



Sector information

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Measurement and control technologies in Munich

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Sensors made in Munich: for a safer, healthier, more successful world

Sensors and actors made in Munich are to be found everywhere: on turbine blades, satellites, automobile brake pads and patient bodies, and in lakes, mobile telephones, shopping carts and the nuclei of individual atoms.

Working in networks of measurement and regulation, the sensors and actors calibrate and control trajectories (of spaceships, oncoming automobiles and electrons), size (of tumors, mountain peaks, steel slabs), weight (of milk being bottled, of scents wafting into our noses), smoothness (of freshly-cast glass, of moving parts in aircraft), position (of children on their ways to school, of drills boring holes into machined parts, and of lasers repairing corneas), vibration (of musical instruments and dam walls), temperature (of newly-born infants, of eons-old stars, of intruders breaking into homes), force (of a foot of a brake pedal, of a collision with another vehicle, of a CFC stopping a bullet), and composition (of blood, soil, smokestack exhaust and lake water).

The information supplied and the commands carried out by the sensors and actors are reducing malfunction, mishap, crime and cheating, and are increasing industrial, scientific and even cultural output and paces of innovation.

That sensors have become so omnipresent and omniscient is largely due to Siemens and its Munich-based progeny Infineon Technologies and EnOcean.



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Measurement and control technologies: the definition

Systems and their constituent components engaged in the measurement of temperature, speed, course, volume, level, tilt, position and other physical parameters; in the detection and determination of substance nature and characteristics; and in the monitoring and controlling of the operations of devices and facilities.

By rendering electric cables, batteries and any other source of power superfluous and by developing ultra-efficient signal transmission technologies, EnOcean has created a generator of put-them-anywhere, do-everything sensors and switches which procure their power from the user's touch, from vibrations in the air or from changes in temperature. These sensors are capable of broadcasting their information up to hundreds of meters away, and are thus able to be placed anywhere in a device or structure.

These are just a few of the world-changing products stemming from EnOcean GmbH. No wonder that the Davos-based World Economic Forum selected the Oberhaching-headquartered company to be one of its 'World Technology Pioneers' for 2006.

This is just the latest of the honors accorded to the company, which was founded in 2001 by Markus Brehler. Among the others: "Start Up of the Year", conferred in June 2006 by Hasso Plattner Ventures. It's a subject Plattner knows something about, having been one of the founders of SAP, the world's largest producer of ERP software.

The signal and energy generation technologies deployed in EnOcean's products were developed at Siemens, in a department run by Brehler, a graduate of the Technical University Munich. It was Brehler who presided over the spinning off of the company, whose development has been partially funded by Siemens. How well this development has been going is indicated by the fact that EnOcean's products are now bestsellers in the facility management and industrial technology sectors.

While helping give birth to self-powered measuring and broadcasting, Siemens' R & D departments were also coming up with a microscale capable of weighing of an individual DNA strand. The microscale technology, in turn, is at the heart of **Quicklab**, which won in November 2004 Germany's "Prize of the Future", awarded by the country's president to the year's most promising product.

The conferring was anything but a surprise. This smart card-sized product is able to do in an hour all of the blood analyses previously undertaken by a fully-equipped laboratory in two days. 'Quicklab' was created by a consortium featuring Siemens, Infineon Technologies and three other partners. At the heart of 'quicklab'



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is a chip capable of indicating and measuring - in electrical impulses - the presence and amounts of DNA and other substances in human blood. Coupled with a laptop, the new product gives physicians, criminologists and environmental detectives the power to make on-the-spot, detailed diagnoses.

The chip was developed by Infineon, which is the master in melding microsystem-based sensors with microelectronic circuits. Other prize-winning products from Infineon include sensors alerting drivers to loss of tire and brake pressure.

If weighing a single DNA strand sounds like the ultimate feat of measuring technology, go to Munich's northern suburb of Garching and the Max Planck Institute for Quantum Optics (MPIQO). A key player in the 12 institute, more than 50 companies-strong sector in the Munich region, the MPIQO, which was led for many years by Professor Theodor Hänsch, who won the Nobel Prize for Physics in 2005, achieved in autumn 2004 a feat which many had considered impossible: they measured the oscillation of light.

