

PRESS RELEASE

SENSOR MARKETS 2008

The most comprehensive, latest market analysis
on the worldwide development of sensors and their applications

Important results of the new international report
on markets, strategies and technologies

Non-military world market for sensors will grow at an average annual rate of 4.5% between 1998 and 2008.

1998: US \$ 32.5 billion

2003: US \$ 42.2 billion

2008: US \$ 50.6 billion

Markets: Highest demand and growth sector for sensors worldwide are motor vehicles. Process industries are second in demand. Excellent prospects for sensors in telecommunication.

Countries: Western Europe has 31.8% of the global demand at present; the USA, 31.1% and Japan, 19.4%. The share of the other countries will grow from 17.7% in 1998 to 19% by 2008.

Trends: Sensors on semiconductor basis will increase their market share from 38.9% in 1998 to 43% in 2008. Strong growth expected for sensors based on MEMS-technologies, smart sensors and sensors with bus capabilities.

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Basle, May 12^h, 1999

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After the world report "**SENSOR MARKETS 2004**" released in 1994, which treated only the Triad markets, INTECHNO CONSULTING now publishes the new world report

„SENSOR MARKETS 2008: Worldwide Analyses and Forecasts for the Sensor Markets until 2008"

for the **first time** with **global** market figures. This more than 1,000-page report is based on 280 new expert interviews conducted worldwide with sensor users and manufacturers. In addition, more than 600 statistics, economic and business reports and specialist articles were evaluated and extensive model computations done.

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Price English Version: US \$ 6,200.--

TECHNOLOGICAL TRENDS

Sensors based on MEMS technologies (microelectromechanical systems) and smart sensors are at the focus of the current sensor development. **MEMS technologies** allow to miniaturize sensors and, at the same time, to integrate their sensor elements with microelectronic functions in minimal space. Only **MEMS technologies** make it possible to mass-produce sensors more and more cost-effectively while improving their functionality and miniaturizing them. Thus, major sensor and electronics manufacturers expect that within a few years, there will be complete video cameras with the image sensor integrated on one chip, and that each of the more than 1 million pixels of that sensor will have its own local intelligence for information preprocessing.

The greatest progress in innovation, however, will happen where MEMS technologies overlap with **smart technologies**. For cameras, this means a trend from the miniaturized camera to the smart **and** miniaturized camera which can integrate image processing functions in a minimal space. The main goal of **smart sensor** development is to improve the reliability and durability of these sensors and to make them more easily adaptable to new functions and conditions during the operating phase. In addition to **self-diagnostic** capabilities, smart sensors can have the functions of self-calibration and self-adaptation. In binary sensors, for instance, the function of **self-calibration** can consist in automatic adjustment of the switching point. **Self-adaptive** sensors can adapt themselves automatically to the measurement task during the set-up phase of a process technological plant, and also allow for greater flexibility in retrofitting these plants.

The main goal in **bus sensor** development is to make them more easily adaptable to communication networks and control systems. On the basis of standardized interfaces it will be possible to link these sensors up to networks without any problems. According to the “**plug and play**” principle, installation in complex measuring and automation systems can be made much easier; the intelligence of the system as a whole can be decentralized, and the sensors can be used in a multiple way by the various controls and control systems.

WORLD MARKET DEVELOPMENT FOR SENSORS - OVERVIEW

The **open world market** for **non-military** sensors will grow from US \$ 32.5 billion in 1998 to US \$ 42.2 billion in 2003 and US \$ 50.6 billion in 2008. Note that at 5.3%, the annual growth between 1998 and 2003 is considerably higher than in the following five years: Between 2003 and 2008, worldwide growth in sensor demand will be 3.7%. By 2003 at the latest, saturation tendencies will begin to show in some automobile electronic systems, e.g., ABS and airbag electronics, but also in office technology. The sensor markets for devices and systems of telecommunication, on the other hand, will remain growth-intensive until 2008.

