

European and French Sensor Industry Technology, market and trends

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>Introduction

An heterogeneous business

Sensors foodchain analysis

European and French sensor markets



- **Detailed analysis of the sensor industry in Europe and France per product segment (temperature, pressure...) and application sector (automotive, industrial...)**

- consumption estimates in million euros per product segment and application sector
- forecasts in value terms from 2007 to 2011

- **Analysis of major technical trends and impact per product segment and application sector**

- digital and wireless sensors market,
- MEMs penetration, sensor networks, etc.

- **Panel analysis of sensor manufacturers/integrators localized in France**

- mapping per product and application segments
- analysis per type of activity in France



Sensor definition

Discrete element, of reduced size, connected to an electronic system, able to measure physical, chemical, electrical parameters, and whose sensitive element (transducer) represents a significant share of the value added.

QuickTime™ et un décompresseur TIFF (LZW) sont requis pour visionner cette image.



Source Solartron Metrology

QuickTime™ et un décompresseur TIFF (LZW) sont requis pour visionner cette image.

Source EPCOS

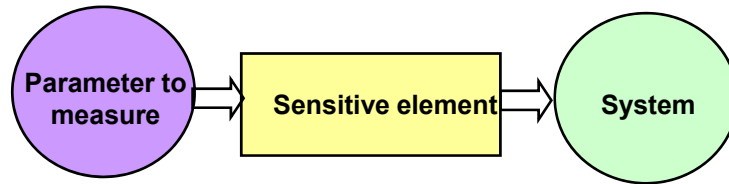
Source Siemens VDO

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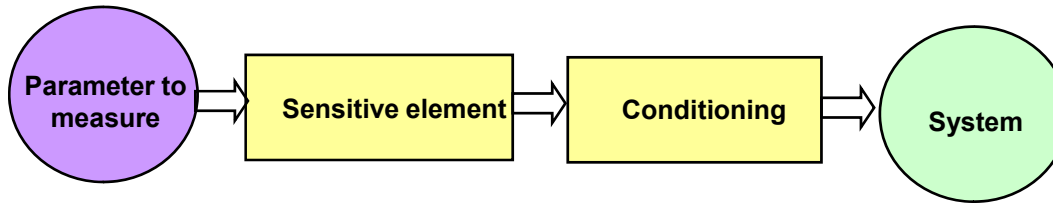


Sensors typologies

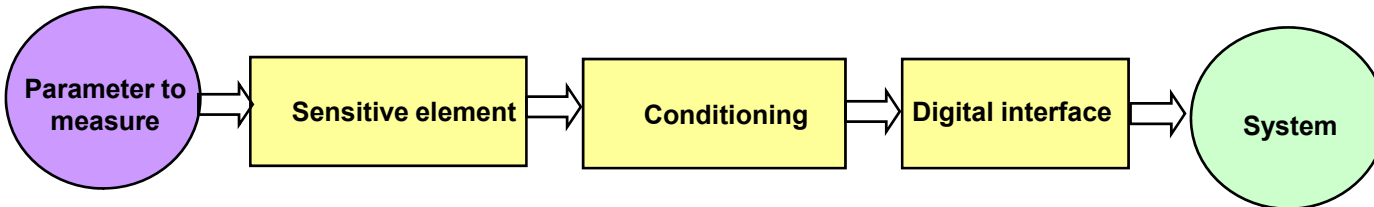
Transducer:



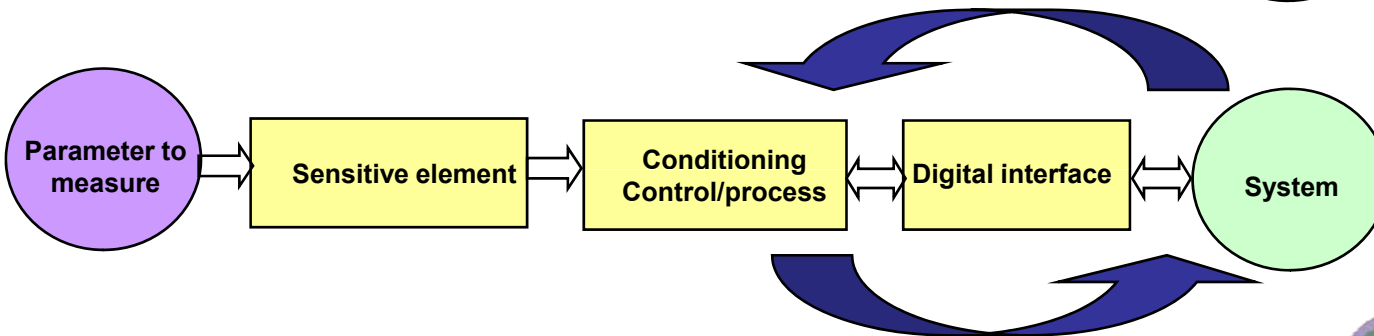
Functional sensor:



Digital sensor:



Smart sensor:



Sensor role in the system

- Depending on applications, sensors are used to satisfy 4 main functions within a system:
 - monitoring & control : in order to increase the **performances** and **regulate** the system
 - security & warning : in order to increase the **safety** of the system and **anticipate** default
 - diagnosis & analysis : in order to **understand** the system and **improve**
 - interface & navigation : in order to **operate** the system and increase **functionalities**
- Historical sensors functions are in monitoring and control as it brings direct system performances improvement
- The others are developing equal or faster
 - sensors are more and more becoming central elements within the system, bringing either new functionalities or reducing Total Cost of Ownership
 - now sensors are starting to be used to prevent rather than to cure, development of sensors usage in early warning systems and intelligent maintenance schemes
 - sensors are also key pieces of new electronics interfaces (natural motion detection)



Survey's product segment scope

- Sensors are either used in stand-alone configurations or integrated within end-equipment
- Detectors represent the vast majority of the sensor industry, at least 70% of the market, providing in general ON/OFF information
- Sensors are basically used to detect and measure four main categories of parameters: physical, mechanical, chemical and electromagnetic

| Physical parameters | Chemical parameters |
|--|--|
| <ul style="list-style-type: none"> • acoustic • flow • humidity | <ul style="list-style-type: none"> • level • pressure • temperature |
| Mechanical parameters | Electromagnetic |
| <ul style="list-style-type: none"> • absolute position • force/deformation • inertial | <ul style="list-style-type: none"> • gas • liquid⁽¹⁾ • solid⁽¹⁾ • current⁽²⁾ • voltage⁽²⁾ • magnetic field⁽²⁾ |

(1): not isolated in the survey's detailed analysis ('other' category)