This is the shortest-lived phenomenon around. Light oscillates 1000 trillion times per second. This achievement came on the heels of another headlining-making accomplishment. The institute built a device capable of detecting one of the universe's weakest and most important phenomenon: gravitational waves.

Hard act to top, but MPIQO managed to do it. Working with Hänsch, Professor Ferenc Krausz first created a titanium-sapphire laser capable of generating X-rays lasting less than 300 attoseconds. An attosecond is the smallest unit of time around. It is one quintillionth--one billionth of one billionth--of a second.

With the help of a self-invented mirror, Krausz is now using the laser to track and measure the movement of electrons in atoms. This, in turn, will provide the scientific world with a powerful new tool: microscopes with a previously-unachieved resolution and rendition of space and time.

For his creation of what is now being called 'attophysics', Krausz won in 2006 German science's top honor--the €1.55 million Gottfried Wilhelm Leibniz prize. Krausz is now being touted as a candidate for a Nobel Prize. Should he some day receive such, he would be following in the footsteps of his mentor Hänsch and of Wilhelm Conrad Röntgen, the founding parent of the M & C community in Munich.



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Röntgen: the master of measurement instruments

Three decades of instrument building—one moment of world-changing discovery. That's the story of Röntgen and his X-rays. The three decades commenced when the scientist, who was born in 1845, was working on his dissertation, which he received in 1869. During this time and during his subsequent professorships, Röntgen developed instruments of unprecedented powers of optical and acoustic recording and measurement. He then used these instruments to track and calibrate the X-Rays, which he stumbled upon in 1895. To make sure that his inventions would be widely disseminated and used, Röntgen refrained from securing patents. This was carried on at TUM (Munich's university of technology) during Röntgen's 20 year-tenure there (1900 – 1920). Röntgen died in 1923.

Sensors, of course, form one part of Munich's M & C community. Handheld and stationary electronic devices are another. The leader in this area in Munich, Germany and in Europe as a whole is Rohde & Schwarz and has been for more than 70 decades. An area of specialty for R & S is monitoring communication networks. Each advance in mobile communications—including the forthcoming UMTS LTE (long-term evolution) generation of wireless applications—have been enabled by performance-assuring systems created by the company.

Major institutions of research and education

Munich is regarded as one of the five leading centers of high-tech R & D in the world. The patent figures back that up. In 2005, Bavarian-based companies and inventors received 13,688 patents.

Continuing one of the world's longest winning streaks, that was, by far, the highest total by any state in Germany or by any region in Europe. Bavaria's continent-leading position stemmed largely from Munich-headquartered companies, with their including Siemens (#1 in patents registered in Germany), chip-maker Infineon (#4) and BMW (#8).

As you would expect, these champion patenters maintain large-sized R & D staffs in Munich. Siemens and BMW for instance, each employ 10,000 researchers in the city.



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In addition to these companies, Munich's R & D community is comprised of the

- TUM (Technical University Munich)
- LMU (Ludwig Maximilians University Munich)
- University of Applied Sciences
- University of the Federal Armed Forces

and of six other institutions of higher education.

In 2006, news weekly **Focus** ranked TUM and LMU number one and two among Germany's 101 universities. This ranking was confirmed by the universities' being awarded a singular honor. They were selected in October 2006 by a panel of experts convened by the German government to be among the three 'elite universities' fast-tracked for further development into international centers of technological excellence.

Also forming part of Munich's R & D community are the

- Fraunhofer Society (with six individual institutes and its national headquarters in Munich),
- Max Planck Institutes (with fifteen individual institutes and its national headquarters in Munich),
- GSF National Research Center for Environment and Health (member of the Helmholtz Association), whose 24 institutes and units have more than 1,700 staff members
- German Aerospace Center, whose eight institutes have 1,050 staff members.

In Munich, 12 institutes devote themselves to developing measurement and regulation technologies.

