Ges tures

… movements, in particular with the arms, hands and head, serving interpersonal communication. They accompany or replace information in a spoken language, and give a visible form to our inner ideas.

In the **past** we swept crumbs off the table and, in a gesture, swept arguments aside.
In the **present** we swipe the screens of our devices.
And in the **future?**

We are in the middle of an epochal change. Gestures used for interpersonal understanding are increasingly expected to be part of human-machine communication as well. Gesture researchers and engineers are needed – and so are you as a road user – to ensure that a self-driving car understands a pedestrian's stop gesture.

The partners of the MANUACT interdisciplinary research project, the TU Chemnitz, the Saxony Museum of Industry Chemnitz, the Museum for Communication Berlin and the Ars Electronica Futurelab (Linz) as well as international artists, invite you to gain a new interactive insight into technology and gestures.

Off we go! Here you can

ges·ture

… making yourself understood using clearly perceptible movements of your arms and hands

re·search

… in contrast to chance discoveries, the systematic search for new insights, as well as the work documenting and publishing them

Research into Gestures

Ever since humans have existed, so have gestures. But gesture research is still very new. Linguists only first started looking at non-verbal communication in the last century. As technical devices have come to be controlled by gestures, the research field has expanded.

How are gestures researched?

Gesture classes create order in the wealth of gestures. Important points of reference here are how an object is represented in gestures and the various ways of executing one and the same gesture. The temporal sequences show when we come to the point 'gesturally'. But a certain caution is also needed. In different cultures, gestures can also be read in other ways or not understood at all …

Follow the pointer for some surprising insights into gesture research!

Subject 1.1

a class of its own

… defined by qualities common to all objects in that class

Gestures are divided into three major classes.

? **Co-speech gestures**	! I also express what I say with my hands, arms and whole body.
? **Emblems, emblematic gestures**	! My gesture is a fixed sign. It conveys a clear message e. g. thumbs up.
? **Signed languages**	! 'Words' signed in non-verbal languages – for non-signers the 'vocabulary' of a foreign language.

Sign languages are no way inferior to spoken languages. When combined, manual signs build complex groups of words and sentences. Their form and meaning are listed in sign language dictionaries. This is very different from co-speech gestures, which can only be understood in the context of the spoken word. Emblematic gestures are located between these two gesture classes. Within a cultural community, these are fixed and are often function without spoken words.

Subject 1.2

rep·re·<u>sent</u> something

… describe something to someone in a particular way

Co-speech gestures may point to objects or imitate their use and form. Just as the ways of pointing can be different, so too can imitative gestures**. Following Cornelia Müller, gesture researchers distinguish four gestural modes expressed by the hands.***

? **The hand (en-)acts.**	! I imitate a hand position.
? **The hand moulds.**	! I form a fleeting three-dimensional figure.
? **The hand draws.**	! I sketch a two-dimensional outline, often using my index finger as a 'pen'.
? **The hand represents.**	! My hand stands for the object.

* Cornelia Müller, "Gestural modes of representation as techniques of depiction", *Body – Language – Communication An International Handbook on Multimodality in Human Interaction.* Berlin.

Subject 1.3

working with a **sys·tem**

… a set of rules to organise something

When we gesture, our hands have considerable freedom. To systematically describe the diversity of possible gestures, researchers apply four key parameters. These are based on the ground-breaking work by American linguist William Stokoe (1919–2000) in his research into sign language notation in the 1960s.*

? **Handshape**	! For the 'V for victory' gesture, for instance, I extend the index and second finger in a v-shape.
.	
? **Orientation**	! The palm faces away from the body. If I turn the palm towards my body, I change the 'V for victory' into a sign that, in the UK, is insulting.
? **Location**	! Held behind my head, the sign for victory signifies 'rabbit's ears'.
? **Movement**	! If I move my hand with the fingers in a v-shape to and fro over my head, I am signing 'peace'.

* William C. Stokoe (1960): *Sign Language Structure. An Outline of the Visual Communication Systems of the American Deaf*. Buffalo.

Subject 1.3

Gesture space … upper, lower, right, left, front, back … Explore all the options!

Try different gestures in different positions in gesture space – the 'victory' gesture is ideal as a warm-up exercise.

