

**CALCULATING EMPIRES: A GENEALOGY OF TECHNOLOGY AND POWER, 1500-2025
OSSERVATORIO FONDAZIONE PRADA, MILAN**

Fondazione Prada presents an exhibition titled “Calculating Empires: A Genealogy of Technology and Power, 1500-2025” by Kate Crawford and Vladan Joler from 23 November 2023 to 29 January 2024 at the Osservatorio, its space located at Galleria Vittorio Emanuele II in Milan.

Osservatorio is Fondazione Prada’s centre devoted to visual experimentation and research on potential intersections and collisions between technologies and cultural expressions. It is a free-thinking platform open to reflection on various artistic and media languages and their impact in an ever-changing political and social landscape.

Conceived by researcher-artists Kate Crawford and Vladan Joler, “Calculating Empires” charts our technological present by depicting how power and technology have been intertwined since 1500. By merging research and design, science and art, Joler and Crawford create a new way to understand the current spectacles of artificial intelligence by asking how we got here — and consider where we might be going. This vast, mind-expanding installation invites visitors to experience the *longue durée* through a visualization of time, politics, and technology.

As Joler explains, “This is the year when generative artificial intelligence has flooded global culture, and dominated attention spans. Millions of people have changed the way they search, write, and make images. But these systems have already shown a capacity to concentrate power, produce ‘hallucinations’ and misinformation at scale, and challenge the perception of a shared reality. Generative AI also has a significant impact on our ecologies, requiring vast amounts of energy, water and minerals.” Crawford adds, “All of these diverse global impacts — from the political to the material — have developed over centuries. But they are obscured by cultures of corporate secrecy and technical architectures, the complexities of colonialism, planetary supply chains, opaque labor contracting, a lack of regulation, and by history itself. ‘Calculating Empires’ contends with how to visualize and critique these systems over time.”

The centerpiece of the exhibition is the *Calculating Empires* Map Room. Here the audience is immersed in a dark environment — like walking into a literal black box. The work, presented to the public for the first time, is a diptych of maps: one speaks to the themes of communication and computation, the other explores control and classification. This map room is an intense physical experience, a vertiginous encounter with five hundred years of history. It is designed to calculate empires, and to explore how empires themselves have calculated.

Calculating Empires is a codex of technology and power which shows how the empires of past centuries are echoed in the technology companies of today. This detailed visual

narrative extends over 24 meters and took almost four years to create, illustrating forms of communication, classification, computation and control with thousands of individually crafted drawings and texts that span centuries of conflicts, enclosures, and colonizations.

Calculating Empires proposes a slower way of reading, placing emerging technological devices and discoveries into a much longer historical and political context. This approach prioritizes complexity, reading across time and phenomena, and clustering movements together to see long-term patterns. One map reveals the multiplicity of our communication devices, interfaces, infrastructures, data practices, and computational architectures and hardware. The other map explores how these technologies are woven into social practices of classification and control: from prisons to policing, time to education, colonialism and economic production, to the multitude of military systems.

It is no coincidence that *Calculating Empires* maps begin in the 1500s, a century in which two enormous political, social, and cultural shifts were underway, movements that would expand for hundreds more years. On one hand, new maritime and trade routes opened up, expanding the colonization and subjugation of indigenous people. On the other, Gutenberg's printing press became an instrument of profound cultural change that led to the reorganization of networked information power. We are at another moment of global transformation, with war, generative AI, climate crisis, and profound uncertainty shaping public discourse.

Calculating Empires takes inspiration from large-scale projects such as Aby Warburg's *Atlas*, developed during the 1920s to compile and juxtapose patterns, ideas, and motifs across thousands of years of human culture, and the Eames' "Mathematica" exhibition in the early 1960s, which addressed the complex history of mathematics through art, design, and education. In different ways, Warburg and the Eames' developed languages of visual representation at scale to convey complex ideas and historical narratives, which were also political interventions into how we perceive and interpret history. Following this tradition, *Calculating Empires* looks at five hundred years of history in order to make political observations about the dangers of centralized power and control over human subjectivity and autonomy.