TUM Technical University Munich

<http://www.tu-muenchen.de>

Most popular with international researchers. Best at securing outside funding (more than €133 million in 2005). Greatest breadth and depth of research. Best at turning innovations into market-making products—and scientists into entrepreneurs. The list of number ones accorded to TUM is long and impressive. No wonder that TUM topped the 2006 rankings of Germany's universities by Focus newsweekly. TUM was also selected in 2006 to be one of Germany's three "elite universities". As such, it is being fast-tracked for further development into a world-class university.

With campuses located in downtown Munich and in the northern 'tech suburb' of Garching, TUM has an enrollment of 20,500. Of them, 20% are non-Germans. The



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university's staff is comprised of 400 professors, 4,000 other researchers and 2,800 support personnel.

The university's M & C facilities include the

Institute for measurement systems and sensor technologies

<http://www.mst.ei.tum.de>

Director: Professor Alexander W. Koch

The institute creates laser based surface analysis systems, fiber optic sensors and image processing devices.

Chair of energy systems

<http://www.es.mw.tum.de>

Professor H. Spliethoff

The chair develops laser spectroscopy-based contact-less systems of measuring gas concentrations and water temperature and pressure. The systems are incorporated into power plants.

Institute for Machine Tools and Industrial Management

<http://www.iwb.tum.de>

Professors Michael Zäh and Gunther Reinhart

Thrusts of the institute's research are the concurrent and joint development and planning of production and assembly systems. Entailed in this is the creation and optimization of operation monitoring and control systems.

Institute for Applied Mechanics

<http://www.amm.mw.tu-muenchen.de>

Professor Heinz Ulbrich

The institute is a leader in the measurement and calibration of movement. It uses its findings to further the development of machines capable of ultra-precise, 3D motion, with these, notably, including robots.

Institute for Physics of Electronic Technologies

<http://www.tep.ei.tum.de>

Professor Gerhard Wachutka

The institute develops the technologies used in the creation, designing and optimization of sensors, actors and other electronic devices. A further specialty is the application of plasma to material engineering processes.

Chair of Geodesy

<http://www.geo.bv.tum.de>

Professor Thomas A. Wunderlich

The chair develops the technologies used in measuring the earth and its constituent parts. These systems are used in industrial operations, where they form the key components of quality assurance networks.



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Ludwig Maximilians University Munich

<http://www.lmu.de>

With 47,000 students, 700 professors and 3,000 researchers, LMU is the largest and—according to the rankings—finest university of the arts and sciences in Germany. Confirmation of the rankings' placements came from LMU's being selected as one Germany's three 'elite universities'. In view of these achievements, it's not surprising that LMU is also a favorite with non-German students, who account for 17% of enrollment. There are many companies and other non-university providers of research funds. These come to no less than €120 million a year.

Photonics and Optoelectronics Group

<http://www.phog.physik.uni-muenchen.de>

Professor Jochen Feldmann

One of the group's thrusts is the development of nano-scale particles capable of serving as sensors.

University of Applied Sciences Munich

<http://www.hm.edu>

The engineers and technicians graduating from the university are in high demand by potential employers. That's because the university's 41 degree programs, attended by 13,500 students and taught by 440 professors, are designed to meet the needs and wishes of today's companies. To that end, the programs are heavy on internships, case studies and on-commission research.

Faculty of High-Precision Mechanics, Microtechnologies and Physical Technologies

<http://www.fb06.fh-muenchen.de/fb/>

The faculty's Professor Hauke Clausen-Schaumann is playing a lead role in the work of the Nanosystems Initiative Munich. This cluster of excellence is developing an atom force spectrometer capable of measuring pico-newton scale forces with the utmost of precision.

University of the Federal Armed Forces

Institute for Measurement and Automation

<http://smarhome.unibw-muenchen.de/ima/>

Director: Professor Hans-Rolf Tränkler

The aptly-named "Smart Home" is the institute's house-cum-laboratory. The entire facility has been equipped with sensors detecting and dealing with any dangers to inhabitant safety, health and comfort. The institute also investigates and models sensor signals. This is a precondition for the developing of new measurement technologies.



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Chair of control and electric measurement technologies

<http://www.prof-boettcher.de>

Professor Jörg Böttcher

The chair is a leader in the development and deployment of technologies measuring radar and mobile communication signals, and of 'intelligent' sensors.

