

# European and French Sensor Industry Technology, market and trends

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# >Introduction

*An heterogeneous business*

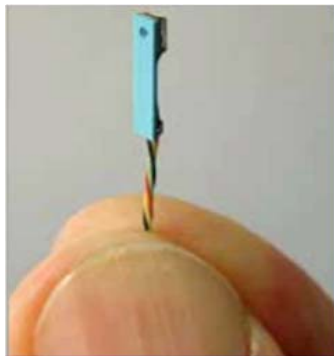
*European and French sensor markets*



- **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 penetration analysis
  - MEMs and thin film technologies penetration, sensors networks, etc.
- **Panel analysis of sensor manufacturers/integrators localized in France**
  - mapping per product segments and application sectors
  - analysis per type of activity in France



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.



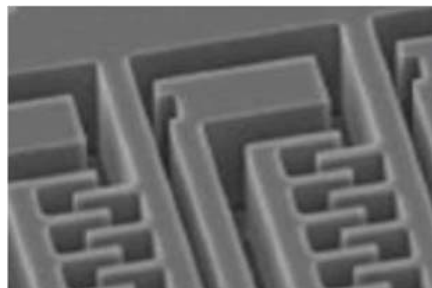
Source EPCOS



Source Solartron Metrology



Source Siemens VDO

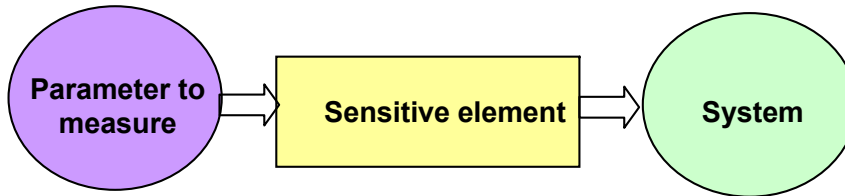


Source Freescale

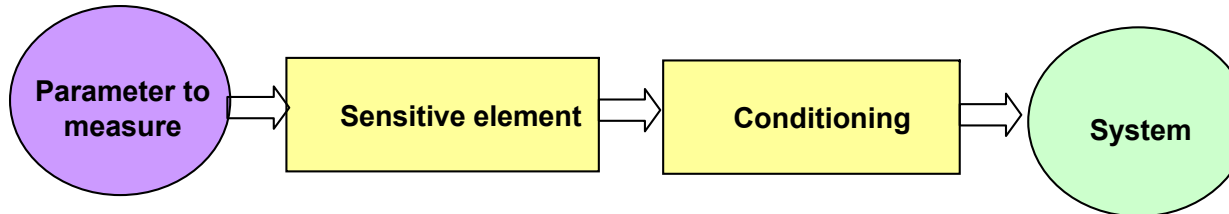


# Sensors typologies

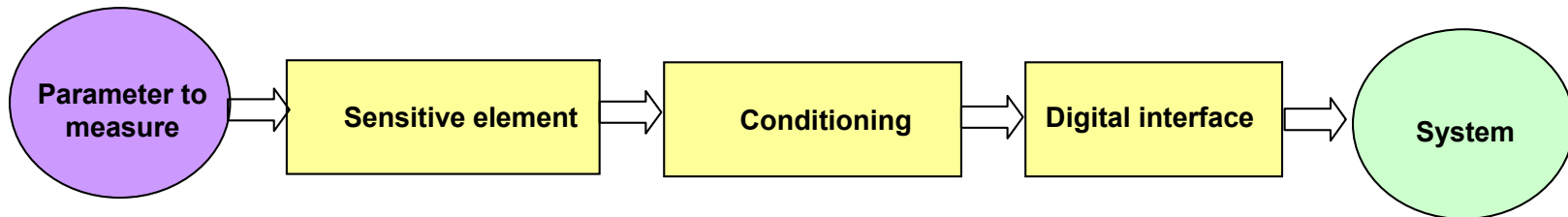
**Transducer:**



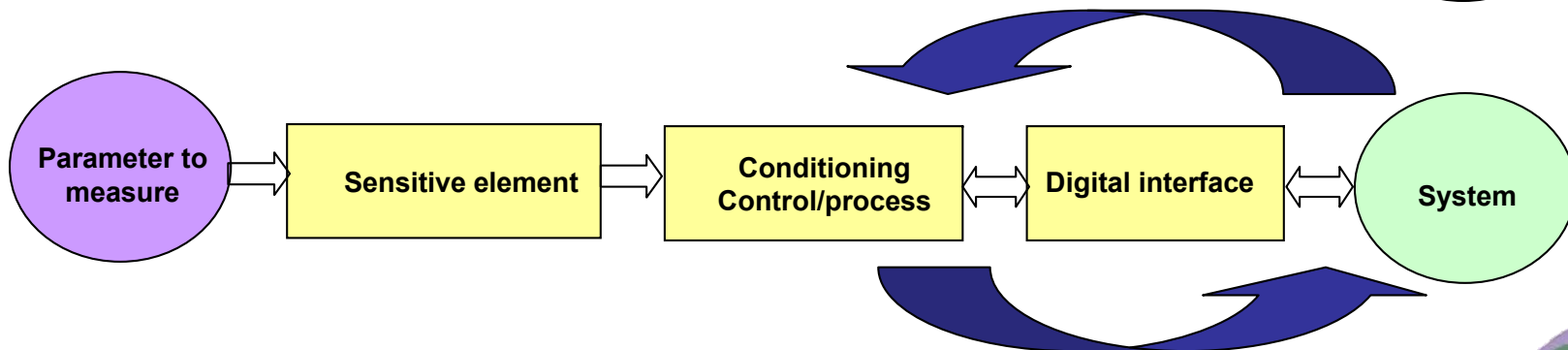
**Functional sensor:**



**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 60 to 70% of the market, providing Boolean information (ON/OFF)
- Sensors are basically used to detect and measure four main categories of parameters: physical, mechanical, chemical and electromagnetic