To describe our hand positions when gesturing, psychologist and gesture specialist David McNeill divided the space in front of our bodies into various areas.* Most of our gestures are in the centre area at stomach height. But we also frequently gesture to the sides. If we use our index finger to point to things around us, we sometimes move our hands into the extreme periphery of our bodies. To imitate large objects, we may even use the upper or lower areas above our heads or below our upper bodies.

* David McNeill (1992): *Hand and Mind. What Gestures Reveal about Thought*. Chicago.

Subject 1.4

in **pha·ses**

… temporal periods within a development

Co-speech gestures not only reveal their meaning in space, but also in time. Gesture researchers divide the temporal sequence into gesture phases – similar to a dramatic composition.

? Resting position	**!** My hands are not moving when I am talking.
? Preparation	**!** I initiate a gesture to accompany my verbal expression.
? Stroke	**!** The phase when the 'apex' of the gesture is reached. At this moment, my hands most forcefully express the dynamic of the gesture.
.	
? Retraction	**!** The tension in my hands relaxes and they retreat towards the resting position.
? Resting position	**!** I continue to talk, but without moving my hands.

Subject 1.5

gesture **cap·ture 1.0**

… documenting gestures in images, audio or writing.

David Efron (1904–1981) was the first researcher to capture gesture phases on film, allowing them to be objectively studied. In 1941, he published his systematic and intercultural comparative analysis.*
He observed immigrant Sicilian and Lithuanian Jewish communities in Manhattan, noting how their increasing assimilation also reduced the differences in their gestural repertoire.

In a similar way to the work of Leipzig psychologist Wilhelm Wundt (1832–1920)*, Efron's study was pioneering in gesture research since he established another key principle in gesture classification and typology. In addition, Efron's research marks the start of modern techniques to record and analyse gestures.

* David Efron ([1941] 1972): *Gesture, Race and Culture*. Den Haag.

* Wilhelm Wundt ([1900] 1904): *Völkerpsychologie. Eine Untersuchung der Entwicklungsgesetze von Sprache, Mythos und Sitte*. Vol. 1. Leipzig.

Do you wear 'ornamental gestures'?
Try it out and hold your gesture for a moment!

Psychological research claims that if we take a particular pose deliberately we feel just the same as if we adopted the pose naturally … What do you think?

Subject 1.6

phenomenal **mul·ti·<u>mo</u>·dal**

… simultaneously through various sensory channels.

Anthropologist Adam Kendon, a leading authority on the study of gesture, believes that co-speech gestures and spoken language are part of one and the same expressive process.* He refers to this interplay as:

? multimodality

! I do not only speak with my mouth, but also with my hands. Since I am not only audible in conversation, but also visible, what I want to say can be best fully understood through the various modalities of the senses.

* Adam Kendon (1980): Gesticulation and speech: Two aspects of the process of utterance. In: Mary R. Key (ed.), *The Relationship of Verbal and Non-verbal Communication*, Den Haag et al, pp. 207–227.

The interplay of speech and gesture becomes especially clear when you omit the audio or visual track in a film sequence. Although what we see or hear is informative in its own right, it needs to be supplemented to varying degrees.

🗗 **Have fun with our 'gesture puzzle'!**

Subject 1.6

Words are listed in dictionaries – and ordered alphabetically. But how do you order gestures? Certainly not by their initial letter! Instead, they can be classified by the parameters of handshape, orientation, movement and location.

The ‘Verb Cloud’ is a sort of interactive gesture lexicon. The verbs are linked to video sequences including explanations by a chair maker and putting up Ikea shelves. Here, gestures express the inner idea of the processes and objects. But why are there different versions of gestures for the same verb? Do different narrators use the same gestures? What is the link between related verbs and related gestures?

‘Thumb’ through the gesture lexicon!

Chose a verb and decode the interplay of word and gesture. Actively experience the task facing every gesture researcher – grouping and classifying. The buttons ‘root’, ‘handshape’ as well as ‘handshape and movement’ can help you associate and organise the gestures.

Subject 1.7

in **retro·spect**

… looking at the past

Take a trip back in time! Look in our mirror and try out a historical gesture!