Max Planck Institute of Quantum Optics

<http://www.mpq.mpg.de>

Managing Director: Professor Ignacio Cirac

Located in the northern Munich suburb of Garching and founded in 1981, this institute has become a world leader in the measuring and manipulating of subatomic forces, with these including the oscillation of light and gravitational waves.

For his work in this field, long-term institute director Professor Theodor Hänsch won the 2005 Nobel Prize for Physics. A hot candidate for this prize is Hänsch's colleague Professor Ferenc Krausz. In 2006, Krausz won the Gottfried Wilhelm Leibniz Prize, the highest and largest (€1.55 million) award in Germany research. Krausz was honored for his measuring and mapping of electron movement within atoms.

Fraunhofer Institute for Reliability and Microintegration

<http://www.izm-m.fhg.de>

Director: Professor Herbert Reichl

The institute has revolutionized the way we monitor the environment and test substances. The institute has replaced the extracting and testing of samples with the deployment of a handheld device. It uses acoustic waves to determine the makeup of samples in-situ. The institute is also at the forefront of incorporating chemical and biomolecule-based sensors into supervision systems. This new technology gives environmental detectives, criminologists and others a powerful new tool in tracking down misdeeds.

Trade fairs and other events

ANALYTICA

April 1 – 4, 2008

Munich Trade Fair Center

Equipment for laboratories and other areas in which analytic tools are employed

<http://www.analytica-world.com>



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AUTOMATICA

June 10 – 13, 2008
Munich Trade Center
Systems automating assembling and handling operations; industrial imaging and positioning systems
<http://www.automatica-muenchen.de>

Laser. World of Photonics

<http://www.laser.de>
June 15 - 18, 2008
Munich Trade Fair Center
Optical technologies: equipment, devices and services

Sources of information and services

Chamber of Commerce for Munich and Upper Bavaria

Munich Office for Start-ups
Max-Joseph-Str. 2
D-80333 Munich
Tel.: +49 (0)89 / 5116-762
Fax: +49 (0)89 / 5116-764
<mailto:meb@muenchen.ihk.de>
<http://www.ihk-muenchen.de>
The Chamber of Industry and Commerce provides services and know-how to companies. This takes the form of technology consultation, establishing contacts to research and development institutes and supplying information.

Bayern Innovativ Corporation for Innovation and Knowledge Transfer

Gewerbemuseumsplatz 2
D-90403 Nuremberg
Tel. +49 (0)911 / 20 67 10
Fax +49 (0)911 / 20 67 17 92
<mailto:info@bayern-innovativ.de>
<http://www.bayern-innovativ.de>
The public sector corporation has a weighty brief: to stage events and to disseminate information which fosters innovation in Bavaria. To that end, Bayern Innovativ has staged since its founding in 1995 events leading to the forging of more than 3,000 inter-corporation working relationships. Linked via its Websites is its network of 40,000 companies and 400 scientific institutes. These are based in a total of 40 countries.



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BayernPatent

Fraunhofer Society for the Promotion of Applied Research

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<mailto:wolfgang.knappe@pst.fraunhofer.de>

<http://www.pst.fhg.de/bayernpatent/index.htm>

Coordinator: Dr. Wolfgang Knappe

Operated by the Fraunhofer Patent Center for German Research and founded in 2000, this Munich-headquartered agency markets the patents and other intellectual property (IP) created by 16,000 Bavarian scientists, many of whom avail themselves of the dedicated services offered by the agency.

Invest in Bavaria

Dr. Markus Wittmann

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<mailto:info@invest-in-bavaria.de>

<http://www.invest-in-bavaria.de>

The state's business development agency offers a comprehensive range of one-stop services, with these ranging from the provision of initial information to the accompanying of prospective investors on tours of potential sites.

City of Munich

Department of Labor and Economic Development

Herzog-Wilhelm-Str. 15

D-80331 Munich

Rita Müller-Roider, business development

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<mailto:rita.mueller-roider@muenchen.de>

<http://www.muenchen.de/arbeitsundwirtschaft>

One important job of the department is to help businesses go to and grow in Munich. To do such, the department supplies information and services enabling companies to secure premises, personnel, permits, contacts and other requisite items. In handling its brief, the department works with other public sector authorities and with professional organizations.

