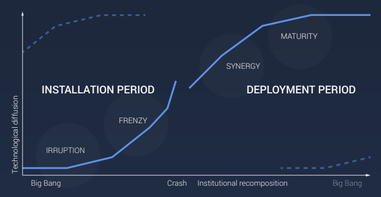
NAVIGATING EMERGING TECHNOLOGIES

The atom. The byte. The gene. The scientific revolution of the last century unfolded the most fundamental building blocks of our today's lives. As we are moving from understanding to manipulation, unprecedented opportunities but also vulnerabilities arise.

The map at hand shall help you to navigate emerging technologies towards a clear-sighted and value-driven application. Each technology is complemented with a brief description and indication of its break-in point. Clustering technologies and linking them to eachother will help you to do associative thinking. Notable (known) technological, societal and economic risks as identified by the World Economic Forum are highlighted next to hypothetical inflection points. Barely visible are firms that are currently leading research or commercialisation in their fields.

THE ROLE OF FINANCIAL BUBBLES AND CRISES
What is the interaction between the emergence of new technologies and the larger economic and social patterns of behavior? Carlota Perez draws upon Schumpeter's theories of the clustering of innovations to explain why each technological revolution gives rise to a paradigm shift and a "New Economy" and how these "opportunity explosions", focused on specific industries, also lead to the recurrence of financial bubbles and crises.



THE ROLE OF TECHNOLOGICAL SYSTEMS AND REVERSE SALIENCE
What holds up progress? An interesting thing about technological systems is that they are not just a bunch of technologies in the same place at the same time, they are systems: their further development is linked together. When some of the technologies in a linked system progress faster than others, the laggards become the limiting factor in the system. Thomas Hughes called these the "reverse salient" with all that implies. The system can not progress until the reverse salient is cured, so economic resources are directed to its improvement. The invisible hand detects what is holding progress back and redirects resources to cure it, so the system evolves faster than its individual technologies would.

ARTIFICIAL INTELLIGENCE

SINGULARITY
Hypothetical moment that the invention of artificial superintelligence will abruptly trigger runaway technological growth, resulting in unfathomable changes to human civilization.

NATURAL LANGUAGE PROCESSING, 1954
The ability to interact between machines and human in natural language.

SPEECH, 1952
Recognition and translation of spoken language into text and vice versa.

COMPUTER VISION, 1966
How computers can be made for gaining high-level understanding from digital images or videos.

MACHINE LEARNING, 1959
Statistical techniques to give computers the ability to progressively improve performance on a specific task with data, without being explicitly programmed.

EXPERT SYSTEMS, 1981
Emulating the decision-making ability of a human expert.

RISING INCOME AND WEALTH DISPARITY

UNDEREMPLOYMENT

PROFOUND SOCIAL INSTABILITY

ADVERSE CONSEQUENCES OF TECHNOLOGY

ROBOTICS

ROBOTICS, 1941
Machines that can substitute for humans and replicate human actions.

ANDROID, 1967
Humanoid robot or synthetic organism designed to resemble a human, especially one with a body with a flesh-like look.

AUTONOMOUS CAR, 1977
Vehicle that is capable of sensing its environment and navigating without human input.

DRONES, 1849
Aircraft without a human pilot aboard and operating with various degrees of autonomy either under remote control by a human operator or autonomously by onboard computers.

TRANSHUMANISM
Hypothetical moment when human beings may eventually be able to transform themselves into different beings with abilities so greatly expanded from the current condition as to merit the label of posthuman beings.

SYNTHETIC BIOLOGY, 1978
Building artificial biological systems for research, engineering and medical applications.

GENOME EDITING, 1991
Genetic engineering in which DNA is inserted, deleted, modified or replaced in the genome of a living organism.

DIGITAL REALITIES

COMPUTER-GENERATED IMAGERY, 1968
Computer graphics to create or contribute to images in art, printed media, video games, films, television programs, shorts, commercials, videos, and simulators.

AUGMENTED REALITY, 1992
Interactive experience of a real-world environment whose elements are "augmented" by computer-generated perceptual information.

VIRTUAL REALITY, 1968
Interactive computer-generated experience taking place within a simulated environment, that incorporates mainly auditory and visual, but also other types of sensory feedback like haptic.

3D/4D SCANNER, 1978
Device that analyses a real-world object or environment to collect data on its shape and possibly its appearance.

FAILURE OF GOVERNANCE

RISING CYBER DEPENDENCY

CYBERATTACKS

EXOSKELETON, 1965
Wearable mobile machine that is powered by a system of electric motors, pneumatics, levers, hydraulics, or a combination of technologies that allow for limb movement with increased strength and endurance.