(2): grouped within the electromagnetic sensors product segment in the survey



Survey's application scope

- Sensors are used in every kind of markets, from industrial process control/regulation to game consoles remote controls
- The following scope has been adopted to cover the majority of sensors applications and ensure a good market coverage
- Sub segments of the “traditional” industrial application sector have been isolated in order to provide a better visibility on the sensor market outlook

| | |
|-----------------------------|--------------------------------------|
| Aerospace & Defense | Industrial process and manufacturing |
| Automotive | IT Infrastructure |
| Building and infrastructure | Laboratories and test |
| Consumer | Medical healthcare |
| Energy and networks | Security |
| Environment | Transportation |
| Home Appliances | |



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Sensors foodchain analysis

European and French sensor markets



Sensors food chain

- The sensors food chain includes:
 - **component manufacturers**: focusing on a general basis on the transducer part (generally Tier N suppliers)
 - **sensors manufacturers/integrators**: taking care of the packaging and interface, sometimes of the electronics (Tier 1 suppliers)
 - **system integrators and OEMs** who are now in demand of complete solutions rather than single components
 - **sensors distributors**: playing a key role between manufacturers and system integrators-OEMs
- Depending on the application sector, the decomposition of the sensor added value is very different
 - while transducers represent 25% of the full sensor value, other elements like conditioning, packaging, interface, test and qualification, see their relative share varying significantly depending on application
 - very few players have kept vertically integrated organizations (e.g. Bosch, Thales)
- Measurement principles are relatively stable but integration technologies are rapidly evolving (stimulating by MEMs penetration)
 - this trend has some deep influence on the industrial landscape (consolidation and technology acquisition)

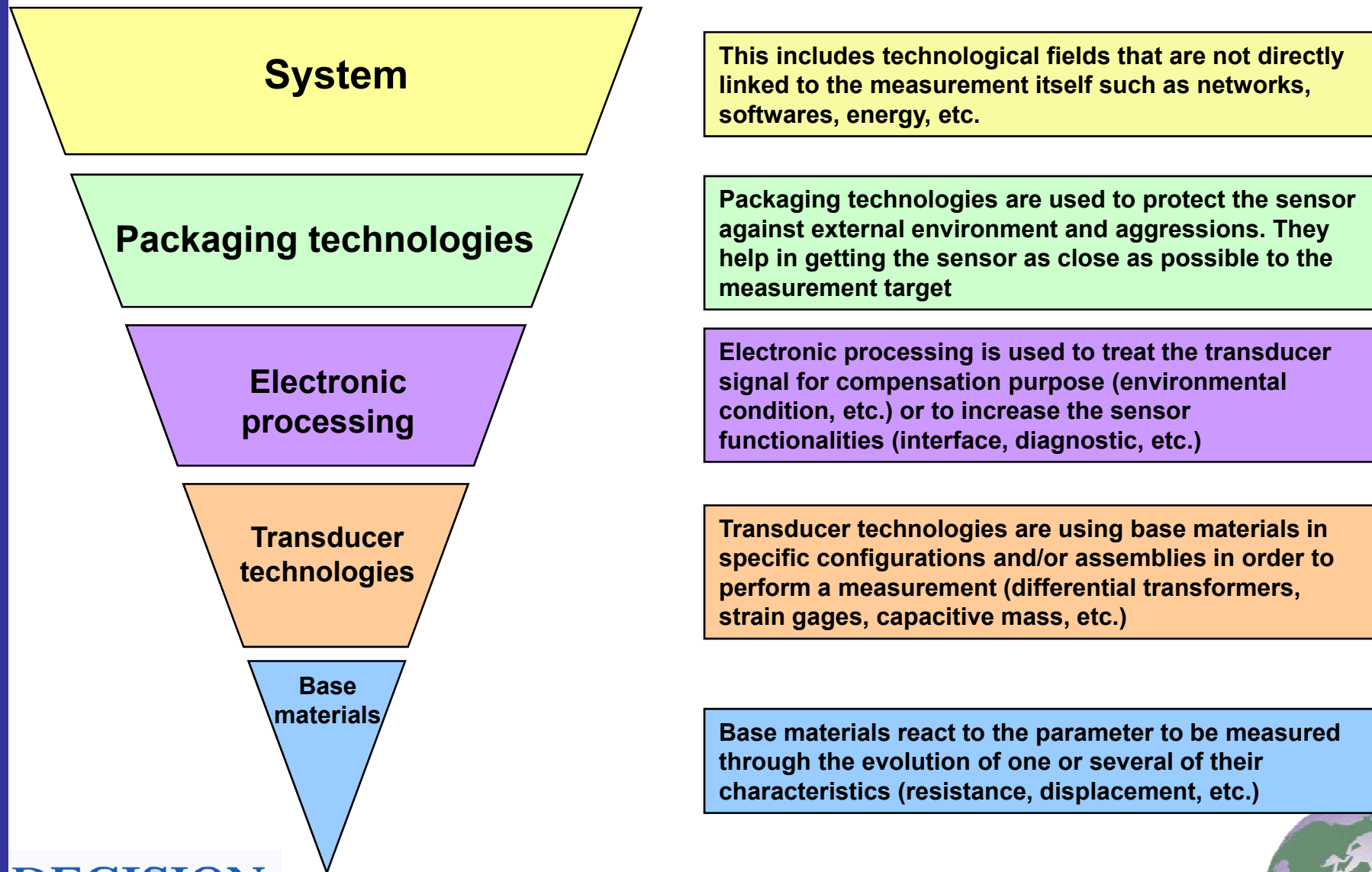


Sensors discrepancy

- Over 100 sensors technologies have been identified during the survey, and many more have not !
 - According to Wikipedia, there are at least 50 technologies for pressure sensing alone
- Depending on application markets, required sensors characteristics are very different. Sensors precision, accuracy, stability, repeatability, reliability have considerable impacts on:
 - transducer technologies
 - integration added value (including test and qualification)
 - and company profiles
- Which turns into a tremendous price discrepancy depending on functions and applications
 - from 100keuros for spatial applications, same sensor can cost 20 times less in industrial applications
 - from 5 to 1000 euros for sensors integrated to an end equipment/platform (as opposed to stand alone configurations)



Sensors technological landscape



Base materials

- A majority of sensors are based on piezoelectric, piezoresistive, photoemission, inductive and capacitive variations. Base materials used in the sensor industry include crystals, ceramics, metals, alloys, polymers, etc. depending on the measured parameter and the application
 - quartz, ceramics, semiconductor (and oxides), carbon, copper, silver, graphite, nickel, platinum, tungsten, magnetic materials (ferrite, μ metal), are commonly used by sensors manufacturers
 - major characteristics for sensor base materials are: stability, reaction time and sensitivity to the measured parameter
- Considering the manufacturing process, thick film processes still represent a majority of the sensor market although the share of thin film sensors is progressing
 - silicon based sensors have experienced some significant development over the last 20 years, eventually representing 15 to 20% of the sensor industry but still too expensive for some type of measurement (e.g. temperature) despite better linearity
 - silicon represent 10% of the temperature sensor market and 13% of the pressure sensor market, penetration is much larger in electromagnetic parameters sensors
- Base materials R&D
 - the development of contactless sensing materials is drawing much attention thanks to better measurement dynamic and robustness: Electromagnetic and optical materials and properties are therefore key research fields
 - sensor fusion is also a key research field for base materials. A better understanding of materials physics can help in getting access to multiple parameter measurements through the same transducer, consequently reducing global cost (temperature + pressure, etc.)



