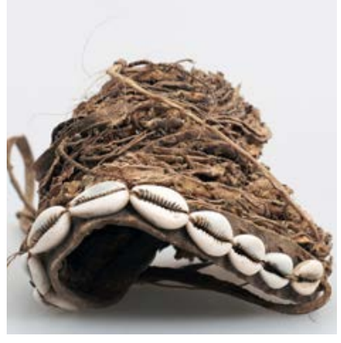
Researching museum objects using AI

German museums contain hundreds of thousands of objects that came to Europe through war, looting or trade during the colonial era, for example. However, in many cases the documented history of these objects – where they come from, what purpose they served, and who once owned them – is incomplete. This is where an interdisciplinary research team led by historian Prof. Dr Dagmar Freist comes into play. In the project Provenance and Collection Research Digital (ProSaDi), the team is working with researchers from the countries of origin to fill in the gaps for two types of collection items selected as case studies, as well as developing digital techniques to process the data about the collection objects and make it easily and universally accessible. The Lower Saxony Ministry of Science and Culture (MWK) and the Volkswagen Foundation are providing just under 3 million euros in funding for the project over a four-year period as part of their Wissenschaftsräume (Science Spaces) funding programme.

The ProSaDi project was launched in response to the ongoing debate about the handling of museum artefacts from former colonial territories. Much of the information compiled by museums over the decades has yet to be digitised and often reflects racist and Eurocentric perspectives. The team will develop IT and AI-supported methods that can be used by museums and other institutions to digitally process and display information about their collections. The aim is to compile the data in a user-friendly infrastructure that allows for easy interconnection and retrieval. Together with international partners, the researchers will also examine the different forms of knowledge production used over time in German museums and in the societies of origin.

In addition, the ProSaDi team will closely interlink research and teaching at the intersection of AI and cultural heritage and develop new concepts for optimising this process. The project team has also enlisted the support of state museums, archives and the Provenance Research Network in Lower Saxony in order to pursue practice-oriented questions. The aim is to ensure that the results of the ProSaDi project are incorporated into everyday practice for museum and archive collections and also applied in the education sector.

The university is a partner in five other projects of the Wissenschaftsräume programme in the fields of physics, environmental sciences, education, sociology and economics.



Left: A headdress made of cowrie shells from Tanzania. The shells of cowrie snails feature in many collections. In the future, an AI will identify individual species.

Right: Jewellery from Oceania. The cowrie shells are woven onto a piece of string.

Below: This belt adorned with cowrie shells comes from the Iramba region in Tanzania.

Utilisation of waste heat from the Data Centre

The university has been recovering waste heat from its Data Centre and using it in its heating system since May of this year. The measure is part of the WärmewendeNordwest research project funded by the Federal Ministry of Education and Research (BMBF), which is headed by energy computer scientist Prof. Dr Sebastian Lehnhoff. The project aims to boost energy efficiency and develop solutions that can be transferred to other universities. The university's heating, cooling, ventilation and power generation systems, which have largely operated independently until now, will be optimised and interlinked in a smart network.

As a first step, the cooling water from the new high-performance computing cluster installed in 2023 will be fed into the university's heating network. The annual heat supply from the heat recovery system is around 500,000 kilowatt hours, which corresponds to the heating requirements of around 30 four-person households and represents a reduction of around 100 tonnes in CO_2 emissions.

Balancing inclusion and academic performance at schools

Measurable academic achievements in the form of grades are a key component of school education. Researchers from the University of Oldenburg and the Free University of Bozen-Bolzano (Italy) are now comparing concepts of academic achievement in primary school education in Germany and Italy and looking at ways to balance achievement, inclusion and educational equality in schools. Prof. Dr Michaela Kaiser is heading the APra project ("Achievement: A social practice in Primary School. An International Comparative Analysis on Germany and Italy"). The German Research Foundation (DFG) and the Province of Bolzano are funding the study over a three-year period with around 800,000 euros.

Properties of crystal surfaces

Prof. Dr Caterina Cocchi and Holger-Dietrich Saßnick from the university's Institute of Physics have developed a new automated method for calculating the physical properties of complex crystalline surfaces using only basic information about the crystal structure. In an article in the journal *npj Computational Materials*, the scientists report that their method can speed up the search for relevant materials for applications in key areas such as the energy sector. The two scientists developed a software programme that requires only the chemical composition of a compound as input in order to calculate the physical properties of the material's surface – for example, the amount of energy required to excite electrons or detach them from the surface. The researchers now plan to combine their method with artificial intelligence and machine learning techniques to further accelerate the process.

Improved battery manufacturing processes

Making European production of lithium-ion batteries more efficient and sustainable is the goal of BATTwin, a recently launched EU project in which the university is involved. Led by an Italian university, the project aims to create a "digital-twin" platform for European battery production plants by 2027. The digital twins in this project are computer models that replicate the processes in a battery cell production plant. A team led by Oldenburg computer scientist Prof. Dr Andreas Rauh is currently developing models that simulate the individual stages of battery cell production. The goal is to reduce scrap rates and minimise energy consumption and emissions during these processes, thus making the entire battery manufacturing process more efficient and environmentally friendly.