POST-SCARCITY
Hypothetical moment when most goods can be produced in great abundance with minimal human labor needed, so that they become available to all very cheaply or even freely.

SWARM ROBOTICS, 2005
Approach emerged on the field of artificial swarm intelligence, as well as the biological studies of insects, ants and other fields in nature, where swarm behaviour occurs.

DISTRIBUTED SYSTEMS

BLOCKCHAIN, 2008
Open, distributed ledger that can record transactions between two parties efficiently and in a verifiable and permanent way, resistant to modification of the data.

DECENTRALIZED AUTONOMOUS ORGANIZATION, 2013
An organization that is run through rules encoded as computer programs called smart contracts.

CRYPTOCURRENCIES, 2009
Digital asset designed to work as a medium of exchange that uses strong cryptography to secure financial transactions, control the creation of additional units, and verify the transfer of assets.

SMART CONTRACTS, 1994
Computer protocol intended to digitally facilitate, verify, or enforce the negotiation or performance of a contract. Smart contracts allow the performance of credible transactions without third parties.

INVISIBLE COMPUTING

AMBIENT INTELLIGENCE, 1998
Electronic environments that are sensitive and responsive to the presence of people.

SEMANTIC WEB, 2001
The Semantic Web provides a common framework that allows data to be shared and reused across application, enterprise, and community boundaries

INTERNET OF THINGS, 1991
Network of physical devices, vehicles, home appliances, and other items embedded with electronics, software, sensors, actuators, and connectivity which enables these things to connect and exchange data.

UBIQUITOUS COMPUTING, 1988
Computing to made to appear anytime and everywhere.

CLOUD COMPUTING, 2006
Ubiquitous access to shared pools of configurable system resources and higher-level services that can be rapidly provisioned with minimal management effort, often over the Internet.

NEUROMORPHIC MACHINES, 2006
Use of very-large-scale integration systems containing electronic analog circuits to mimic neuro-biological architectures present in the nervous system.

SMARTPHONE, 1994
Cellular phone, communication device, and handheld personal computer including numerous third party software applications acquired through an app store.

DATA FRAUD OR THEFT

THE END OF PRIVACY
Hypothetical moment when extensive use of cheap sensors and big data offer many actors the ability to monitor nearly everything, growing concern over the impact of "intrusive" technologies.

AMPLIFIED HUMAN

RISING GEOGRAPHIC MOBILITY

HIBERNATION, 2007
Seasons of low body temperature, slow breathing and heart rate, and low metabolic rate.

4D PRINTING, 2012
Type of programmable matter, wherein after the fabrication process, the printed product reacts with parameters within the environment and changes its form accordingly.

INCREASING POLARIZATION OF SOCIETIES

SPREAD OF INFECTIOUS DISEASES

MOLECULAR ASSEMBLER, 1992
Device able to guide chemical reactions by positioning reactive molecules with atomic precision.

SUPERBUG
Hypothetical moment when bacteria change so antibiotics no longer work in people who need them to treat infections.

PERSONALIZED MEDICINE 2005
Medical decisions, practices, interventions and/or products being tailored to the individual patient, based on their predicted response or risk of disease.

BIOPRINTING, 2006
Production of living organs that are constructed with the appropriate biological and mechanical properties.

AGEING POPULATION

ENERGY

ENERGY PRICE SHOCK

ENERGY HARVESTING, 2000
While the input fuel to some large-scale generation costs resources like oil or coal, the energy source for energy harvesters is present as ambient background.

FUSION POWER, 1946
Form of power generation in which energy is generated by using nuclear fusion reactions to produce heat for electricity generation.

ARTIFICIAL PHOTOSYNTHESIS 1960
Chemical process that replicates the natural process of photosynthesis, converting sunlight, water, and carbon dioxide into carbohydrates and oxygen.

BIO ENGINEERING

MEMORY IMPLANTS, 2012
Modification of engramsengrams using optogenetics, which employs lasers to stimulate genetically engineered cells designed to reach to them.

WEARABLES, 2004
Electronic devices that can be worn on the body as implants or accessories.

BIOFUEL, 1826
Produced through contemporary biological processes, such as agriculture and anaerobic digestion, rather than a fuel produced by geological processes such as coal and petroleum, from prehistoric biological matter.

EPIGENETICS, 2008
The study of heritable phenotype changes that do not involve alterations in the DNA sequence.