The above growth rates are to be considered as **conservative** from the sensor manufacturers' as well as from the potential investors' point of view, because they take the expected price deterioration for most sensors into consideration. The corresponding market figures are thus based on **current prices**. Consequently, the respective growth rates are **nominal** growth rates. Moreover, this study analyses and forecasts only sensor applications that are foreseeable today under technological, economic, and partly legal considerations - and can, therefore, be object of a well-founded market analysis. New and, as yet, unknown applications may well lead to sudden leaps of demand and cause additional growth of around 1% and possibly even more between 2003 and 2008; in this case the factual sensor growth would even reach 4.5% to 5% during that period.

Note that the growth rates for sensors were considerably higher in the past three to four years than those forecasted for the following years. These growth rates, which reached averages of up to 9% in the last three to four years, particularly in Germany, mirror the strong upturn in machinery - especially machine tools - in this period, and also a clear upturn in the automobile industry, which led to high growth rates for certain electronic systems. 1998 was a regular boom year for machinery, which had still been in a cyclical trough in 1994. For the next five years, however, lower growth rates are to be expected, due to the highly cyclical nature of the demand for machinery.

CONTINUING PRICE PRESSURE ON SENSORS

In the **future**, price pressure on sensor manufacturers will continue, especially caused by the growing importance of the Internet and **electronic commerce**. Should the **economies stagnate** in the big industrial countries, the price pressure would even intensify.

INTECHNO CONSULTING expects further price deteriorations for many types of sensors. Within the mass markets of automobile electronics, consumer and office electronics, it is **MEMS technology** in particular that allows mass production of sensors and price reductions in spite of rising performance requirements.

A 30% price deterioration for sensors in the automobile industry is expected over the next 10 years. The price slump will be even more dramatic for the newly introduced automobile sensors (yaw rate sensors, radar distance sensors, steering angle sensors). In machinery, too, the price pressure on established sensors, e.g., position sensors and binary position sensors, is expected to continue.