Neapolitan archaeologist Andrea de Jorio (1769–1851) is regarded as the first ethnographer of gestures. He noticed how many of the gestures in the Roman frescoes in Pompei and Herculaneum were still used on the streets of Naples. De Jorio's descriptions and drawings evidence at least the formal continuity of certain gestures from antiquity to the present day.*
John Bulwer's (1606–1656) *Chirologia* from 1644 is one of the very first scientific works on gestures.* Yet even in the *Sachsenspiegel*, the most important law book in the Middle Ages, the figures in the illustrations use markedly exaggerated gestures.*

* Andrea de Jorio (1832): *La mimica degli antichi investigata nel gestire napoletano*. Naples.

* John Bulwer (1644): *Chirologia, or, The natural language of the hand* […]. London.

* Universitätsbibliothek Heidelberg, *Heidelberger Sachsenspiegel* (Cod. Pal. Germ. 164)

a **view into the dis·tance**

… a sweeping view of something far off, usually also facilitating an overview

Join us on a long-distance journey! Try out an indigenous Australian animal gesture and view your mirror image!

In the nineteenth century, the problem of recording gesture also arose in encounters with other cultures. For example, the work of British anthropologist Walter Edmund Roth (1861–1933) contains exact descriptions of sign language used by indigenous Australians.* The gestures, illustrated by precise drawings, describe animals. Even now, the drawings still offer a vibrant insight into how the gestures were made and the principles underlying them.

* Walter E. Roth (1897): *Ethnological Studies among the North-West-Central Queensland Aboriginals*. Brisbane and London.

"Side note"

Gesture sculptures

Gestures are transient signs. They seem to pass without leaving a trace. Yet every gesture also has its own form which those talking, as well their counterparts, perceive and interpret physically and visually. At the RWTH Aachen, a process was developed to visualise the invisible traces of movement, capturing the fleeting and momentary. Using motion capture technology, the hand movements recorded were calculated as models and printed in 3D. As materialised gestures in real space, the resulting fragile sculptures illustrate the dynamic of physical forms of expression.

Materialised gestures (1): Draft description of the Documenta archive building, Kassel, 2017
"That was the idea: a kind of plinth on the square... and set on it a filigree construction, temporary, wafer-thin, with the individual archive points in the construction" (05:28–05:41)

Lead: Hannah Groninger and Natural Media Lab (Irene Mittelberg)
Technical realisation: Tobias Heimig
3D print: Fabri-Lab
On loan from RWTH Aachen, Department of Sculptural Design

Subject 1.8
primarily **evo·lu·tio·nary**

… developing slowly and gradually – in a narrower sense related to genetics and the history of the species

? Primate

! I am one.

The hand plays a preeminent role in evolution. It allows primates to grasp objects and use them as tools. But in contrast to an ape's hand, the human hand has two particular qualities – a long, flexible thumb and a powerful little finger able to rotate and flex to the thumb. Moreover, for humans it is child's play to move the fingers independently – with the exception of the ring finger. A perfect basis for gestures!

The mobility and dexterity of our fingers is also due to us no longer needing our hands for walking …Looking ahead, one could now ask: How far do humans change when tools and hand movements are replaced or disappear entirely?

? **Robot**

! From the Czech: *robota*, meaning serf or forced labour – Will robots be servants, friends or just machines?

Robot arms are specialised for particular tasks. In recent technologies, though, many features imitate the multifunctional human hand. But they also go beyond the limits of the human hand. For example, they can move especially heavy objects or rotate 360 degrees…

Operate a gripper arm yourself!

"Side Note" 1.9

Gesture **cap·ture 2.0**

… record in writing, (moving) images or electronically

Gesture researchers use a variety of recording techniques. For a long time, they only had drawings to help them in their work. Precise images of movement sequences only became possible after the invention of photography and film. The last years, though, have seen the emergence of new technologies.

? **Motion capture**

! Markers on hands or data gloves allow gestures to be recorded by special cameras.

? **Non-invasive methods**

! Recording techniques interfering with processes as little as possible, e.g. sensors working with structured light, recording muscle activity or using radar.

Recording techniques

Mechanical tracking using a ShapeHand data glove
ShapeHand captures many finger, thumb and hand joint movements, as well as complete hand and arm movements, and poses. The data glove has 40 flexible external bend sensors (8 sensors on each finger/fibre optic band) conveying data on how far a finger is bent. This information allows the angle of the finger to be calculated.