Transducer technologies

- Transducers have not experienced significant evolution during the last 20 to 30 years
 - market is still populated with a lot of mature technologies (Force, Temperature, Flow, etc.) where product evolution has been essentially based on signal processing and ICT progress rather than measurement principles and technologies
 - variable reluctance, differential transformers, thermocouples, rulers and coders, etc. still represent the majority of the sensor transducer technologies
- The development of Micro Electro Mechanical Systems (MEMS) is about to change this relative status quo, opening the way to new measurement techniques and sensors applications
 - MEMS sensors have experienced some significant development since the mid 90's in automotive application for inertial measurements (airbags, electronic stability program, etc.)
 - natural motion detection in mass market applications (game consoles, mobile phones, PCs, etc.) is now giving another boost to inertial MEMS, which represent in 2007 39% of the world inertial sensor market
 - complex materials assembly as well as miniaturization (Nano Electro Mechanical Systems), will make possible to develop new transducers technologies and principles like optical MEMS, microfluidic devices, etc. potentially opening the way to brand new sensors applications, in particular in the bio-sensors field
- The development of contactless silicon transducers (Hall effect, GMR, fluxgate) will also continue in order to increase sensitivity, miniaturization and reduce cost
 - these transducers will penetrate professional markets after having proved their reliability in mass market applications (aerospace is considering to integrate Hall sensor technologies in new aircrafts developments)



Electronic processing

- The linearity of base materials has always been an issue, therefore electronic compensation circuitry is commonly used in addition to the transducer in order to compensate for its variations
- With the progress of miniaturization, it is now possible to place the electronic circuitry close and even within the transducer, allowing additional sensors functionalities to develop
- #1: Digital sensors are connected to communication buses and provide digital signals rather than analog ones
 - digital sensors have increased functionalities such as auto or re-configuration, diagnostic capabilities, etc.
 - digital sensors globally represent 16% of the World sensor market (14% in Europe and 12% in France). Significant applications in industrial (20% penetration) but very limited in others (aeronautic, automotive) as cost remains an issue
 - development of MEMs and Silicon based sensors will certainly help increase the penetration of digital sensors, which is expected to reach 24% of the European sensor consumption in 2011
- #2: Electronics miniaturization and integration also makes possible to develop sensors able to communicate wirelessly
 - demand for wireless sensors has been developing for more than 10 years in the industrial sector but autonomy and EMC have limited market development. Representing in 2007 a minority of the sensor market (<5%), wireless sensors are still associated with energy autonomy problems and increased cost, thus limiting their development
 - wireless sensors will however continue to increase their market penetration, eventually representing close to 10% of the sensor demand in Europe in 2011, thanks to the development of low power communication standards (Bluetooth, Zigbee) and price decreases



Packaging technologies

- If transducers represent in average 25% of the total sensor cost, sensors packaging added value vary drastically depending on the application (aerospace vs. digital entertainment)
- As sensors continue to increase their penetration in every kind of application and platform, they are also being placed closer to the measured parameter in order to increase reliability and precision. Sensors consequently have to handle:
 - harsh environment and operating conditions (temperature, vibration, chemical aggressions, etc.) with constraints constantly increasing
 - in parallel to reduced placement area and volume
- Sensor fusion, meaning the integration of several transducers within one package, is also developing. This means the ability to integrate heterogeneous technologies into one single package
- If the evolution of packaging techniques seems to answer positively to these new constraints, the expected development of brand new sensors application is also creating new packaging needs, among them:
 - medical: human body is very aggressive to electronic, packaging has also to be extremely resistant and miniaturized
 - textile: new potential applications of sensors within clothes are numerous (for healthcare, entertainment and security purposes). This creates some new challenges for sensor packaging and stimulate research activities in domains such as flexible and stretchable packaging and interconnection



System

- The system research area is gaining increased importance thanks to the development of new sensor network concepts and the optimization of existing embedded sensors
- Sensor networks (wired or wireless) are developing in order to facilitate the multiplication of measurement points, increase monitoring coverage and control capabilities in domains like:
 - Home and building (power savings, intelligent building)
 - Environment monitoring (temperature, humidity, polluting agents detection)
 - Human body monitoring and Personal Area Networks (healthcare, entertainment and connectivity)
 - Security and Defense (perimeter surveillance systems, hazardous substance detection, etc.)
- In order to operate, sensor networks rely on communicating and intelligent sensors, impacting sensor development in the following areas
 - wireless communication protocols standards (Bluetooth, Zigbee), sensor network typologies and control strategies
 - sensor power consumption and energy harvesting technologies (electromagnetic, optical, vibration, temperature)
 - as well as upper layers of the system such as database management, communication infrastructure and security
- Virtual (soft) sensors are also developing in order to access new parameters without implementing additional hardware in the system
 - virtual sensors are based on a deep understanding and computer modeling of the system behavior
 - they require available processing resources and are generally used in order to optimize existing architectures



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European and French sensor markets



Consolidation is under way

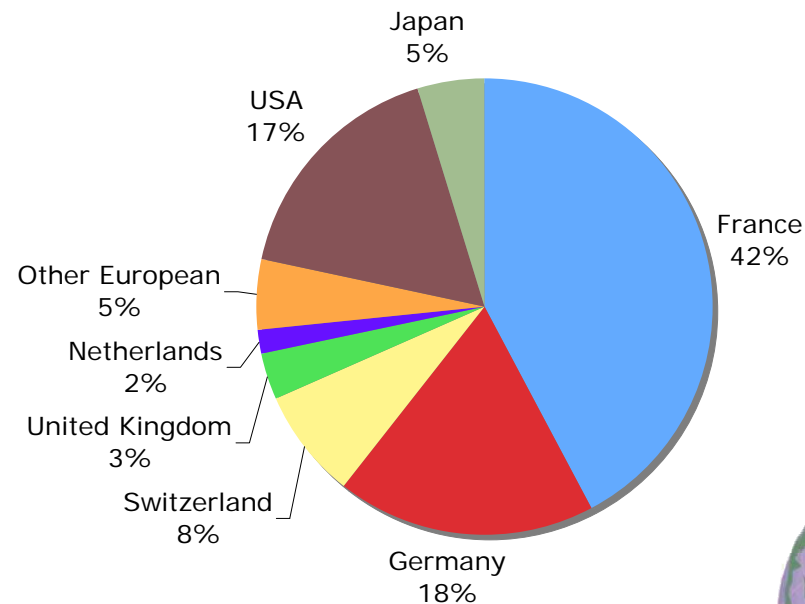
- The sensor market has experienced over the last decade a significant consolidation process that has eventually led to the creation of large industrial conglomerates through acquisitions
 - these conglomerates have both large product and end market coverage (in particular for industrial application segments)
 - most significant are: Ametek, Baumer, Emerson Process, Esterline, GE Sensing, Industrial Scientific Corporation, Measurement Specialties, Meggitt, Schneider, Spectris, etc.
- Examples of industry consolidation in France:
 - Auxitrol (affiliate of the US Group Esterline since 1972, acquisition of Sagem pressure sensors business line and Fluid Regulators Corp. in 1997, acquisition of BVR Aero Precision in 2003)
 - Sensorex (affiliate of Vibro-Meter France since 2005, part of Meggitt UK)
 - Humirel (created in 1998, acquired by Measurement Specialties in 2004 US)
 - Kavlico's (US) acquisition in 2004 and BEI Technologies (US) in 2005 by Schneider Electric
- To increase market coverage, reach critical mass and develop technical and marketing synergies between business lines
 - in line with OEMs demand looking for complete measurement and system solutions