To contextualize this new work, the visitor first encounters Joler and Crawford's *Anatomy of an AI System*, part of the permanent collection of MoMA in New York and the V&A in London. *Anatomy of an AI System* is an exploded view diagram focusing on the case study of the Amazon Echo voice-assisted AI. This anatomical map visualizes the three central extractive processes required to run any large-scale AI system: material resources, human labour, and data. Deep interconnections exist between the literal hollowing out of the Earth's materials and the data mining of human communication, culture, and connection. Where *Calculating Empires* is about time, *Anatomy of an AI System* is about space.

If the visitor reads the map from left to right, the story begins with the Earth and the exploitation of deep-time geological processes and ends with the decay of toxic electronic waste in the ground. But if the audience reads it from top to bottom, the story begins and ends with a human being. At the top is the human user, talking to the Echo and, at the same time, providing Amazon with valuable verbal response training data that it uses to refine its voice-activated artificial intelligence systems. At the bottom of the map is another human story: the entire history of human knowledge and culture, which is currently being extracted to train and optimize artificial intelligence systems.

The *Anatomy* room looks at the hundreds of nested supply chains of minerals, energy and human labor that has driven the rise of AI. It includes a dissected Echo, a collection of all the individual minerals that are mined to make the Echo, and a display of the patents that outline Amazon's corporate vision of AI. The patents reveal a plan to use AI to surveil the labor of factory workers, as well as the activities of neighbors as they walk along the street, and the alleged emotions and health status of every individual Echo user.

The project also includes a work realized by artist Simon Denny in 2019 that was directly inspired by *Anatomy of an AI System*. Titled *Document Relief 1, 3, 22 (Amazon Worker Cage patent)* 2019-2020, it is a recreation of Amazon's patent for a cage to house workers inside distribution warehouses.

The exhibition concludes in a cabinet of curiosities, an eclectic collection of books, devices, and ephemera spanning from 1500 to 2023, and a space to reflect. There are physical examples of the objects and books illustrated in the map room, exploring the relationships between classification, computation, and control, from early calculation machines to semiconductor chips.

The final space is a small library that invites visitors to read, reimagine, and write their own additions, revisions, and complications of history in the hand-made volumes. Any exhibition that spans centuries will necessarily be incomplete, impartial, and subjective: it can never be finished. So these maps are designed to be open to feedback, and to change over time.

"Calculating Empires: A Genealogy of Technology and Power, 1500-2025" is accompanied by an illustrated publication in the Quaderni series, published by Fondazione Prada, including an essay by Kate Crawford and Vladan Joler.

Press contacts

Fondazione Prada
T +39 02 56 66 26 34
press@fondazioneprada.org
fondazioneprada.org

Biographical notes

Kate Crawford is a leading international scholar of artificial intelligence. She is a Research Professor at USC Annenberg in Los Angeles, a Senior Principal Researcher at MSR New York, and was the inaugural Visiting Chair for AI and Justice at the École Normale Supérieure in Paris. Her latest book *Atlas of AI* won the Sally Hacker Prize, the ASSI&T Book Award, and was named one of the best books of the year by both the *Financial Times* and *New Scientist*. She has also created art installations and visual investigations which have been shown in more than a hundred exhibitions worldwide. Her project *Anatomy of an AI System* with Vladan Joler is in the permanent collection of MoMA in New York and the V&A in London, and was awarded the Design of the Year Award in 2019 and included in the Design of the Decades by the Design Museum of London. Her research and art collaboration with Trevor Paglen, *Training Humans*, premiered at Fondazione Prada's Osservatorio and won the Ayrton Prize from the British Society for the History of Science. She currently leads the Knowing Machines Project, a transatlantic research collaboration of scientists, artists and legal scholars that investigates training data. She was named on the *TIME100* list in 2023 as one of the most influential people in AI.