Marker-based tracking
This optical tracking process uses specially attached reflective markers. The system comprises six OptiTrack cameras equipped with infrared LEDs so the markers reflect towards the cameras. The reflected light is captured by the camera lenses, supplying the necessary data to record a movement in space.

Markerless tracking with Kinect time-of-flight cameras
The Kinect depth camera operates rather like an echo sounder with time-of-flight techniques. After emitting an infrared pulse, the camera individually measures for each 512 × 484 pixel the time of light travel before an object reflects the light back to the sensor. The data gathered supports a reconstructed 3D-image of the scene in front of the camera. Thanks to the extreme wide-angle camera lens, it can capture a full image of a standing person at a distance of one-and-a-half metres.

Myo armband – Gesture control through muscle activity
With its eight EMG (**e**lectro**m**yo**g**raphy) sensors, the Myo armband measures the electrical activity of muscles to detect five different gestures. These five hand movements are making a fist, wave right, wave left, spreading the fingers, and a double tap using finger and thumb. Thanks to its 9-axis IMU (inertial measurement unit) of position and tension sensors it can read the movement and rotation of the forearm. Via a Bluetooth Smart connection, the Myo armband communicates the commands to technical devices.

Project Soli – A radar technology to recognise gestures
The Soli sensing technology emits electromagnetic waves in a broad beam. Objects within the beam scatter the energy, reflecting some part of it back towards a radar antenna. The interaction sensor is so precise that it can even exactly track sub-millimetre hand movements at high speed. Soli enables the control of devices with a simple set of gestures. These gestures – known as Virtual Tools – mimic familiar interactions with physical tools.

Leap Motion – Gesture recognition with infrared LEDs and infrared cameras
The Leap Motion Controller is a small USB device with two cameras and three infrared LEDs which transform a limited space into a 3D interface. The large angle of view of around 150 degrees detects movement in a hemispherical space at a distance of around one metre. The device ‘tracks’ the hand’s position in this space at a rate of up to 200 frames per second. Leap Motion uses infrared cameras and advanced mathematical algorithms to translate the hand and finger movements into 3D data. A diagnostic visualizer then transfers this into a sort of skeletal view.

Do not touch! Work the marble labyrinth using Leap Motion – just with gestures.

Subject 2

Hand grip

… to carry out a task, a hand movement belonging to an activity

From hand grip to gesture control

Concrete actions, gestures in interpersonal communication and gestures to control interfaces or interact with virtual objects are not the same, even if they may be very similar – and this has inspired the **MANUACT interdisciplinary research project**. **It brings together specialists in linguists and ergonomics to investigate how gestures are derived from manual actions and how far they are suited to human-machine communication.**

In future, will we control our world – intuitively and contactless – with the existing repertoire of everyday gestures? Or do we need to learn new gestures for each device?

Subject 2.1

<u>ar</u>·chi·ving knowledge

… long-term storage for posterity, preserving it and making it available

? Gestures are a repository
someone
of knowledge
promise

.

! I turn an imaginary handle to ask
in a car to open the window and
'I'll call you' with a gesture recalling an
old-fashioned telephone handset.

Gestures often lag behind technical advances. Our devices constantly evolve and develop and, along with them, so do the hand grips needed to operate them. Gestures and language take much longer to change. Since some gestures derive from operative processes, they form a bridge to earlier technologies.

The 'phone gesture' – from telephone to smart phone

'I'll call you!' – Many years ago, did people hold their fist to their ear to symbolise a phone's earpiece? Or did they turn an imaginary rotary dial? Today, the most common gesture for phoning is holding the hand with splayed thumb and little finger to the cheek. The gesture represents a phone receiver with microphone and earphone, even if the phone now looks different – and is frequently operated in a completely different way.

How will things look in future? Will phoning be visible at all in future? And which gesture will then signal 'let's phone …'?

Subject 2.2

as **me·ta·phor**

… transferring from a primary context into a different one

? Using gestures metaphorically

! I also use the stop gesture figuratively to emphatically reject or deny something
– not only to stop someone.

Which gesture could be suitable to operate a virtual globe?
An aeroplane flying across the world! The MANUACT project's pilot study on using Google Earth showed how productive test subjects found the 'aeroplane gesture' for navigating a virtual globe. The study's findings suggest that metaphorical gestures allow digital human-machine interfaces to be far more intuitively designed.