SENSOR WORLD MARKET DEVELOPMENT FOR THE MAJOR APPLICATION SECTORS

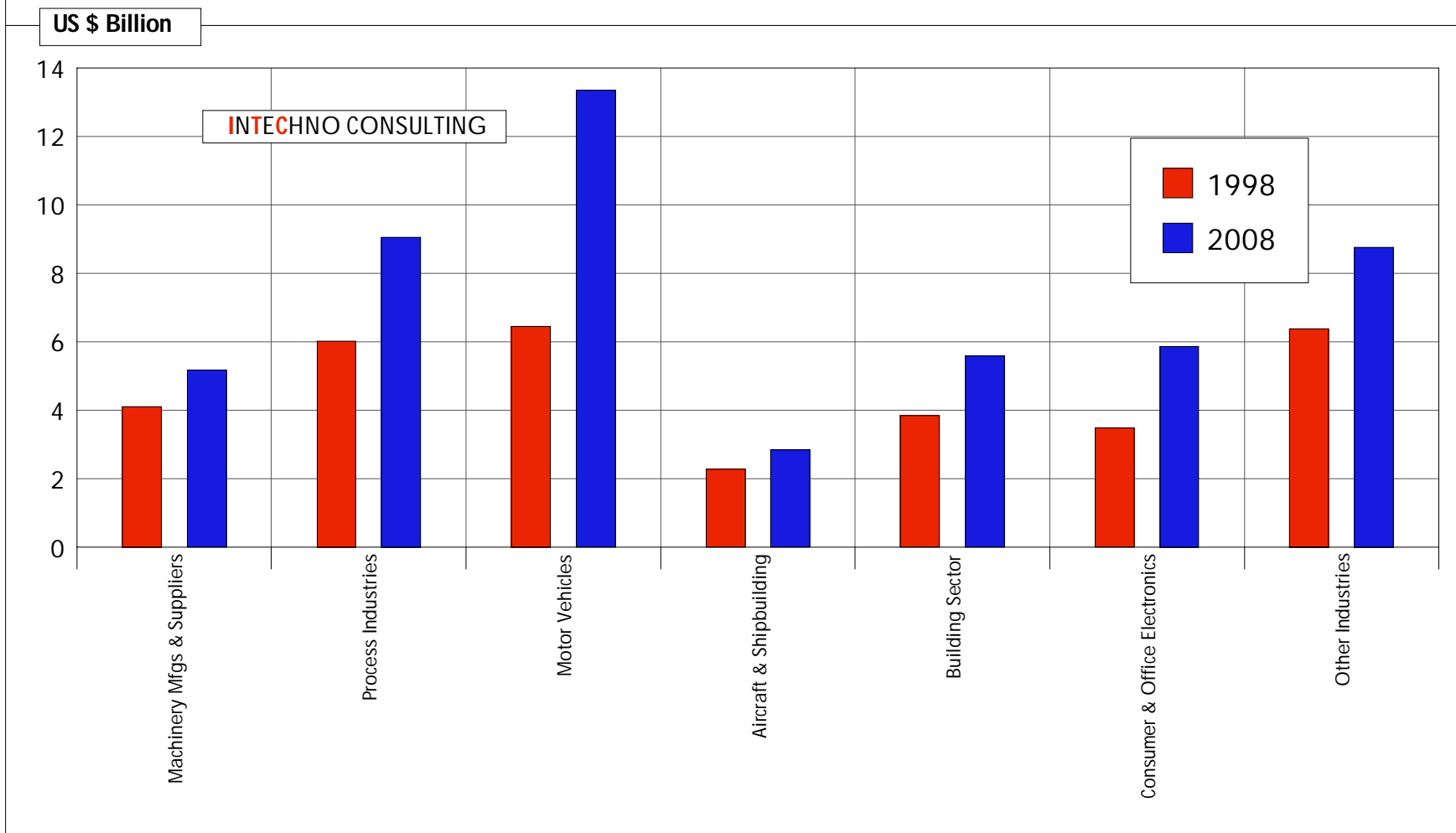
Figure 1 shows an overview of the sensor market development for the major application sectors.

Machinery

The sensor market for machinery comprises all sensors that are purchased by machinery manufacturers (OEMs), their suppliers, and the respective end-users from the manufacturing industries. Worldwide, this market is expected to grow from US \$ 4.1 billion in 1998 to US \$ 5.2 billion in 2008. This corresponds to a growth rate of only 2.4%. Without these suppliers, the sensor market is US \$ 2.4 billion already. Note in this context that 1998 was a boom year in the demand for capital goods, and therefore, machinery of all types; this cannot be expected to continue unlimited. In view of this industry's very high share in the total demand for sensors, a slowdown in growth rates over the next few years is expected. On the other hand, industries that had left the highly industrialized countries might return with increasing factory automation. This is especially true for miniaturized and high-quality electric and electronic products. As a consequence, this return of some of the manufacturing industries leads to a significant increase of demand for automation products and services in the countries concerned. The sensor industry, however, will profit from this growth only in part. The greatest part of it concerns software, engineering, and automation services.

In general machinery, distribution channels will undergo a perceivable shift: Instead of the machinery manufacturers themselves, more and more of their suppliers - e.g., manufacturers of motors and drives, pneumatics and hydraulics - will buy sensors and integrate them into modules or aggregates that they sell to the machinery manufacturers. The background of this is the trend towards less production depth in the machinery industry.

Figure 1: Development of the World Market for Sensors until 2008: Segmentation by Industries



Process Industries

Each country's demand for process sensors depends on the real investments made in its various industries (**end-user aspect**) and on the country's position in process technological machinery and plant construction (**OEM aspect**). The **end-users' sensor demand** is, however, not proportional to the amount of real investments made; rather, it also depends very much on the type of real investment and on the safety regulations, quality requirements, and automation efforts in the respective country. With respect to the total value of real investments, modernization investments - especially rationalization investments - have a much higher share of automation and, therefore, sensor demand than new, enlargement, and replacement investments.

The key determinant for **OEM sensor demand**, on the other hand, is the production volume of each country with respect to process technological machinery and plants.

