical installation
Vincent Jaccoud,
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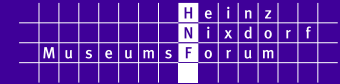
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Sarah Kenderdine,
Amador Vega,
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Texts

Lisandra S. Costiner,
Bettina Korintenberg,
Daniel Irrgang,
Amador Vega,
Peter Weibel,
Siegfried Zielinski,
the artists

Translation EN → FR
Vivienne Baillie

Editing and proof reading
Lisandra S. Costiner,
Anne-Gaëlle Lardeau

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- | | | | | | |
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