Vladan Joler is an academic, researcher and artist whose work blends data investigations, counter cartography, investigative journalism, writing, data visualization, critical design and numerous other disciplines. He is SHARE Foundation co-founder and professor at the New Media department of the University of Novi Sad. In 2018, in cooperation with Kate Crawford, he published *Anatomy of an AI System*, a large-scale map and long-form essay investigating the human labour, data and planetary resources required to build and operate an Amazon Echo device. A previous study, entitled *Facebook Algorithmic Factory*, included deep forensic investigations and visual mapping of the algorithmic processes and forms of exploitation behind the largest social network. Vladan Joler's work is included in the permanent collections of the Museum of Modern Art (MoMA) in New York City, the Victoria and Albert Museum and the Design Museum in London, and also in the permanent exhibition of the Ars Electronica Center. His work has been exhibited in more than a hundred international exhibitions, including institutions and events such as: MoMA, ZKM, XXII Triennale di Milano, HKW, Vienna Biennale, V&A, Transmediale, Ars Electronica, Biennale WRO, Design Society Shenzhen, Hyundai Motorstudio Beijing, MONA, Glassroom, La Gaîté Lyrique, the Council of Europe in Strasbourg and the European Parliament in Brussels.

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List of exhibited artworks and objects

LEVEL 1
ANATOMY OF AN AI SYSTEM

Kate Crawford and Vladan Joler, *Anatomy of an AI System: The Amazon Echo as an Anatomical Map of Human Labor, Data and Planetary Resources*, 2018
<https://anatomyof.ai>

Vladan Joler, *New Extractivism*, 2021,
video animation by Živa Stanojević and
Aleksandar Ilić, sound by Igor Lečić

Amazon Echo exploded view

Simon Denny
Document Relief 1 (Amazon Worker Cage patent), 2019
Courtesy: The Artist and Galerie Buchholz,
Berlin/Cologne/New York

Simon Denny
Document Relief 3 (Amazon Worker Cage patent), 2019
Courtesy: The Artist and Galerie Buchholz,
Berlin/Cologne/New York

Simon Denny
Document Relief 22 (Amazon Worker Cage Patent), 2020
Courtesy: The Artist and Galerie Buchholz,
Berlin/Cologne/New York

DISPLAY CASES

Bauxite
Al – Aluminum
Bosnia
Wiring in microchips, heat sinks for
cooling, CPUs, graphic processors,
electric power lines
Toxicity: =

Emerald
Be – Beryllium
China
Telecommunications infrastructure
equipment, computers, and cellular
phones
Toxicity: toxic

Ga – Gallium
China
Advanced semiconductors for microwave
transceivers, DVDs, laser diodes in
compact discs, and other electronic
applications
Toxicity: –

Tourmaline
B – Boron
Brasil
Nanowires
Toxicity: toxic

Pyrolusite
Mn – Manganese
Germany
Primary cathode material in lithium-ion manganese (NCM) batteries
Toxicity: moderate

Wolframite and silica
W – Wolfram (Tungsten)
China
Tungsten is one of the most important components in modern integrated circuitry
Toxicity: highly toxic (compounds)

Nd – Neodymium
China
Strong permanent magnets and lasers
Toxicity: slightly toxic

Muscovite
K – Potassium
Serbia
Potassium-ion batteries or K-ion batteries
Toxicity: toxic (hyperkalemia)

Stibnite
Sb – Antimony
China
Diodes and infrared detectors
Toxicity: toxic

Erythrite
Co – Cobalt
Democratic Republic of the Congo
Rechargeable batteries, semi-conductors, hard disk drives, and integrated circuits
Toxicity: toxic

Ammonite in oil shale
Oil shale
Russia
Liquid fuels
Toxicity: pollutant

Quartz
Si – Silicon
Serbia
Silicon wafers
Toxicity: high (silicosis)