In total, the world market for sensors in the process industries will grow from US \$ 6.0 billion at present to approximately US \$ 9.1 billion by 2008. This is based on the assumption that growth between 2003 and 2008 will be considerably stronger than between 1998 and 2003. The major demand sectors are the chemical industry with 36.3%, power plants with 14.3%, the petroindustry (refineries and petrochemicals) with 12.1%, and the food sector with 10.2% of global demand.

Motor Vehicles

Over the past few years, electronics have played a more and more important part in the automobile industry. Electronics will continue to grow in importance during the next few years. Overall, the average share of electric and electronic components in the total production costs of a vehicle will rise considerably within the next ten years.

The market for sensors in motor vehicles is expected to grow from US \$ 6.4 billion at present to US \$ 13.3 billion in 2008. Especially sensors for **safety systems** will continue to have excellent prospects: While the market penetration of ABS and driver/passenger airbags is very advanced already, acceleration sensors for side impact and head airbags as well as sensors and transponders for children's seat detection are only just beginning to penetrate the market. Sensors for vehicle stability control, adaptive headlight control, tire monitoring and run flat tires are just at the start of their development, too. Sensors for burglary protection as well as for monitoring and controlling the distance to the vehicle in front are now in the phase of market introduction. In addition to these, there are a multitude of other safety-related applications.

Another application area for the various sensors is **comfort and convenience electronics** in motor vehicles as well as **driver assistance systems**. Especially optical image sensors are expected to have a bright future here. For air conditioning and climate control in motor vehicles, humidity sensors and sensors that measure air quality are up and coming. The trend towards power steering on the basis of electric motors also has its effect on the types

and quantities of sensors needed. Another major area of innovation that will require sophisticated sensor technology is that of electronically controlled automatic transmissions, electronic automatic manual transmissions and continuous variable transmissions (CVT).

Other Sectors

Next to the automobile industry, household appliances and consumer electronics, **information technology** is a mass consumer of sensors, too. Growth is very strong in acoustic sensors for cellphones and cordless telephones, magnetic field sensors for magnetic storage media, and customer terminals of the most varied types. Particularly strong growth is seen in conventional photodetectors for local area networks as well as PIN and APD photodetectors for regional, municipal, and long-distance networks.

Demand keeps growing in **medicine** and lab analytics for chemical sensors for measurements in gases and liquids, but also for biosensors.

SENSOR WORLD MARKET AND WORLD MARKET DEVELOPMENT - SENSOR TYPES

Types of Sensors:

The world markets for the ten types of sensors with the **highest market volumes** rank as follows in 1998:

- No. 1: Temperature sensors
- No. 2: Pressure sensors (excluding differential pressure)
- No. 3: Flow sensors (including differential pressure for flow measurements)
- No. 4: Binary position sensors (proximity switches, light barriers, reflector type photo-sensors)
- No. 5: Position sensors
- No. 6: Chemical sensors for measurements in liquids
- No. 7: Level sensors (including differential pressure for level measurements)
- No. 8: Speed/rpm sensors
- No. 9: Chemical sensors for measurements in gases
- No. 10: Flue gas and fire detectors.

Note that this ranking varies considerably between countries. the ten most **growth-intensive** sensor types are rain sensors, thickness sensors, liquid quality sensors, navigation sensors, tilt sensors, photodetectors, glass breakage detectors, biosensors, magnetic field sensors, and motion detectors.

Degree of Integration:

The worldwide sensor demand of US \$ 32.5 billion in 1998 comprises around US \$ 29.3 billion for **housed and ready-to-use sensors** and US \$ 1.7 billion for **sensor elements without housing**. Worldwide demand for **sensor modules** was approximately US \$ 0.6 billion, and for complete **sensor systems**, US \$ 0.9 billion. The latter include, for instance, radar sensors for sea-going and inland ships as well as complete navigation sensors like the IRS systems (integrated reference systems) based on laser gyroscopes that serve aircraft navigation.