The 'aeroplane gesture' – From pushing to flying high

Our globes from yesterday and today highlight the progressive decoupling of cause and effect. Increasingly, globes can be rotated without touching them. The human movement to trigger the globe's rotation is reduced to merely pressing a button. But the interactive future of a spherical model of the Earth offers itself to metaphorical gestures.

Make the globe rotate – and fly away!

❐ Try the 'aeroplane gesture' to navigate the virtual globe!

Subject 2.3

hạnd·le

… use (properly)

? **analogue tactile handling**

! The force of my hands has an immediate– real – effect, e.g. giving clay a particular shape.

How does this relate to gestures? Imitative gestures may be based on how we handle things in reality. Hand movements can evolve into communicative gestures by becoming detached from a concrete object. This detachment also applies to interface-oriented handling. Since this lacks direct causal relationships or haptic feedback, we can also talk of gestures here, even though there are fundamental differences to interpersonal communication.

? **digital interface-oriented handling**

! With my gestures, I model a virtual form which – after data capture and processing – becomes visible on a monitor.

So are we facing the end of apprehending things – in both senses of the word – as we know it? Or will there be a future where the virtual feels very real?

Subject 2.4

Spinning– past > present > future

The technique of spinning does not just involve one hand grip, but three hand movements: stretching the fibre to be spun, then twisting and finally winding the yarn. In the traditional method of spinning with a spindle, twisting the yarn had to be interrupted to wind it. The medieval spinning wheel first turned spinning into a continual process. The eighteenth-century invention of the 'spinning jenny' was a crucial step. Here, the machine took over the hand movements of holding and controlling the fibre to be spun into yarn.

Chronology of spinning
ca. 4000 B.C. hand spindle
After 1000 A.D. manual spinning wheel
ca. 1480 Saxony wheel (spinning wheel with flyer)
ca. 1530 treadle spinning wheel
1767 Hargreaves' spinning jenny
1769 Arkwright's spinning frame machine
1779 Crompton's spinning mule
1790 Hand-operated mule
1825/30 Self-acting mule
1828 Ring spinning frame
1967 Rotary spinning machine

Subject 2.5

Clay modelling– real > gestural > virtual

The earliest known ceramics today are handmade clay figures from around 25,000–29,000 years ago. The first potter's wheel was invented approximately 5,000 years ago. Down the centuries, the hand movements used by potters have hardly changed – in contrast to the potter's wheel itself. Today, ceramics are produced in very many different ways. Industrial pottery, for example, uses a rotating roller-head to press the clay body into a mould. The roller-head and mould replace the potter's hands, though without copying the hand movements. And in future? Could the art of pottery be practiced virtually?

Chronology of pottery making
ca. 25000 B.C., first ceramic figures (shaped freely by hand)
ca. 3000 B.C., potter's wheel, previously coil technique
4th century B.C., first foot-powered potter's wheel in the Mediterranean region
By ca. 500 A.C., hand-operated wheel or flywheel
13th–19th centuries, medieval disc wheel
16th century modern spindle wheel (Italy)
1809 Invention of mechanical press-moulding
1959 Injection moulding process for ceramics

Clean-hand pottery – using a virtual potter's wheel!

Try out our interactive potter's wheel and create a pot just by gestures alone!

If you observe the shape of the modelling movements at the interactive potter's wheel, you'll certainly notice similarities to gestures in interpersonal communication. In both cases, the wall of a three-dimension, transitory sculptural vessel is formed which differs from the basic activity of modelling clay in two key aspects: first, no real clay wall of a vessel is made and, second, there is no haptic feedback – you literally have 'nothing' in your hands, and yet a 'communicative' success.

Subject 3

In·dus·trial cult·ure

… comprises the entirety of the material and immaterial goods characterising the industrial era

Industrial culture: expanding and reducing the hand

Historical machines cannot be fully understood without information on the hand movements to operate them. This motoric knowledge is an essential part of our industrial culture.

With industrialisation, the hand's function changed. Tools expanded the hand's abilities, while automation reduced it to uniform movements. Robots completely replace the human hand – using very similar sequences of movements.

The manual work of the industrial future?
Gestures!?
Welcome to the interface to the future!