DE-EXTINCTION, 2003
Process of creating an organism, which is either a member of, or resembles an extinct species, or breeding population of such organisms.

MACHINE SYMBIOSIS

BRAIN-COMPUTER INTERFACE 1977
Direct communication pathway for bidirectional information flow between an enhanced or wired brain and an external device.

BIOMETRICS, 1891
Using aspects of human physiology, chemistry or behavior for biometric identification and authentication.

SYNTHETIC MATERIALS

BIOPLASTIC, 1926
Plastics derived from renewable biomass sources, such as vegetable fats and oils, corn starch, or microbiota.

PROGRAMMABLE MATTER 1991
Changing physical properties of matter like shape, density, conductivity, optical properties, in a programmable fashion, based upon user input or autonomous sensing.

NANOTECHNOLOGY, 1959
Manipulation of matter on an atomic, molecular, and supramolecular scale.

NOOTROPICS, 1972
Drugs, supplements, and other substances that may improve cognitive function, particularly executive functions, memory, creativity, or motivation, in healthy individuals.

SYNTHETIC TISSUE, 1970
Combination of cells, engineering and materials methods, and suitable biochemical and physicochemical factors to improve or replace biological tissues.

BIOSPHERE

EXTREME WEATHER EVENTS

WEATHER MODIFICATION, 1950
Intentionally manipulating or altering the weather.

SYNTHETIC MEAT, 2013
Meat grown from in vitro animals cell culture instead of from slaughtered animals.

VERTICAL FARMING, 1964
Producing food and medicine in vertically stacked layers using indoor farming techniques where all environmental factors can be controlled.

GEOENGINEERING, 1965
Deliberate and large-scale intervention in the Earth's climate system, usually with the aim of mitigating the adverse effects of global warming.

BIODIVERSITY AND ECOSYSTEM COLLAPSE

QUANTUM REALM

QUANTUM COMPUTING, 1980
Large-scale quantum computers would theoretically be able to solve certain problems much more quickly than any classical computers.

QUANTUM MATERIALS, 2012
The properties of the material are uniquely defined by quantum mechanical effects that remain manifest at high temperatures and macroscopic length scales.

QUANTUM DOMINANCE
Hypothetical moment when quantum computers exceed classical computing systems with a winner-takes-all effect.

QUANTUM CRYPTOGRAPHY 1983
Exploiting quantum mechanical properties to perform information-theoretically secure cryptographic tasks.

QUANTUM DOTS, 1986
Very small semiconductor particles, only several nanometres in size, so small that their optical and electronic properties differ from those of larger particles.

SPACE FRONTIER

SECOND SPACE RACE
Hypothetical moment following the first space race fueled by conflicting political and social ideologies, to capture economic superiority through space exploration and exploitation.

ASTEROID MINING, 2006
Minerals like gold, iridium, silver, platinum can be mined from an asteroid and then used in space for construction materials or taken back to Earth.

GRAPHENE, 2004
Strongest material ever tested, efficiently conducts heat and electricity, and is nearly transparent.

TIME CRYSTAL, 2017
Structure that repeats in time, as well as in space.

DEEP SPACE GATEWAY, 2017
Proposed staging point for lunar exploration and crewed missions to destinations such as Mars.

ARTIFICIAL GRAVITY, 2006
String theory predicts that gravity and electromagnetism unify in hidden dimensions and that extremely short photons can enter those dimensions.

ARMED FORCES

WEAPONS OF MASS DESTRUCTION

FORCE FIELD, 2008
Barrier made of energy, plasma, or particles to protect a person, area, or object from attacks or intrusions.

DIRECTED ENERGY, 2009
Inflicts damage at a target by emission of highly focused energy, including laser, microwaves and particle beams.

PARTICLE BEAM, 1989
High-energy beam of atomic or subatomic particles to damage the target by disrupting its atomic and/or molecular structure.

CLOAKING DEVICE, 1991
Obscure objects from at least one wavelength of electromagnetic emissions or use use artificial materials called metamaterials to bend light around an object.

LIVING

SMART HOME, 1975
Home automation system that controls lighting, climate, entertainment systems, and appliances. It may also include home security such as access control and alarm systems.

ARCOLOGY, 1969
Field of creating architectural design principles for very densely populated, ecologically low-impact human habitats.

ZERO-ENERGY BUILDING, 2008
The total amount of energy used by the building on an annual basis is roughly equal to the amount of renewable energy created on the site.

As of July 2018
Designed with curiosity and care by Matthias Koller
Please send any suggestions to matthiaskoller@me.com
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