Large crystals of Zinc, Lead, and Arsenopyrite with Quartz and Pyrite
Zn+As – Zinc and Arsenic
Kosovo
Arsenic: integrated circuits
Zink: low-field thin-film transistors, transparent conducting oxide contacts, sensing
Toxicity: toxic (Arsenic)

Halite
Li – Lithium
Bolivia
Lithium-ion batteries
Toxicity: toxic (Lithium overdose)

Magnesite with Silicon carbide vein and Brucite
Mg – Magnesium
Turkey
PVC replacemen. Heat transfer and dissipationShield electromagnetic and radio frequency interference; casings for hard drives, cameras, cell phones, laptops, and portable media devices
Toxicity: toxic (Lithium overdose)

Uvarovite
Cr – Chromium
Russia
Protection of metal surfaces against corrosion in electrical and electronic equipment, particularly for coating of electro-galvanized steel and aluminum
Toxicity: high (cancer)

Cadmium Smithsonite
Cd – Cadmium
UK
Batteries and electroplating
Toxicity: toxic

Spodumene
Li – Lithium
Democratic Republic of the Congo
Lithium-ion batteries
Toxicity: toxic (Lithium overdose)
S – Sulfur
Bolivia
Ore processing
Toxicity: low

Cassiterite
Sn+Ta
Tin and Tantalum
Democratic Republic of the Congo
Tin: solders
Tantalum: electrical circuits, capacitors, resistors
Toxicity: moderately

Coal
C – Carbon
Serbia
Coal is primarily used as a fuel
Toxicity: pollutant

Native Copper
Cu – Copper
Poland
Electrical wiring, electronics circuitry
Electrical contacts
Toxicity: toxic

Hematite
Fe – Iron
Morocco
Hard drives, magnetic cards, transformers, motors generators, speakers
Toxicity: toxic (Iron overdose)

Monazite
REE – Nd, La, S, U, Th
Czech Republic
Magnets, electrodes, and carbon-arc lighting, as a catalyst in catalytic converters and for precision glass polishing
Toxicity: toxic waste

Svalerit (Zinc) and Galenit (Lead) base with traces of Titanium, Nickel, Iron, Gold, Silver, Wolfram, and Arsenic
Au+Ag+Ti – Gold, Silver, and Titanium
Kosovo
Gold: connectors, switch and relay contacts, soldered joints, connecting wires and connection strips
Silver: printed circuit boards to switches and TV screens. Silver membrane switches, which require only a light touch, are used in buttons on televisions, telephones, microwave ovens, children's toys, and computer keyboards
Titanium: computers, mobile phones, wearable devices

Malachite
Cu – Copper
Democratic Republic of the Congo
Electrical conductor in many categories of electrical wiring
Toxicity: toxic

Apatite
P – Phosphorus
Pakistan
Semiconductors, insulators, imaging tools, night vision devices, mid-infrared optical modulators, on-chip spectroscopy
Toxicity: toxic

Cinnabar
Hg – Mercury
Mexico
LCD screens and monitors, laptop screen shutoffs, batteries
Illegal gold mining
Toxicity: highly toxic

Patents
US Patent No. US20150066283A1, "System and method for transporting personnel within an active workspace," Amazon Technologies Inc, 2015.
US Patent No. US1142740 B2, "High density, robotic warehouse system," Amazon Technologies Inc, 2022.
US Patent No. US10096319B1, "Voice-based determination of physical and emotional characteristics of users," Amazon Technologies Inc, 2018.
US Patent No. US11632456B1, "Call based emotion detection," Amazon Technologies Inc, 2023.
US Patent No. US11195408B1 "Sending signals for help during an emergency event," Amazon Technologies Inc, 2021.

US Patent No. US2017/0175413A1, "Multi-level fulfillment center for unmanned aerial vehicles," Amazon Technologies Inc, 2017.
US Patent No. US994222B1, "Authentication with wearable device," 2018.
US Patent No. US10511810B2, "Accessing cameras of audio/video recording and communication devices based on location," 2019.