Converting carbon dioxide into useful chemicals

Harnessing the power of the sun to convert carbon dioxide into useful chemicals is the goal of a new junior research group at the University of Oldenburg. The international team of researchers led by Oldenburg chemist Dr Lars Mohrhusen is pursuing an ultra-sustainable strategy which involves developing precious metal-free catalysts that chemically activate carbon dioxide, a relatively inert greenhouse gas, using sunlight. The Federal Ministry of Education and Research (BMBF) will provide around 2.6 million euros over the next six years for the Su2nCat-CO project. Mohrhusen and his colleagues will focus on developing catalyst materials based on readily available and inexpensive components such as titanium dioxide and using them for the energy-efficient conversion of carbon dioxide into substances such as methane, methanol or formaldehyde which can then be processed into plastics or synthetic fuels. At present, most catalysts used for this conversion process contain precious metals. Besides requiring large amounts of energy to create the right conditions for the chemical reaction, these materials also have the disadvantage of being expensive and not very durable.

Dedicated to pain prevention

Teaching people in the German-Dutch border region how to prevent chronic pain and provide better treatment to those already affected is the goal of the project "Pain in the Ems-Dollart region: a hidden disease with far-reaching consequences", a collaboration between the University Medicine Oldenburg and the University of Groningen (Netherlands). Funded by the EU Interreg VI A Germany-The Netherlands subsidy programme, German and Dutch scientists and doctors from both countries are currently planning several initiatives within the project. Two key components will be coordinated in Oldenburg: a bilingual media campaign focused on educating people via social media channels about how to best deal with pain, and the development of pain management training programmes for healthcare professionals. The project will run until the end of 2027.

Genetic element could be a sensitive biomarker

A genetic element known as a plasmid which is found in the digestive tract of more than 90 percent of people in industrialised nations could be used as a biomarker to detect faecal contamination and other health hazards, an international team led by Prof. Dr Murat Eren from the Helmholtz Institute for Functional Marine Biodiversity has reported in the journal Cell. Plasmids are sequences of DNA that lie outside the chromosomes and are found in the cells of all living organisms. Identifying these sequences using current biotechnology tools has proven to be a difficult undertaking. The researchers therefore decided to use a new machine learning approach to analyse the genetic information in the human gut in its entirety. Using this approach, the team identified over 68,000 plasmids in the human gut flora and found one plasmid that was particularly prevalent in their dataset. This plasmid consists of only two genes, one of which is used for self-replication while the other enables transfer to other bacterial cells – no further benefit has been identified to date. Further analyses revealed that this particular plasmid is basically only found in the human gut and in environments influenced by humans. This means that it could potentially serve as a powerful biomarker for identifying health hazards such as contamination of drinking water.

New cause of hidden hearing loss revealed

Hidden hearing loss may have a different cause than previously assumed, a team of researchers from the Cluster of Excellence Hearing4all led by Prof. Dr Georg Klump and Dr Sandra Tolnai from the Department of Medical Physics and Acoustics have discovered. In experiments with gerbils, whose auditory range is similar to that of humans, the team found evidence that certain neurotransmitter receptors may play a decisive role in how the brain separates different sound sources from one another and enables directional hearing. Directional hearing is an important prerequisite for tuning into the desired sound source and being able to comprehend it in situations where there is a lot of competing background noise. When it becomes increasingly difficult for a person to hear properly in a noisy environment, this is known as hidden hearing loss. Up to now it had been assumed that damage to the inner ear – caused, for example, by exposure to loud music – was responsible for this form of hearing loss.

Outlooks

When will cancer become less frightening?

Prof. Dr Frank Griesinger
Internal Medicine / Oncology

When a patient is diagnosed with cancer, their world falls apart. In that moment, only one thing matters to them: can it be treated?

In recent years, cancer treatment has advanced dramatically thanks to progress in molecular medicine, which provides insights into which molecular properties facilitate tumour growth – and which drugs can inhibit it. This has taken precision oncology, or personalised cancer treatment, a huge step in the right direction. Another approach that has become established in the past decade and is used to treat many types of cancer are drugs known as immune checkpoint inhibitors, which make cancer cells visible to the immune system.

These and other effective innovations are constantly being refined – and new ways to help patients are being added to the list. The next major breakthrough could come in the form of an mRNA vaccine against cancer. The idea here is to use AI-assisted processes to develop vaccines designed to target the specific characteristics of each tumour based on individual tumour samples and the patient's individual immune system. The vaccine then functions like a cheat sheet, telling the immune system how to recognise the tumour so that it can fight and destroy it.

Innovations like these show that cancer treatments are becoming increasingly individualised and diverse because every cancer and every patient is different. This may not take the initial shock out of a cancer diagnosis, but it means that in the future we medical professionals will be able to respond more often to the question "Can it be treated?" with a confident "yes".