Munich Network - Netzwerk Munich e.V.

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<http://www.munichnetwork.com>

Munich has one of the five largest technology communities in the world. That the community is also one of the closest and hence most productive is thanks to the ties fostered by the network among its 280 members, which include tech developers, venture capital funds, service providers and others. Keeping Munich's economy on course helps the department handle its other key responsibility: promoting the city's business community on the national and international level.

Innovative companies

An unvaryingly high quality of performance—that's what operators expect their communication, transportation and manufacturing systems to achieve. This quality is assured by the M & C systems developed by such Munich-based long-term champions as

Rohde & Schwarz GmbH & Co. KG

<http://www.rohde-schwarz.de>

For more than seven decades, the company has been Europe's leading manufacturer of electronic systems used in monitoring communication systems and their components. The Munich-headquartered company has more than 6,800 employees and an annual turnover of more than €1.3 billion. Newest products assure performance of WLAN end-devices and of UMTS networks.

Sensors form the heart of measurement and control devices. The world's most advanced sensors stem from Siemens and its corporate progeny...

Siemens AG

<http://www.siemens.com>

The technology giant's Automation & Drives division is one of the world's leaders in the development, installation and maintenance of wireless, self-powered sensors. These are placed in trains, power plants and in and on anything else with mission-critical moving parts. Another specialty: the sensors at the heart of biometric devices

EnOcean GmbH

<http://www.enocean.com>

Sensors and switches capable of procuring their own power from the user's touch, from vibrations in the air or from changes in temperature, of broadcasting their



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information up to hundreds of meters away, and of thus able to placed anywhere in a device or structure.

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Infineon Technologies AG

<http://www.infineon.com>

One of the world's major microelectronics companies, Infineon is a leader in the developing and manufacturing of ultra-compact, microelectronics-based sensors forming the hearts of in-situ automotive-use pressure monitoring, rollover sensing and anti-lock brake systems. Other corporate sensors detect and measure magnetism, temperature, pressure, position, distance, direction, speed and combinations thereof.

Epcos AG

<http://www.epcos.com>

The world's second largest producer of passive electronic components manufactures a wide range of sensors.

... and from other Munich-based companies

MEL Mikroelektronik GmbH

<http://www.melsensor.de>

Produces systems controlling the operations of automatic paint lines; also develops laser-based quality assurance systems used to monitor welding robots

MESSRING Systembau MSG GmbH

<http://www.messring.de>

Produces and distributes sensors and sensor-based systems determining course and force of motion, plans and assembles crash test facilities

Soliton GmbH

<http://www.soliton-gmbh.de>

Produces optical measurement systems, interferometers, laser-based machining systems and much more

STM Sensor Technologie München GmbH

<http://www.stmsensors.de>

Producer of subminiature and optical sensors, of high-performance optronic systems and of photoelectric barriers



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As many of Europe's leading manufacturers and providers of technical services are based in Munich, it's not surprising that M & C companies specialized in providing industrial applications flock to the region.

Bourns Sensors GmbH

<http://www.bourns.com>

American-owned producer of sensors and potentiometers used in the automotive and electronics manufacturing sectors

Emerson Process Management Manufacturing GmbH

<http://www.emersonprocess.de>

American producer of devices managing industrial processes

Gretag Macbeth GmbH

<http://www.gretagmacbeth.com>

Now part of America's X-Rite group, the company is the leading producer of devices measuring intensity of color.

LDS Test and Measurement GmbH

<http://www.lds-group.com>

British-owned supplier of technologies measuring voltage, vibration and communication signals.

Thorlabs GmbH

<http://www.thorlabs.com>

The New Jersey-headquartered company distributes equipment measuring and controlling polarization, among many other items of photonic development.

This sector information has been carefully researched and diligently compiled. Nevertheless, the City of Munich does not accept any liability or give any guarantee for the validity, accuracy and completeness of the information provided. Please direct any questions, comments or suggestions to:
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