Subject 3.1

using **tools**

… an extraneous object expanding the capabilities of one’s own body

? Expanding the hand

! From the hand axe on, humankind further refined the hammer and associated tools down the centuries to intensify the targeted force effect of our hands as much as possible.

The incredible hammer!

An aid for hammering or forging? Since the Stone Age, the hand axe was the universal tool. Later, this first evolved into the stone hammer and then the metal hammer. The initial mechanisation of the forging process led to the water-powered hammer mill of the Middle Ages. Its shape was based on the hand hammer – and the associated movement was transferred to a simple machine. With industrialisation, forging was partially replaced by other shaping processes such rolling or pressing. Here, large steam hammers or smaller spring hammers opened up new possibilities.

Chronology of the hammer
1.76 million years B.C. first hand axe
9th century B.C. iron hammer
13th century spread of (water-powered) mechanical hammers
16th century drop hammer
ca. 1840 steam hammer
1867 spring hammer

Subject 3.2

design further **au·to·<u>ma</u>·tion**

… so evermore processes can run without human assistance

? Reducing the hand

! In an era where specialised machines also carry out many formerly skilled manual activities, our hand grips for very diverse tasks are reduced to uniform movements – e.g. pressing a button.

The special feature of modern gesture control is a renewed diversity in operating movements. However, they lack any direct causal relationship with perceptible feedback.

Automobile! Automatic. Autonomous?

Originally, a worker used a multiplicity of hand grips to manufacture a car part. The introduction of assembly line production enabled many more cars to be constructed in the same time. But this dissected work processes into discreet, precisely defined hand grips performed sequentially. The work became repetitious and monotonous. Over the years, machines or robots took over more and more individual production steps. In the smart factories of the future, the workpiece will ultimately communicate directly with the machine. Humans will then just have a control and surveillance function – probably via gesture-controlled interfaces.

‘Hand in hand’ with a robot?

Many people fear the use of robots will leave them unemployed. Recent developments in robotics seek to turn this forbidding machine into a helpful colleague. The Kuka LBR Iiwa 7 on show here can register and copy a human’s hand movements. So in a certain sense, it learns from its human colleagues**. Is this a glimpse of the future of human-machine cooperation?**

Subject 3.3

A window to the world – a digital interpreter for deaf-blind people

Often, deaf-blind people lead very isolated lives. In many countries, the LORM alphabet is one of the few methods they can use to communicate. In LORM, deaf-blind people use tactile and stroke movements to write messages in another person's palm. But this only works where both know the LORM alphabet and are close enough to touch each other's hands.

At the Design Research Lab of the Berlin University of the Arts, a team led by Tom Bieling is working closely with those affected to research into technical solutions. Using the LORM Hand, the LORM alphabet can be translated into digital text or decoded. Using touch sensory technology, the message is read and sent by SMS and email, as a spoken message or shared on Facebook and Twitter (@LormHand). Tiny motors in the LORM Hand enable it to transform messages received into vibrations able to be read by the user. In this way, deaf-blind people around the world can communicate with one other.

Subject 3.4

tomorrow's **fu·ture**

… the time subjectively following the present – once with a religious dimension

Even rhetoric in the classical world describes the power of gestures. In future, gestures may also be the first choice for interacting with technology.
Today, researchers are already working on gesture controls for industrial robots, cars or the smart home. Sensors for video games can transfer movements to avatars and allow players to become immersed in virtual realities. Robot arms can be made to operate in particular ways, repeating a programmed action.

Gestures based on our natural repertoire promise intuitive human-machine communication. But where will gesture control be fully accepted? And what is just gimmickry?

Gesture control – contactless, but with haptic feedback!

? **Haptic feedback**

! In future, for example, if I get into a gesture-controlled car, ultrasound sensors will tell me when my hands are correctly in the operating field. And I will receive tactile feedback on the gestures executed.

Try out the Ultra Haptics interface in Bosch's new concept car.

In 1900, a group of French artists around Jean-Marc Côté created their visions of the future. Their works show the world a hundred years later – as they envisaged it in 2000. Some things have become reality, others still seem absurd and bizarre.

What do you think? What does a gesture-controlled world look like? How does this impact interpersonal communication? How will we be using our hands in 2119?

Outro

take a moment to **re·fl<u>e</u>ct**

… ponder, contemplate, think it over, …

Say goodbye with your favourite gesture!