Sensors on Semiconductor Basis and Fiberoptic Sensors:

Two of the most innovative classes of sensors are those on semiconductor basis and fiberoptic sensors. The world market for sensors on **semiconductor basis** grows from US \$ 12.6 billion in 1998 to US \$ 21.8 billion in 2008. The world market for **fiberoptic sensors** is close to US \$ 175 million at present, and will reach approximately US \$ 350 million by 2008. Both classes comprise almost all types of sensors. Above all, communication technology is stimulating the ongoing technological development of fiberoptic sensors; particularly the enormous progress in LANs will have a strong impact on innovation and market penetration of fiberoptic sensors.

DEVELOPMENT OF THE SENSOR WORLD MARKET BY COUNTRIES

As the overview in **Figure 2** shows, the US \$ 32.5 billion worldwide sensor demand in 1998 is divided among the countries and regions as follows:

| | |
|------------------------------------|-------|
| - Germany | 10.9% |
| - France | 5.3% |
| - United Kingdom | 4.0% |
| - Italy | 3.7% |
| - Other Western European countries | 7.8% |
| - USA | 31.0% |
| - Other American countries | 6.1% |
| - Japan | 19.4% |
| - Other Asian/Pacific countries | 8.8% |
| - Rest of the world | 3.0% |

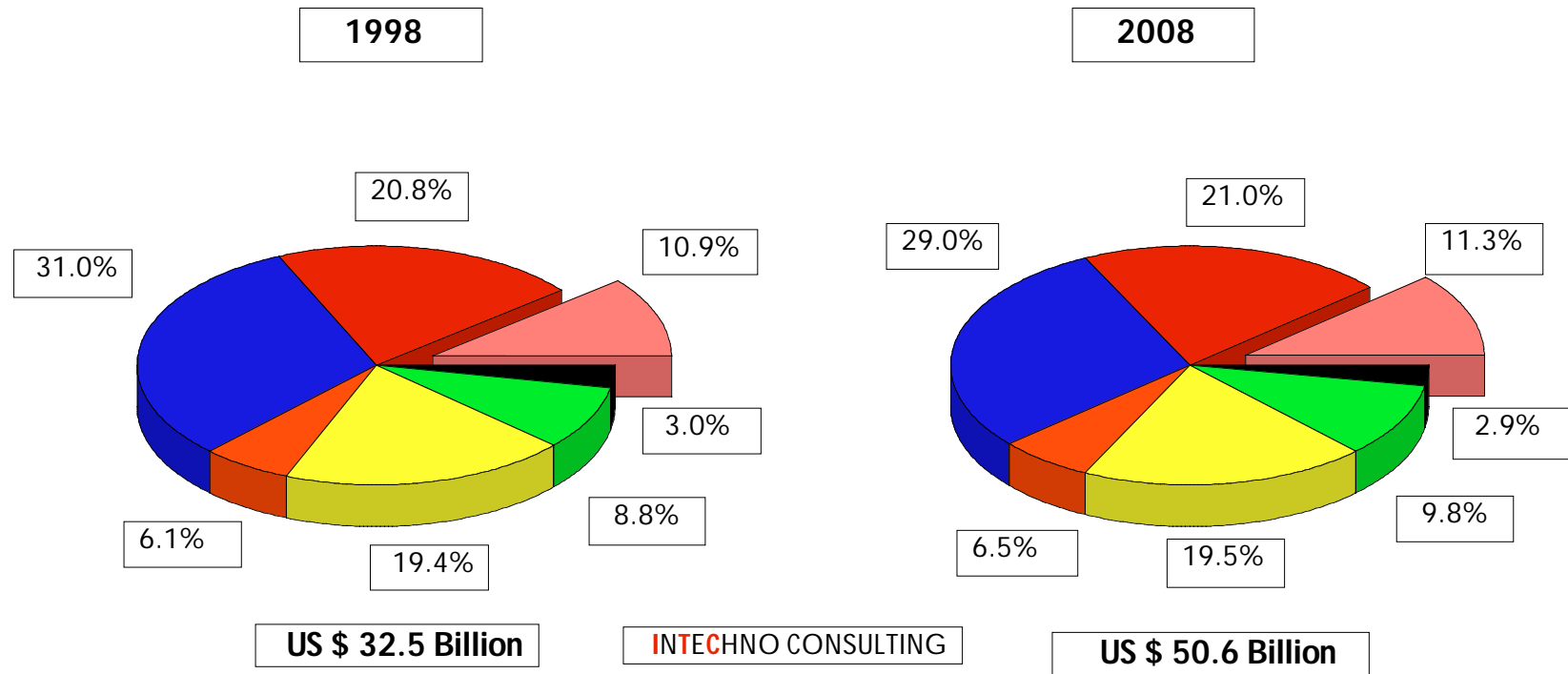
Until 2008, Germany's share is expected to rise slightly; the share of the Asian/Pacific region without Japan should reach close to 10%. The reasons for this growth are the expected recovery of this region within the next ten years and the enormous pent-up demand for goods of all types.