LEVEL 2 CALCULATING EMPIRES

Kate Crawford and Vladan Joler, *Calculating Empires: A Genealogy of Technology and Power, 1500-2025*, 2023

DISPLAY CASES

Carl Linnaeus, *Wästgöta Resa* (Wästergötland travel), Gothenburg, 1928

Athanasius Kircher, *World Geological Map Volcanoes, Ocean Currents & Chasms*, 1665

Georgius Agricola, *De re metallica* (On the matter of metal), 1556

Philip II of Spain, silver 1 Reales Spanish Colonial Cob Coin, Mexico, c. 1556–98

Map of Milan by Matthaeus Merian, 1646

Matthew Fontaine Maury, *The Physical Geography of the Sea*, New York, 1885

Jacob Bohme, *The Signature of All Things*, 1664

Aristotle, *Historia Animalium* (History of animals), 1558

Alain Manesson Mallet, *Description de l'univers. De la sphère* (Description of the universe. The globe), plate LXVII, 1683

James W. Redfield, *Comparative Physiognomy or Resemblances between Men and Animals*, New York, 1853

Cesare Lombroso, *L'uomo delinquente* (The delinquent man), vol. 2, Turin, 1889

Extract from newspaper during the French Revolution: *Journal du matin*, 1796

Alfred Chapius and Edouard Gelis, *Le monde des automates* (The world of automata), Paris, 1928

Thomas More, *Utopia*, 1516

Jean-Jacques Rousseau, *Discours sur l'origine et les fondements de l'inégalité parmi les hommes* (Discourse on the origin and basis of inequality among men), Amsterdam, 1755

The Penny Black, the world's first adhesive postage stamp used in a public postal system, London, 1840

Sterilization stamp, B of H, Greenville Ohio, c. 1950

Soviet bone record, c. 1950

Police identification card using Alphonse Bertillon's anthropometric method, France, 1900

Newspaper article about the methods of Alphonse Bertillon, 1898

Prof. Stampfer's Stroboscopic Disc No. X, Trentsensky & Vieweg, 1833

Antique Hong Kong fortune telling physiognomy book

Charles Darwin, *The Expression of the Emotions in Man and Animals*, London, 1897

Sir Francis Galton, *Natural Inheritance*, 1892

Wechsler Adult Intelligence Scale IQ Test Kit, 1971

Gil Boyne, *Self-Hypnosis Conditioning*, vinyl LP, Self-Help Institute, 1973

Simon Binet, *The Measurement of Intelligence*, 191663 Edison gold-molded phonograph wax cylinders, 1904

NATO flyers distributed in Yugoslavia, 1999

Yugoslav military telegraph, 1960s

German WWII Volksempfänger radio receiver, VE 301Wn, 1933

Stoelting Co. Polyscribe polygraph, c. 1975

Apollo 12, 16, and 17 landing geologic maps, 1972

US Assessment report on Uranium by the Department of Energy, 1980

Silicon wafers, c. 1970s-1980s

NVIDIA A100 chip, released May 2020

US military aperture cards, c. 1960s

Soviet computer punched paper tape, c. 1960–70

25 IBM computer Hollerith punch cards, 1972

National Archives Microfilm, 1860 census, Northumberland County, Pennsylvania, USA, 1860

Minox-C subminiature spy camera, c. 1969

American Psychiatric Association, *Diagnostic and Statistical Manual of Mental Disorders DSM-II*, Washington D.C., 1968

Police Identikit, 1968

Alfred C. Kinsey, Clyde E. Martin, and Wardell B. Pomeroy, *Sexual Behavior in the Human Male*, 1948

Computer programming fortan IV booklet, BN, 16, 1966

Frederick Winslow Taylor, *The Principles of Scientific Management*, 1911

Cybernetics and its Future, Soviet cybernetics book, 1979

Cybernetics. Development Prospects, Soviet cybernetics book, 1979

William H. Sheldon, *Atlas of Men*, 1954

Mrs Beaton's Cookery and Household Management, [1960] 1976

Joseph Weizenbaum, *Computer Power and Human Reason: From Judgment to Calculation*, 1976