Sensors manufacturers geographical mapping

- 212 sensors manufacturers have been integrated into the panel analysis during the course of the survey
- European companies represent 78% of the panel
- Out of the 212 sensors manufacturers, 183 have a local office in France
- Out of the 183, 113 either have a production or development site in France
- In comparison, the German sensor industry is composed of 420 members (including 70 R&D institutes)

Companies within the panel per country of origin



Companies localized in France

- The following 183 companies have been identified in the panel as having a representation in France
- In bold are 113 companies with a presence in France other than pure commercial, either in production and/or development
- Within these 113 companies, 30 indicated in red are focusing on sensor integration, the others are developing/manufacturing discrete sensors. Most of them are small and niche players

France suffers from a deficit in sensors development and manufacturers with respect to the end demand of OEMs

ABB
ADT
AHLBORN
AIRINDEX
AKOTRONIC
ALLEGRO
ALLIANCE Instrument
ALLIANTECH
AMG microwave
AMM
ANALOG DEVICES
ANDILOG
ASC Instrument
ASCO INSTRUMENTS
ASCO Joucomatic Numatics
ASHCROFT Instruments
ATEQ
ATEXIS
ATMEL
AUTOCUISE
AUXITROL
AXOM
BALLUFF
BEI IDEACOD
BERTHOLD
BERTIN Technologies
BIACORE
BOSCH
BOURDON - HAENNI
BRONKHORST
BURKERT
CADDEN
CAPACITEC
CAPTEC
CAPTELS
Carlo Gavazzi
CEDES
CHERRY
CIMEL Electronique
CITYSENSORS
CMR
CODECHAMP
COFRATHERM
COMPAUT
CONTINENTAL
CORREGE
CRANE Aerospace
CROUZET

DELPHI
DISPROCOM
DJB Instruments
DOERLER
E+E ELEKTRONIK
E2V technologies
EFE
EFS
ELECTRICFIL
Electronique ContrTMle Mesure
ELMOS
ELOBAU
EMERSON
ENDRESS + HAUSER
ENERDIS
Environnement SA
EPCOS
ERCIAT
E-T-A
ETAMIC-HOMMEL
EURO PHYSICAL ACOUSTICS
EUROFARAD
FGP sensors
FIRST Technology
FLINTEC
FOGALE nanotech
FREESCALE
Fritz K bler
FUJI Electric
GAROS
GEFRAN-CORECI
GEORGIN
getAMO
GRUTER ET MARCHAND
Hamamatsu
HBM
HEITO
HUBA Control
HUMIREL
IBS Precision Engineering
IDIL
IFM Electronic
IJINUS
IMPAC
INDUSTECHNIC
ITECA SOCADEI
IXSEA
JPC

JTEKT
KAVLICO
KELLER
KISTLER
KLOE
KOBOLD
KROHNE
KULITE
LaVision
LEM
LESCATE
LEUZE Electronic
LINOS
LITTOCLIME
LOREME
MARTEC
MCB Industrie
MCC
MEGATRON
MEIRI
MELEXIS
MEMSCAP
METRAVIB
MICREL
Micro-contrTMle Spectra-Physics
Micro-Epsilon
Moving Magnet Technologies
N'oSENS
NGK / NTK Technical Ceramics
NIVUS
NKE
Ocean Optics
OLDHAM
OMICRON
OMRON
OPTEL THEVON
ORION TMI
PANASONIC Electric Works
PARATRONIC
PCB Piezotronics
PONSEL
PRECILEC
PROSENSOR
PYRO CONTRILE
SAUTER REGULATION
SCAIME
SCHLUMBERGER
SCHNEIDER ELECTRIC

SENSOR
SENSOPART
SENSOR TECHNICS
SENSOREX
SENTRONIC
SERCEL
SETNAG
SICK
Siegfried & Vester
Siemens Building Technologies
Siemens Automation & Drives
SMARTEC
SNR
SOFRADIR
SOFRASER
SOLARTRON
SONOTEC
SOPHYSA
STEDAM
STERELA
STIL
STMicroelectronics
THALES AVIONICS
THERMOCOAX
THERMO-EST
TME
TRAFAG
TRONICS
TRW
TURCK BANNER
TYCO
ULIS
VAISALA
VALEO
VEGA
VISHAY
WABCO
Wenglor Sensoric
Yokogawa



Companies localized in Ile de France

- 87 companies of the panel have an office in Ile de France
- 39, in bold, have either production and/or development capabilities in IdF (others are sales offices)
- Within these 39 companies, 19 in red are considered as sensors integrators, the others are developing/manufacturing discrete sensors

The relative proportion of sensors integrators is larger in IdF than at the country level, thus increasing the contrast with sensors manufacturing capabilities

ABB
AHLBORN
ALLIANCE Instrument
ALLIANTECH
 ANALOG DEVICES
ANDILOG
 ASC Instrument
ASCO INSTRUMENTS
 ASCO Joucomatic Numatics
 ASHCROFT Instruments
ATEQ
ATEXIS
AXOM
 BALLUFF
 BERTHOLD
BERTIN Technologies
 BIACORE
BOSCH
 BRONKHORST
CAPACITEC
 Carlo Gavazzi
 CHERRY
CIMEL Electronique
CITYSENSORS
COFRATHERM
DELPHI
DISPROCOM
 ELMOS
 EMERSON