SUCCESS FACTORS AND STRATEGIC OPTIONS

The major **success factors** for sensor manufacturers specialized in mass applications are highly efficient mass production facilities, an increasingly internationalized distribution, and absolute customer orientation. The sensor product to be marketed in the future will be less and less just sensor hardware, but will include more and more software, service, and consulting. Telecommunication-based maintenance, services and distribution will offer highly innovative perspectives here.

Sensor manufacturers that specialize in sensors for the process industries, should focus their **technological innovation** efforts on smart and bus sensors. In the future, these sensors will contribute to huge cost savings in the engineering, installation, and start-up phases, and above all, in the operation phase of the various process industries. While smart and bus sensors are the focus of technological innovation in the process industries, motor vehicles need, above all, sensors based on MEMS-technology: Only these sensors meet the requirements of massive cost reduction in the case of mass production.

Figure 2: Development of the World Market for Sensors until 2008: Subdivision by Countries and Regions



- Germany
- USA
- Japan
- Rest of the World
- Other Western Europe
- Other Americas
- Other Asia-Pacific

The real touchstone for innovation success in new sensor products or sensor concepts is not the technological solution of a development problem, but **market acceptance**. The goal of innovation marketing is **not** to push feasible technological concepts on the market, but to get marketable products by making market requirements the key factor in all development efforts on from the start.

Chances in this field result from the ever-changing **customer requirements**, which become more differentiated and more complex all time. Since not all expectations can be fulfilled, those customers who are most promising with respect to corporate philosophy have to be selected in order to form appropriate development partnerships for technology and service innovation. The customer's efforts to reduce production depth and to focus on core competencies offer a broad variety of opportunities for innovative service concepts, including sensor-based solutions with high value creation.

Plant operators within the **process industries** look increasingly for adequate products and service concepts for the **modernization phase** and, above all, the **operation phase** of their plants. For the sensor manufacturers this means an even greater need to match with the plant operators' needs during the operation phase. The range of services may even include operation services - not for entire plants, but for parts of plants or of the customer's activities. One example are remote-monitored storage tanks. In addition to supplying just filling sensors, sensor manufacturers can develop to become external service suppliers who take charge of procurement, maintenance, cleaning and even safety and security services. Through specific cooperation as well as for the single sensor company, the future might hold interesting diversification opportunities, in line with the motto: "Development **from a technology provider to a service provider**".

To further strengthen the success of sensor manufacturers, it is advisable for them to compare their own products, services and activities systematically with other industries in a **benchmarking** procedure on a regular basis.

Sensor manufacturers that specialize in mass production, above all, can learn from the semiconductor industry how to be successful in an environment of worldwide competition, high capital expenses, and, consequently, absolute necessity of prioritization and selection within and between the areas of administration, distribution, logistics, production and development. **Customer satisfaction analyses** on a regular basis are another important way to secure market positions, to find service innovations, and thus to achieve customer loyalty.