Intelligent machines support humans. Where a delicate hand is required, autonomous intelligence allows assembly processes to be performed with less repetitiveness, fewer errors and reduced fatigue.

Artificial cognition requires many skills.

Superbly networked

What is second nature for humans presents an enormous challenge for machines: recognizing the environment and reacting to it flexibly. So how can this be realized in computer architectures, machine control systems, and robotic designs?

Cognition technology poses all kinds of questions in brain research, psychology and biophysics, computer science, mechanical engineering, control engineering and mechatronics – questions that are being answered in close, interdisciplinary collaboration. Since 2006, CoTeSys has pooled the expertise of around 100 scientists of the Technische Universität München, the Max Planck Institute of Neurobiology, the Ludwig-Maximilians-Universität München, Universität der Bundeswehr – the German Federal Armed Forces University of Munich and the German Aerospace Center DLR in Oberpfaffenhofen. CoTeSys is financed with federal and state funds through the German Excellence Initiative.

The Excellence Cluster CoTeSys - Cognition for Technical Systems

Participating research institutions

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- Ludwig-Maximilians-Universität München
- Universität der Bundeswehr München
- Max Planck Institut of Neurobiology
- German Aerospace Center (DLR)

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Into the Future with Intelligent Machines

Intelligent machines are a key technology of the 21st century.

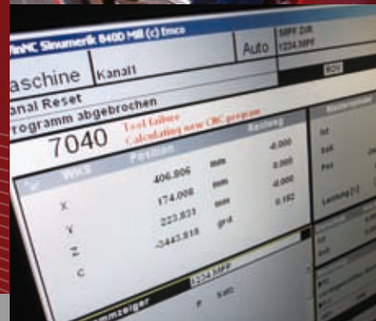
CoTeSys develops intelligent technology

Computers have become commonplace on desktops and in machine tools. The next evolutionary step will be machines that learn, decide and act autonomously and adaptively – with the goal of supporting humans, either as all-round robots in industrial production or as helping hands in nursing and in the household.

Cognition technology is the crux. In order for machines and humans to work together, machines must learn to accomplish tasks the way humans do – without rigid programming. They must be aware of their environment and react flexibly. This is the goal of CoTeSys, the Cluster of Excellence Cognition for Technical Systems, coordinated by the Technische Universität München.

Technology requires human support, especially in unusual situations, for example when a drill bit breaks. In manufacturing, unforeseen events are on the order of the day.

Intelligent machines look for alternatives autonomously when tools break, allowing production processes to continue until spare parts become available.



To build machines that can support us intelligently we need to understand the way the human brain works.

Learning more about our brains

Artificial cognition calls for profound insight into the workings of the human brain. Before we can build machines that are aware of their environment and able to react flexibly, we must first learn how humans accomplish this task. This is why the CoTeSys team includes neurologists, brain researchers and psychologists.

For example, at the Ludwig-Maximilians-Universität, CoTeSys researchers are investigating the brain's ability to filter truly relevant information out of the permanent torrent of information we are flooded with. Or how humans can cooperate without constantly getting in each other's way. In another project, researchers are investigating how nerve cells react to visual information at lightning speed and how this can be emulated using technology.

For robots, humans are spontaneous and unpredictable.

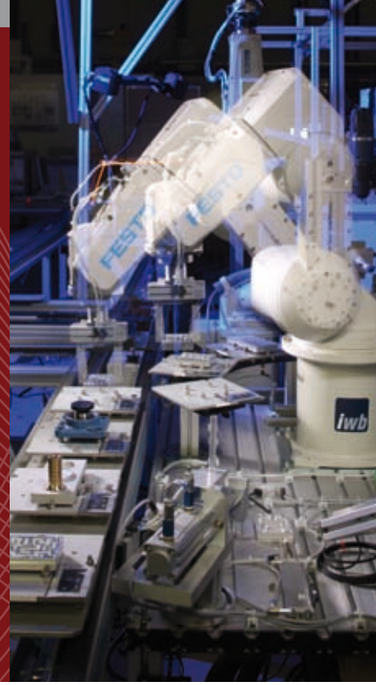
Working with partners

When machines and humans work together, machines must determine how they can best support humans – and not hinder or even harm them. This requires great cognitive skill and the ability to make flexible decisions.

Cognitive assembly assistance systems operate in the CoTeSys pilot factory. They support humans in assembling complex components and project instructions directly onto the workplace or onto head-mounted displays. Depending on the alertness of their human counterparts, they can selectively alter assembly programs to preclude monotony. They search for replacements when parts are missing and recognize instructions given as human gestures. No static computer program can do this kind of work; intelligent machines learn autonomously.

The CoTeSys service robot at work in the lab. When interacting with humans, facial expressions and gestures play an important role in communication.

Industrial products are increasingly tailored to very specific customer needs. Cognitive robots can produce different models simultaneously and do not break their stride when operational faults arise.



Working hand in hand. Robots must also learn the human skill of grasping objects.

Assembly instructions right on the workbench. Task-specific support is adapted to the human partner's level of alertness.

Computers are taken for granted when dealing with information.

Helping hands of the 21st century

In a few years, intelligent machines will not merely process information. To a large extent they will act independently on command. As helping hands they will attend to mundane tasks, support the handicapped and relieve us of tedious routine work. Service robots are the next growth market.

But mobile machines still have a lot to learn before they can provide meaningful services. For example, at the Technische Universität München they are learning to deal with everyday situations, to autonomously grasp contexts and actions, and to draw up their own work schedules. Service robots are the wishing tables of tomorrow.

Industrial products are tailored to very specific needs.

Production with maximum flexibility

The idea is to make assembly line production as flexible and intelligent as shop floor manufacturing. This can only be achieved with machines that autonomously recognize what is required and can flexibly adapt to accommodate variations. The operator simply tells a machine what to do and the machine will figure out how to do it – without time-consuming programming.

Test systems that autonomously adapt assembly processes are already operational in the CoTeSys pilot factory. They actively assist their human partners, reacting automatically in accordance with the situation – at one moment assembling a toy, at another piecing together a desk set, depending on the work pieces available. They support their human counterparts, even mindful of dwindling attentiveness and fatigue.