ENERDIS
Environnement SA
 EPCOS
ERCIAT
 E-T-A
EURO PHYSICAL ACOUSTICS
EUROFARAD
FGP sensors
 FIRST Technology
GEORGIN
GRUTER ET MARCHAND
 Hamamatsu
 HBM
HEITO
 IBS Precision Engineering
 IDIL
IXSEA
JPC
 JTEKT
 KISTLER
 KOBOLD
 LEM
LESCATE
 LEUZE Electronic
MARTEC
 MCB Industrie
MEIRI
 MELEXIS
Micro-contrTMle Spectra-Physics

Micro-Epsilon
 NGK / NTK Technical Ceramics
 Ocean Optics
 OMRON
OPTEL THEVON
 PANASONIC Electric Works
 PCB Piezotronics
SCHLUMBERGER
 SCHNEIDER ELECTRIC
 SENSOPART
 SICK
 Siemens Building Technologies
 Siemens Automation & Drives
SOFRADIR
 SOLARTRON
 SONOTEC
SOPHYSA
STEDAM
 STMicroelectronics
THALES AVIONICS
 THERMOCOAX
 TRAFAG
 TRW
 TURCK BANNER
 TYCO
VALEO
 VISHAY
WABCO
 Yokogawa



Introduction

An heterogeneous business

Sensors foodchain analysis

>European and French sensor markets



Sensor consumption per application sector, 2007

| Sensor Type | # | Europe | | | # | France | | |
|-------------------|-----|------------------|------------------|-----------|-----|------------------|------------------|-----------|
| | | In million euros | Market structure | %2007 -11 | | In million euros | Market structure | %2007 -11 |
| Industrial | 1. | 2 643 | 26% | 7% | 3. | 480 | 23% | 6% |
| Automotive | 2. | 2 304 | 23% | 3% | 2. | 500 | 24% | 3% |
| Aerospace/Defense | 3. | 1 684 | 17% | 8% | 1. | 630 | 30% | 8% |
| Laboratories/test | 4. | 952 | 9% | 4% | 4. | 170 | 8% | 6% |
| Consumer | 5. | 724 | 7% | 2% | 8. | 32 | 2% | 3% |
| Medical | 6. | 534 | 5% | 16% | 7. | 34 | 2% | 9% |
| Security | 7. | 250 | 2% | 5% | 9. | 30 | 1% | 5% |
| Transport | 8. | 226 | 2% | 5% | 5. | 65 | 3% | 8% |
| Building | 9. | 204 | 2% | 7% | 6. | 60 | 3% | 6% |
| Energy | 10. | 199 | 2% | 4% | 10. | 30 | 1% | 10% |
| Home Appliances | 11. | 183 | 2% | 2% | 12. | 14 | 1% | 3% |
| Environment | 12. | 160 | 2% | 15% | 11. | 28 | 1% | 11% |
| IT infrastructure | 13. | 138 | 1% | 4% | 13. | 10 | 0% | 3% |
| TOTAL | | 10 198 | 100% | 6% | | 2 083 | 100% | 6% |



Sensor consumption analysis per application sector

Global European sensor market overview

- Industrial sector and sub-sectors (including buildings, test&labs, environment, etc.) represent 51% of the European sensor market
- 2 of the TOP3 sensors markets in Europe, namely Industrial and Aerospace&Defense enjoy very strong end-demand perspectives in Europe over the forecast period
- Labs&Test application sector represent almost 10% of the European sensor market due to the localization in Europe of major R&D sites and final assembly/test operations (small volumes but very high ASPs)
- Consumer is not driving the sensor growth in Europe due to the influence of low cost countries and production displacement towards the East
- Among other application sectors, Medical and Environment are the ones with the highest growth perspectives over the forecast period with respectively 16% and 15%. Building sensor demand will grow above average (7%), although limited by the impact of the installed base
- Security, despite high market expectations, will have a moderate growth (5%) as most of the current applications rely on military based expensive technologies and adapted business models still needs to be found in order to accelerate application penetration



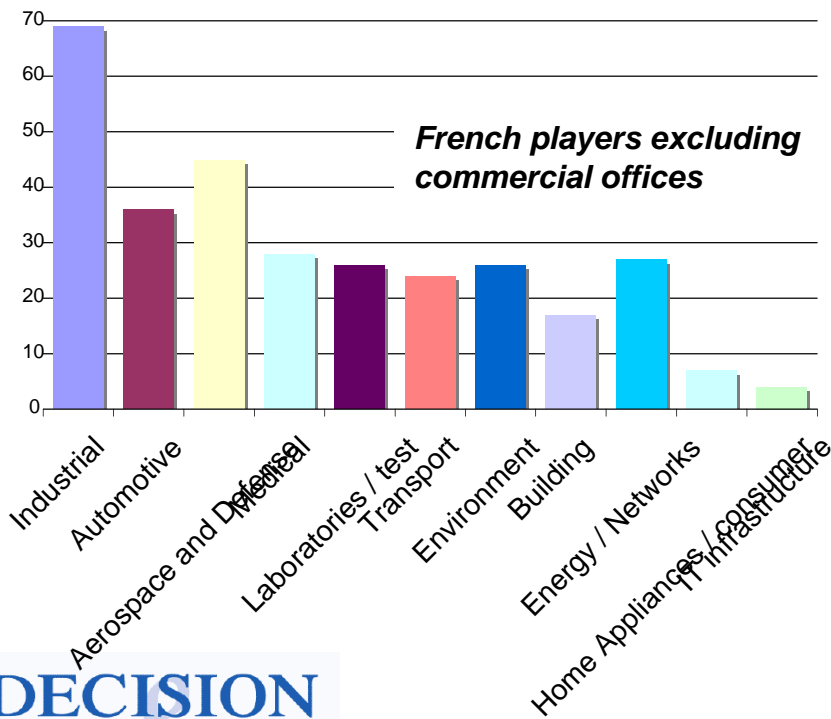
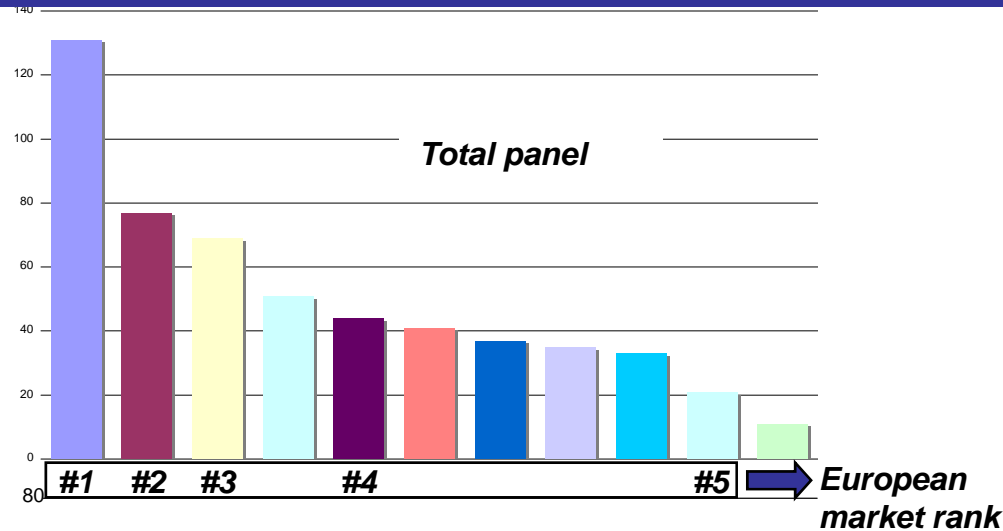
Sensor consumption analysis per application sector