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

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

(2): grouped within the electromagnetic sensors product segment



# 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 European 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	



*Introduction*

# **>An heterogeneous business**

*European and French sensor markets*



- 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)



# 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 coverages (in particular for industrial application sectors)
  - most significant are: Ametek, Baumer, Emerson Process, Esterline, GE Sensing, Industrial Scientific Corporation, Measurement Specialties, Meggitt, Schneider, Spectris, etc.
- Some 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 discrepancy

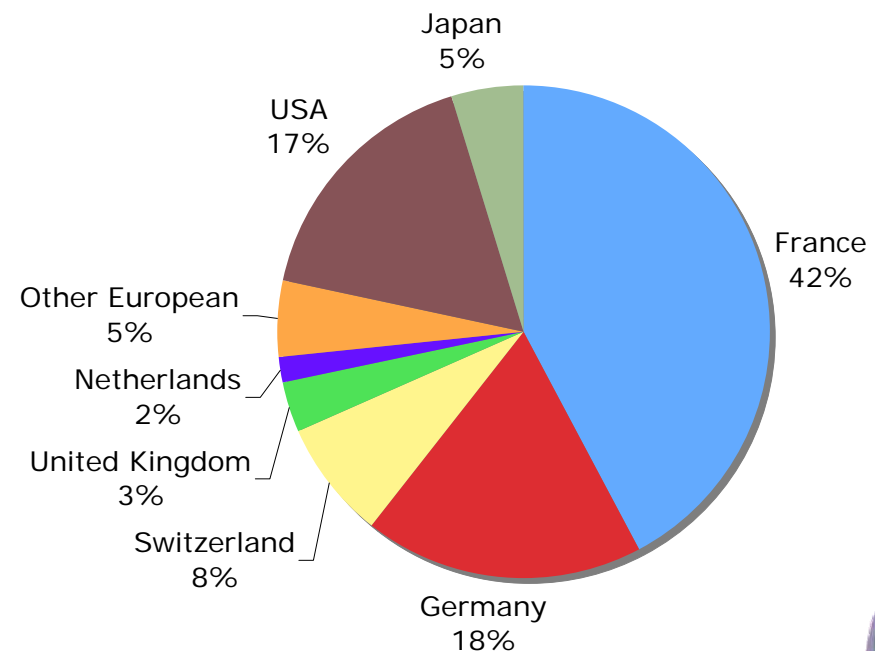
- Over 100 sensors technologies have been identified during the survey, and many more have not !
  - According to Wikipedia, there are at least 50 technologies for pressure sensing alone
- Depending on application markets, required sensors characteristics are very different. