



DATA



DATA

DATA

An exhibition by

The Danish Museum of

Science and Technology

& Catch



**DATA DATA DATA**

**2020**

Exhibition catalogue produced by  
The Danish Museum of Science and Technology  
and  
Catch - Center for art, design and technology

Curators and editors:  
Majken Kramer Overgaard and Jacob Thorek Jensen

Graphic design:  
Julie Østengaard

## INDHOLD

DATA DATA DATA	1
WHAT DOES THE WORD 'DATA' MEAN?	2
EARLIEST STORAGE TECHNOLOGIES	3
DANISH INVENTOR REVOLUTIONIZES DATA STORAGE	5
THE DATA EXPLOSION REQUIRES NEW TECHNOLOGIES	7
'THE CLOUD' DATA STORAGE NOW AND IN THE FUTURE?	9
GROW YOUR OWN CLOUD	11
IMMERSION - LEARN MORE ABOUT YOUR DATA	12
SHARE YOUR THOUGHTS	12

# DATA DATA DATA

The exhibition DATA DATA DATA tries to create a new awareness of data usage and its consequences. Today, many people find that their ability to control private data is under pressure. Therefore, the Danish Museum of Science & Technology, in collaboration with Catch, have chosen to focus on the development of different types of technology that are able to store and make data accessible. The exhibition also examines the way companies and states access and handle personal data and how this has affected our society over time.

Trading data has become one of the largest businesses in the world. We are granted free access to apps and services if we provide data about ourselves, and our data is often sold as a commodity on the global market. Our computers, phones, and even fire alarms, and refrigerators, are equipped with microphones and cameras. We communicate with our digital devices through Siri, Alexa, and other intelligent applications – Are someone on the sideline eavesdropping and sifting through our data at the same time? Technology is able to assist us in our everyday lives, but as an ordinary citizen it can be difficult to comprehend the

true consequences of our usage of different apps and digital platforms – Does the access to our private data, by states and companies, challenge our basic human rights and potentially undermine our democracy?

The exhibition presents different technologies to illustrate how storage, data processing, and the understanding of data has evolved over time. It contains examples of data storage in various materials from the late 1700s and 1800s, and it treats some of the technological breakthroughs that occur during the 20th century, as for example magnetic and optical data storage.

We no longer have physical CDs or binders resting on our bookshelf. Most of our data are stored in 'the cloud' in the form of large data centers distributed all around the world. Recently, Denmark has become an attractive country for the establishment of data centres. The exhibition examines the role data centres play in our society today by viewing data storage in a historical perspective. However, we will also give a glimpse of possible futures and explore if we are able to develop alternative types of data storage where individuals can once again gain ownership and control their own data.

# WHAT DOES THE WORD 'DATA' MEAN?

In order to understand the importance of the way we store and handle data, here is a brief overview of what the notion of data covers

## From the Danish national encyclopaedia

**data**, information or facts. Within IT, data is formalized information that can be processed by a machine, e.g. a person's height, date of birth and name. The opposite is informal information, e.g. that the person is beautiful and friendly.

Data only makes sense if you know what it refers to and the data has been translated into information. For example, the number 130,825 becomes information if we are aware that the number represents a date of birth indicated by day, month, and year.

The word 'data' is the plural of the Latin *datum* which means 'the given' or 'that which we take for granted' and it is derived from the Latin word *dare*, which means 'to give'.

## From wikipedia.dk

Data is often attributed to a collection of information, which are typically the result of experience, observation, experimentation, or a set of premises. Data can contain numbers, words, or images – or they can build upon a number of measurements of different variables.

## From the Danish national dictionary

1. accurate information, often expressed in an objective or measurable form
2. systematic processing of data using computers

# EARLIEST STORAGE TECHNOLOGIES

It is part of human nature to store knowledge in the form of data. The earliest humans for example did it by painting motifs in caves and later the art of printing revolutionized the storage of knowledge. At the end of the 1700s, data storage began to have a different function. Experiments were initiated with storing data in different materials and decoding them again using a machine that is able to act on the basis of the data.

In 1802, the French weaver and merchant Joseph-Marie Jacquard was granted a patent for his invention of the programmable loom. Jacquard 'encodes' the pattern that the loom has to produce in cardboard cards. The encoded data consist of holes in a number of cardboard cards which are tied together in long sequences or 'code strings'. The programmable loom is able to 'decode' the code string by either pushing a metal split, connected to the threads on the loom, through the hole in the cardboard, or by holding the

split back against the non-perforated cardboard. This enables the programmable loom to produce textiles with the pattern stored on the punch card. **The punch card system** was invented! Jacquard was well aware that his invention was unique, but of course he could not imagine what it would lead to.

Entertainment is another area that would be affected by the principle developed by Jacquard. During the 19th century, various technologies are being developed to play back stored music. These include **The Polyphon**, where music is stored on metal plates. Other similar technologies where music is stored on cardboard cards like the ones used by Jacquard's programmable loom also exist.

The analog storage of data was significantly refined by Thomas Edison with the development of **the phonograph** from 1877. Here, sound was stored on a thin piece of metal foil. The technology was further developed by Graham Bell, who used wax rollers to store sound.

His phonograph was also fitted with an engine which allowed playback to take place at a consistent pace. In 1889, the first phonograph comes to Denmark. It is brought home by consul general Gottfried Ruben. From 1889 to 1897 he makes audio recordings of several singers and actors. A large number of these recordings have fortunately been preserved and digitized. The recordings are freely available at the Danish Royal Library's website under The Ruben Collection. Here you can listen to some of the world's oldest audio recordings.

It is common for the above storage technologies that they are stored on a physical device such as a cardboard card, a metal disc, or a wax roller. You were able control your own data if only you did not lose the physical unit on which the data was stored. If you wanted to erase your data, you only had to destroy the physical device.

# DANISH INVENTOR REVOLUTIONIZES DATA STORAGE

At the end of the 19th century and during the beginning of the 20th century, several new technological breakthroughs are made. Breakthroughs that change our society significantly. The camera for capturing moving images is invented, man fulfills an ancient dream and becomes able to fly. Within the field of data storage, progress is being made as well, and one of its originators is even situated in Denmark.

In 1898, Valdemar Poulsen submits an application for a patent on a **telegraphone**, and the following year the patent is granted. Poulsens telegraphone is based on the principle of magnetic storage of data on a metal wire. Later, the telegraphone is further developed, and it becomes possible to store magnetic data on a metal plate as well. Valdemar Poulsen worked for Copenhagen Telephone Company and believed that he had solved one

of the great challenges of the relatively new invention; the telephones, by inventing the automatic answering machine.

However, it was not the answering machine that Valdemar Poulsen became the inventor of, but the principle of magnetic storage of data; which in this case consisted of sound. The telegraphone never became a success despite the fact that the invention was awarded a Grand Prix at the World's Fair in Paris in 1900 and later received other distinctions. However, Valdemar Poulsen's discovery revolutionized data storage in the following century.

In the 1930s Poulsen's principle for magnetic storage of data was used as a basis for the development of the tape recorder. The tape recorder stores data by using magnetism on a thin plastic tape that has been coated with a magnetic material and is essentially based on the same principle as Poulsen's telegraphone.



The tape recorder does not have a noticeable impact on society until after World War II.

**The cassette tape** is introduced in 1963 and subsequently becomes a commonly widespread technology. The technology is used in the walkman and boomboxes in the 1980s. But already in the 1970s, a cassette tape able to store moving images was developed, and the **VHS** and **Betamax tape** was introduced.

It is not only within the field of sound and moving images that Poulsen's invention will make its mark on the 20th century. The development of the computer in the 20th century is perhaps the most important technological invention of the century. The invention certainly has a huge impact on the development of new technologies. The computer's **hard drive** also uses magnetism to store data on metal disks. The same principle is used for storing data on **floppy disks**, which were the most commonly used storage medium for computers from the late 1970s to the early 1990s.

Credit cards such as VISA and Mastercard, as well as the Danish Dankort, which is introduced in 1983 also builds on Poulsen's principle. Here, the magnetic stripe is based on Poulsen's technology. It is common for this type of storage technology that we still have ownership and control the date it holds ourselves.

# THE DATA EXPLOSION REQUIRES NEW TECHNOLOGIES

During the middle of the 20th century, a number of significant technological achievements are paving the way for digital society as we know it. The invention with the greatest impact on our everyday lives undoubtedly is the transistor, presented in 1947. The transistor is the foundation of our digital society. Our electronic devices contain more transistors than the number of leaves on all the trees in the world. The digital development is leading to a demand for new and improved technologies to store data.

Optical storage has a major impact on the way we store our data. The first documented use of optical storage is carried out as early as 1884, when Graham Bell is able to store sound on a glass plate by the use of light. However, optical storage is not refined to such a degree that it can be utilized commercially until after the Second World War.

The American James T. Russell is most often recognized as the inventor of digital data storage on a disk. An invention he applies for patent on in 1966.

Optical data storage basically means that data is attached to a surface or embedded in a translucent medium, from which data later can be retrieved by the use of a light source. The reflective light is used to read the information. Data is stored as microscopic lines or dots, or in the form of geometric shapes, or otherwise. A device as the computer can later read and decode the data into binary code consisting of 0s and 1s.

In 1982, the first **CD-ROM** is presented. The name is an abbreviation of the English words Compact Disc and Read Only Memory. In the beginning, the format is unable to compete with the VHS tape. CDs cannot be overwritten, but they are able to contain large amounts of data,

and subsequently rewritable CD-R discs are developed. CDs eventually outperforms other formats and becomes a frequently used format for storing music, software applications and data for computers.

In 1995, the **DVD** is developed. The DVD has a higher storage capacity than the CD, but already at the start of the millennium, a new medium with a significantly higher capacity emerges; the **Blu-ray** disk. Both the DVD and the Blu-ray are based on the technology in the CD.

It is common for optical storage devices that consumers are able to store and restore data. The capacity of the devices is constantly changing, but historically we have always owned and been able to control our data.

# 'THE CLOUD' - DATA STORAGE NOW AND IN THE FUTURE?

Today, we often store our data in 'the cloud'. The cloud refers to large data centers with numerous servers, distributed all around the world. In Denmark, we have a number of large data centers and a large number of smaller server parks. Three of the world's largest tech-companies have chosen to establish data centres in Denmark. Google is building a large data center in Fredericia, Apple is building in Viborg, and Facebook one in Odense. This is where the 'the cloud' and the internet materialize in buildings, servers and cooling facilities. This is where data are stored so that they are ready to appear on your phone, tablet, or computer. You can save a photo of your family and loved ones by the click of a button, or you can locate and share notes and comments in minutes. A large number of servers are needed to store the big amount of data we generate. Right now, the total amount of data in the world doubles approximately every second year.

The companies that offer us storage capacity on their servers are making it easy and convenient for us to live in a digital world. We do not need to store data on our computers locally anymore. Instead, we store them on Google Drive, in Dropbox, and Microsoft OneDrive, etc. The tech-giants offer the infrastructure we need to maintain our digital lifestyle. Data are constantly available on our devices, but we no longer know where they are located physically - Who has access to our data, and what do they use them for? While our data are stored far away at large centres, they have been made accessible all the time everywhere. However, as it has become less costly to store, record, and analyse data, our data have become an attractive commodity. Our data contain precious information about us, but others control and are allowed to sell this information. The price for our instant access to data seems to be that we have lost control with our data.

Now, our data can be used to control us.

Even though data are immaterial and non-tangible unlike a VHS tape or a USB stick, they still leave traces and affect our climate. Today we are talking about 'data warming'. The usage of 'the cloud' and the operation and cooling of servers emit CO2 at the same level as air traffic. According to the Danish Council on Climate Change, a single large data center has an electricity consumption equivalent to four percent of Denmark's collected consumption of electricity. Ten years from now, data centers are expected to increase Denmark's electricity consumption by as much as 17 percent.

On the wall you can see examples of data centers from around the world. The centers represent a new form of architecture that sometimes is staged and interpreted as other types of architecture have been during centuries; as centers of power and knowledge. Elsewhere, the centers are considered only to be infrastructure. Sometimes it can even be difficult to distinguish the buildings from prisons or warehouses.

# GROW YOUR OWN CLOUD

The artwork Grow Your Own Cloud (GYOC) reinvents 'the cloud' by storing data in DNA from plants in the same manner as nature stores data. The art project seeks to create a new organic type of 'cloud' that emits oxygen instead of CO<sub>2</sub>.

The installation is a modern 'data garden'. It contains plants encoded with data and tools that the audience can use to experiment with decoding hidden messages. This involves advanced DNA data science, a technology that potentially is able to store all the data in the world in a single kilogram of DNA. GYOC works *with* nature instead of against it and strives to reduce the threat of 'data warming'. The work also invites visitors to experience data as an alternative material form, and to explore a world where data is once again an accessible private resource, that can be shared within the framework of an open society, in opposition to something stowed away on servers, owned by global corporations.

The artwork is the product of a collaboration between artists Cyrus Clarke (UK), and Monika Seyfried (PL), as well as researcher Jeff Nivala (US). The project is supported by Unlisted Projects (US), The Museum of Human Achievement (US), Danish Arts in Austin, Roskilde Festival (DK), and CATCH (DK).

# IMMERSION - LEARN MORE ABOUT YOUR DATA

On the table in the middle of the exhibition, the various technologies from the collection of the Danish Museum of Science & Technology are put into perspective through a number of books and articles. We have selected three relevant books, each with a unique perspective on data and privacy in our time.

*Permanent Record*, tells the story of Edward Snowden who broke with the American intelligence services and revealed that the American state was secretly trying to record every phone call, text message, and email. The result was an unprecedented system of global mass surveillance which was able to violate the privacy of every citizen.

*The Age of Surveillance Capitalism*, by Shoshana Zuboff describes the negative impact of digitisation and surveillance capitalism on democracy and personal freedom.

*Exposed - The limits of privacy in a digital age*, is a Danish anthology that investigates how we can ensure the privacy of citizens in a digital world. The anthology examines how the Danish public administration and private companies are

collecting and using personal data from Danish citizens to an extent that has never been seen before.

We are working on a collection of articles that can be found in the portfolio on the table. Here you can read about GDPR and the Danish data protection legislation, data centers, data and economics as well as about artistic initiatives and activism which looks critically on the use of and legislation on data. Please feel free to contact us at [mov03@helsingor.dk](mailto:mov03@helsingor.dk) if you have articles or know of themes that you would like to share with us.

## SHARE YOUR THOUGHTS

We invite all guests in the exhibition to share their experiences, thoughts, and knowledge, about data and data storage on the Post-it notes placed on the table in the exhibition hall. You are welcome to use the opportunity to tell about your favourite data, where, and how you would imagine to store data in the future, or maybe you could tell about uncertainties related to where and how you store data today?