French sensor market characteristics

- Global growth of the French sensor market demand will be similar to the European market with 6% average growth over the forecast period, but the growth drivers are different between France and Europe due to the end-demand structure
- French TOP3 sensor market is reversed versus Europe, putting Aerospace&Defense application in first position (30% of the sensor market) followed by Automotive and Industrial application sectors
- The share of industrial sector and sub-sectors falls to 43% in France compared to Europe (51%)
- Compared to other European countries, the medical end sector is not as important in France, which turns into a lower demand and growth for medical sensors although dynamic (9%) compared to European trend
- But France as some very dynamic application sector for sensors such as Transport and Energy due to the presence of World class OEMs and infrastructures
- Environment, will be the most dynamic application sector for sensor demand in France with 11% average growth over the forecast period



Panel mapping per application sector



Total panel

- Applications addressed by companies of the panel are in line with the European market
 - except for the consumer application sector, mainly addressed from abroad by low cost players
- The large number of actors addressing the industrial sector illustrates the diversity of this sector with a lot of niche sub-sectors

French players

- A lot of small and niche players in France
 - large number of actors addressing the industrial and aerospace&defense sectors
 - automotive application sector relatively weak in the mapping due to the small size of players localized in France
- Presence of major OEMs in France has an influence on the sensors industrial base
 - Aerospace&Defense, Environment, Energy



Sensor consumption per product segment, 2007

| | Europe | | | | France | | | |
|-------------------|--------|------------------|------------------|-----------|--------|------------------|------------------|-----------|
| Sensor type | # | In million euros | Market structure | %2007 -11 | # | In million euros | Market structure | %2007 -11 |
| Temperature | 1. | 1 197 | 12% | 5% | 3. | 202 | 10% | 6% |
| Position | 2. | 990 | 10% | 4% | 2. | 204 | 10% | 3% |
| Pressure | 3. | 987 | 10% | 7% | 1. | 231 | 11% | 7% |
| Electromagnetic | 4. | 973 | 10% | 5% | 5. | 176 | 8% | 6% |
| Inertial | 5. | 840 | 8% | 10% | 4. | 193 | 9% | 9% |
| Flow | 6. | 694 | 7% | 5% | 6. | 150 | 7% | 3% |
| Force | 7. | 629 | 6% | 5% | 7. | 150 | 7% | 7% |
| Level | 8. | 546 | 5% | 5% | 8. | 105 | 5% | 5% |
| Gas | 9. | 508 | 5% | 10% | 9. | 105 | 5% | 11% |
| Acoustic | 10. | 507 | 5% | 6% | 13. | 74 | 4% | 7% |
| Distance | 11. | 423 | 4% | 5% | 10. | 98 | 5% | 4% |
| Absolute Position | 12. | 380 | 4% | 8% | 11. | 82 | 4% | 7% |
| Humidity | 13. | 365 | 4% | 6% | 12. | 77 | 4% | 6% |
| Others | - | 1 159 | 11% | 6% | - | 236 | 11% | 6% |
| TOTAL | | 10 198 | 100% | 6% | | 2 083 | 100% | 6% |



Sensor consumption analysis per product segment

Global European and French sensor market overview

- The structure of the sensor consumption per product segment is much more fragmented than per application sector
 - this is due to the large scope of parameters that are being measured in the main application sectors (industrial, aero, auto)
- New applications of inertial sensors and gas sensors are stimulating both product segments (10% average growth over the forecast period)
- More mature sensor products like Temperature, Position, Flow, Force, Electromagnetic, etc. are still growing, though less rapidly due to cost decrease and thin film penetration
- The analysis of the aggregated market structure per product segment category (cf. product segment scope) gives the following

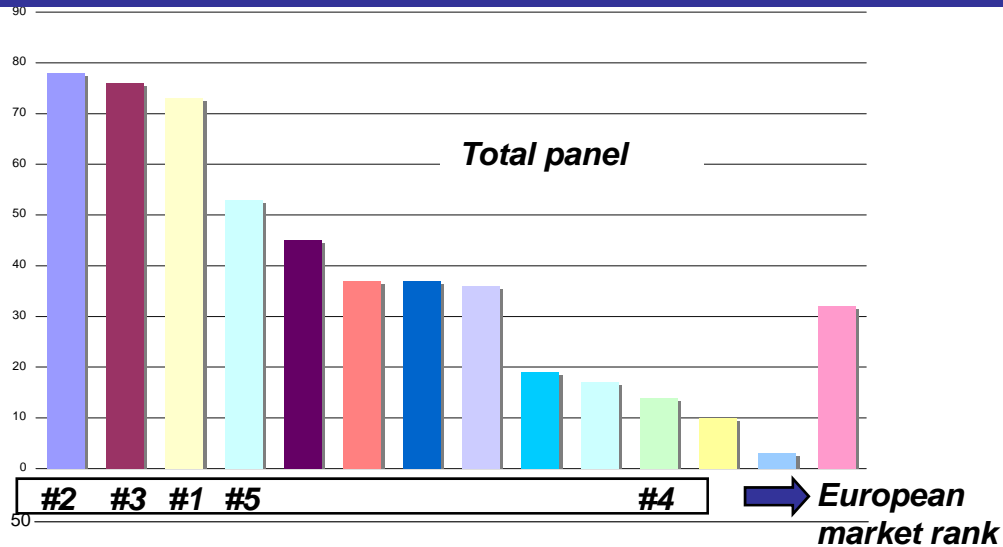
| Product segment category | European sensor market structure | French sensor market structure |
|--------------------------|----------------------------------|--------------------------------|
| Physical | 37% | 35% |
| Mechanical | 37% | 40% |
| Chemical | 16% | 16% |
| Electromagnetic | 10% | 8% |

- Physical and mechanical sensors represent the vast majority of the sensor market in Europe (and France too) with 75% of the global market

- Structure in France shows a larger share of mechanical sensors due to the relative size of aerospace&defense and automotive application sector