Humanscale 1/2/3/4

Ernst Neufert, *Architects' Data, The Handbook of Building Types*, second (international) English edition, [1936] 1980

Bernardino Ramazzini, *De Morbis Artificum* (Diseases of workers), 1700

Maxwell Maltz, *Psycho-cybernetics*, [1960] 2016

The Exciting life of Internet Packet, SHARE Lab – collection of slides 2015–21

Matematika – Stanko Uršič – Transparency Sheets, 1980s

Braun ET66 Calculator, Dietrich Lubs and Dieter Rams, 1987

BOOKS

John Evelyn, *Sylvia, or a Discourse of Forest Trees*, 1664

John Locke, *Two Treatises on Government*, 1690

Pierre-Joseph Proudhon, *What Is Property? Or, An Inquiry into the Principle of Right and of Government*, 1840

G.B. Duchenne de Boulogne, *The Mechanism of Human Facial Expression*, 1862

Gabriel Tarde, *Laws of Imitation*, 1890

Lord Bacon, *Novum Organum or True Suggestions for the Interpretation of Nature*, 1901

Galileo Galilei, *Dialogue Concerning the Two Chief World Systems*, 1953

Philip Morrison, Phylis Morrison, Office of Charles and Ray Eames, *Powers of Ten: About the Relative Size of Things in the Universe and the Effect of Adding Another Zero*, 1982

William Aspray, *John von Neumann and the Origins of Modern Computing*, 1990
Henri Lefebvre, *The Production of Space*, [1974] 1991

Thomas Richards, *The Imperial Archive: Knowledge and the Fantasy of Empire*, 1993

Michael Foucault, *The Order of Things: An Archaeology of the Human Sciences*, [1966] 1994

Paulo Freire, *Pedagogy of the Oppressed*, [1970] 1996

Claude E. Shannon and Warren Weaver, *The Mathematical Theory of Communication*, [1949] 1998

Fredrich A. Kittler, *Gramophone, Film, Typewriter*, [1986] 1999

Ian Hacking, *The Emergence of Probability: A Philosophical Study of Early Ideas about Probability, Induction and Statistical Inference*, [1957] 2006

Karen Barad, *Meeting the Universe Halfway: Quantum Physics and the Entanglement of Matter and Meaning*, 2007

Lorraine Daston, *Objectivity*, 2007

Umberto Eco, *The Infinity of Lists*, 2009

Critical Cartography, SHARE Lab and Friends, 2014–18

Simone Browne, *Dark Matters: On the Surveillance of Blackness*, 2015

Donna Haraway, *Simians, Cyborgs, and Women: The Reinvention of Nature*, [1991] 2015

Tung-Hui Hu, *A Prehistory of the Cloud*, [1978] 2015

Yuk Hau, *The Question Concerning Technology in China: An Essay in Cosmotechnics (Urbanomic/Mono)*, 2016

Achille Mbembe, *Necropolitics (Theory in Forms)*, [2016] 2019

Martin Arboleda, *Planetary Mine: Territories of Extraction under Late Capitalism*, 2020

James C. Scott, *Seeing Like a State: How Certain Schemes to Improve the Human Condition Have Failed*, [1998] 2020

Oscar H. Gandy Jr., *The Panoptic Sort: A Political Economy of Personal Information*, [1993] 2021

Kate Crawford, *Atlas of AI: Power, Politics, and the Planetary Costs of Artificial Intelligence*, 2022

Justin Smith-Ruiu, *The Internet Is not What You Think it Is: A History, a Philosophy, a Warning*, 2022

Ifeoma Ajunwa, *The Quantified Worker*, 2023

Vladan Joler, Francesco D'Abbraccio, Andrea Facchetti, Kate Crawford, and Daphne Dragona, *Black Box Cartography – A critical cartography of the Internet and beyond*, 2023