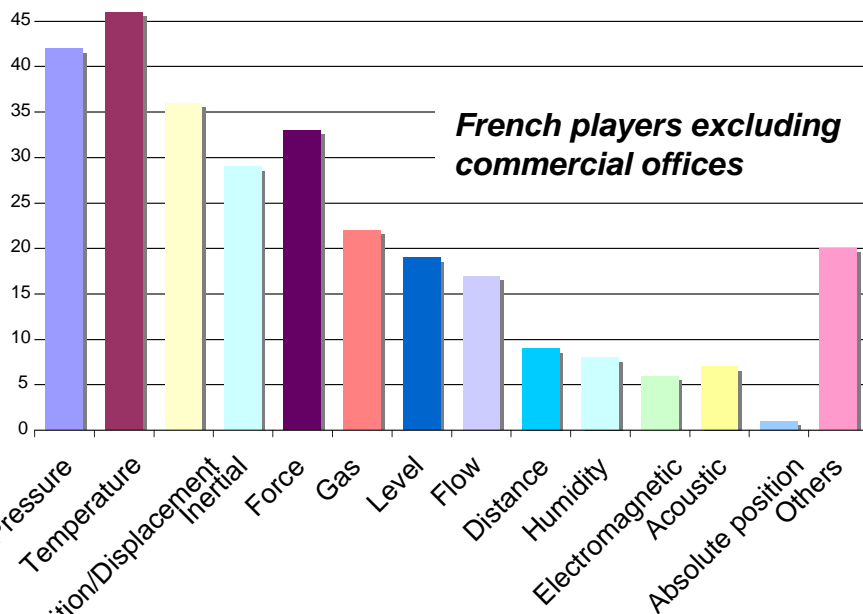


Panel mapping per product segment



Total panel

- Product segments addressed by the panel's companies are in line with the European market
 - except for electromagnetic sensors, where few semiconductor companies are predominant and the offer is consolidated
- Large number of actors in the main product segments that illustrates the disparity of the sensor market



French players

- Temperature and force are over represented in the French players panel mapping
 - due to the disparity of applications in the French industrial application sector (food and chemical)
- Position/Displacement are under represented in the French players panel mapping
 - due to the relative weakness of industrial equipment production in France



>Conclusion



Sensor market and average growth in Europe

- The European sensor market is estimated at 10 billion euros in 2007
- This represents 28% of the World sensor market (36 billion euros)
- The average sensor market growth is estimated at 6% in value terms between 2007 and 2011

- Average growth trend is similar to the World electronic equipment market during the period
 - at least twice the growth rate of the electronic component market in Europe
 - sensors are generally at the origin of new functionalities and market development in electronic and industrial equipment

- While Europe represents 20% of the World electronic equipment production, its share of the sensor market is significantly larger (28%)
 - this is due to the leadership position of Europe in application sectors that are “sensor intensive” such as industrial, automotive and aerospace & defense



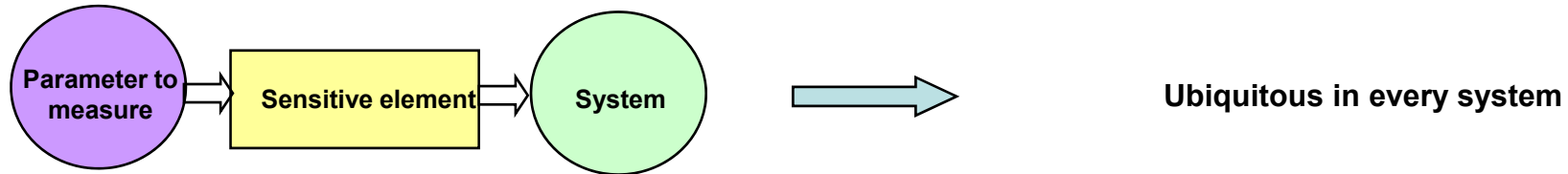
Sensor market and average growth in France

- The French sensor market is estimated at 2 billion euros in 2007, which represents 20% of the European sensor market
 - the French market is also specialized on sensor intensive application sectors such as aerospace&defense, automotive and industrial
- Average growth in France is estimated at 6%, similar to the European market
- However, the growth structure and drivers are different between France and Europe, especially from an application market perspective
 - the dynamic of the French market can be largely explained by the current demand in aerospace&defense applications which remains in France the first end application sector for sensors
 - the French industrial sensor market is also very much specialized in process and food industry rather than industrial equipment manufacturing
- Other important sensor markets in Europe are Germany and Italy where
 - with large and dynamic end markets in Automotive and Industrial
 - and a strong sensor manufacturing industrial base compared to France

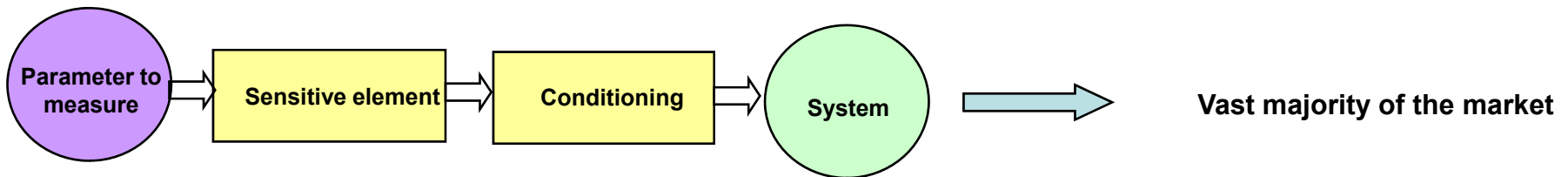


Sensor typology and market penetration

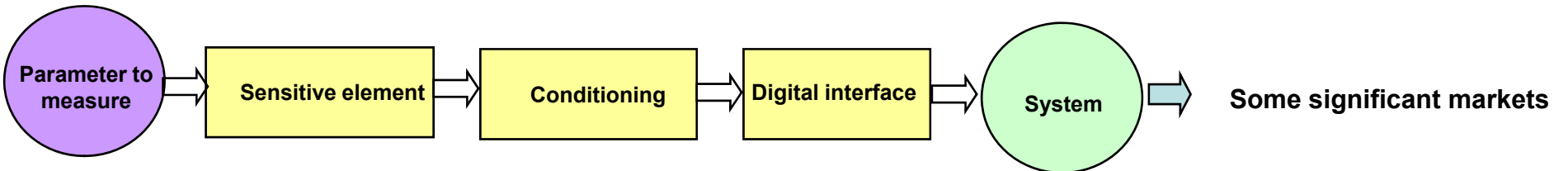
Transducer:



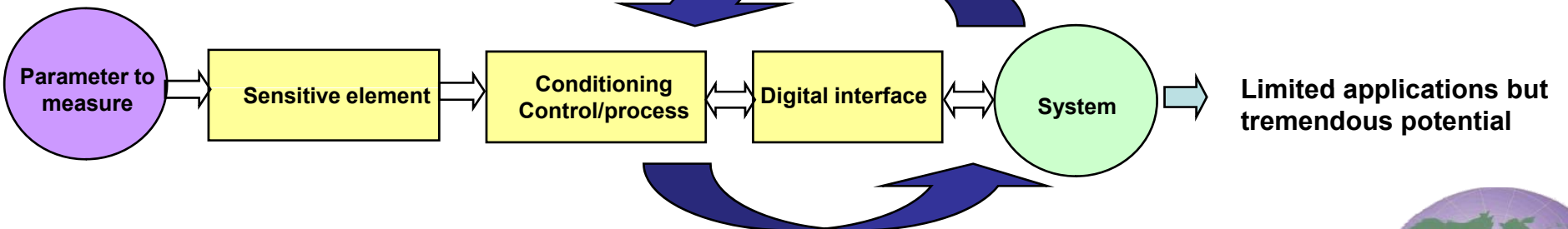
Functional sensor:



Digital sensor:



Smart sensor:



Sensor industry overview

- **Actors**

- an heterogeneous industry both in terms of end application markets and in terms of added value from the actors (complex value chain)
- an industry that is under consolidation where France do not have the sensor manufacturing base corresponding to its local end application demand and integration capabilities (with respect to Germany or Switzerland)

- **Markets**

- some historical end markets with long industrial cycles (industrial, aerospace & defense, etc.) and slow technology penetration
- ...and others with tremendous potential (consumer, medical, environment, security), relying on new sensor deployment concepts, features, integration know-how and business models (sensors networks, autonomous and abandoned sensors, smart sensors)

- **Technology**

- the dynamic development of thin film integration technologies (ICs, MEMS, etc.) is supporting this trend by allowing new integrated solutions along with sharp potential price decrease
- it is in a position to modify profoundly the technological landscape of the sensor industry, still dominated by mature solutions
- and introduce new products segments (e.g. bio-sensors, spectrometers), features (e.g. wireless, energy autonomy), which can in turn trigger the development of new applications (in medical, environment, security, consumer, etc.)



Evolution towards system

- System approach is intimately linked to the sensor market development
 - sensors have a direct impact on users (functionality, interface) and ownership cost (diagnostic, maintenance)
 - thus representing an opportunity to be in direct contact with OEM (system level definition), who are in demand of complete solutions
- From curative to palliative functions
 - new concepts of continuous monitoring in order to optimize maintenance schemes and procedures in historical markets (aerospace and defense, industrial manufacturing, etc.)
 - early warning (environment, medical, security), diagnostic functions (all application sectors) as well as energy savings and control (intelligent building, distribution networks, consumer devices) heavily rely on sensors
- These evolutions rely on new products development and technology integration with the following key characteristics: multiple measurements, smart and interconnected sensors, energy autonomy
-at a reasonable cost
 - regulation and standardization are key steps in order to facilitate market development and reach acceptable cost
 - depending on application, collaboration throughout the foodchain (from OEMs to transducer manufacturers) can also help in developing efficient solutions based on available technologies



>Appendix



- **Application sectors**

- 13 application segments, providing a comprehensive coverage of European and French sensor consumption
- including professional application sectors analysis such as (building, energy, environment, transportation...)

- **Product segments**

- 13 product segments based on measured parameters,
- e.g. position/displacement, pressure, temperature, etc.

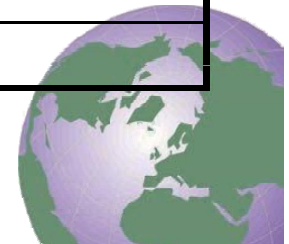
- **Sensors consumption analysis based on**

- European industrial and electronic production analysis and associated sensor content
- more than 50 interviews in Europe and France with sensors manufacturers, integrators, end-users and laboratories



Application markets definition

| End application Market | Definition |
|------------------------|---|
| Aerospace/Defense | Embedded sensors in aerospace and military platforms (civil/military aircraft, weapons, etc.) |
| Automotive | Embedded sensors in passenger cars (engine, body, chassis) |
| Building | Embedded sensors in home, office and public buildings as well as real estate infrastructures (civil engineering) |
| Consumer | Embedded sensors in mass market products (mobile phones, TVs, media players, computers, etc.) |
| Energy | Sensors used in power plants as well as energy transportation networks |
| Environment | Sensors used to monitor environmental parameters (meteorological sensors, air/water monitoring, etc.), excluding those integrated to an equipment platform (e.g. gas sensors in cars) |
| Home Appliances | Embedded sensors in large and small appliances (coffee machine, washer and dryer, etc.) |
| Industrial | Sensors used in industrial process and manufacturing including petrochemical industries, equipment manufacturing and assembly plant, food industry, etc. |
| IT infrastructure | Embedded sensors in computer and telecom networks and infrastructure (e.g. data warehouse) |
| Laboratories/test | Sensors used in R&D, laboratories and for test purposes |
| Medical | Embedded sensors in medical equipment including medical imagery, drug delivery, implantable devices, homecare devices, etc. |
| Security | Sensors used for personal, goods, site and homeland security |
| Transport | Sensors used in railway and marine transportation equipment and networks |



Companies and organization interviewed

| Manufacturers & Distributors | | OEMs | | Labs | Organizations |
|------------------------------|------------------------|-------------------|---------------|----------------------|---------------------------|
| Ademics | Infineon | Airbus | Sagem | LAAS | Alliance7 |
| Alliantech | Kistler | Bosch | Schlumberger | LETI | ANR |
| Aragonesas | LWorks | Clemessy | SEB Group | Pole capteur Bourges | Cetiat |
| Auxitrol | MicroEpsilon | EADS Secure Net. | SPX (for BMW) | Pole mer | Cetim |
| Bossa Nova | Micronas | EDF | Continental | Technopole Anticipa | Exera |
| Bronkhorst | Oxford Tech. Solutions | ELA Medical | Technip | Rennes University | Fédération ATMO |
| City Sensors | Pepperl&Fuchs | GE Healthcare | Tecnotest | | Ministère de l'équipement |
| Corrsys | Prosensor | Kirsten Soldering | Thales | | SYMOP |
| Epcos | Rheinhardt | MBDA | Veolia | | |
| First Sensor Tech. | Sensor | PSA | | | |
| Freescale | Sensorex | | | | |
| Gefran | Tronics | | | | |



Sensors manufacturers panel: purpose and methodology

- The sensors manufacturers panel has been realized in order to get a representative analysis of the sensors industry in France both in terms of product segment and application sectors
- Due to the disparity of the sensors industry in terms of value chain, technologies, applications and the lack of professional representation in France, this panel is not aimed to be exhaustive
- Companies within the panel have been continuously integrated throughout the course of the survey, based on desk researches (press, internet and companies websites, dedicated trade shows exhibitors list, etc.)
- Several structural information have been aggregated at the company level in order to provide some qualitative description of the panel and prove its relevance with the French market structure, including:
 - origin of the company
 - product segment and application sector coverage
 - type of activity and localization in France

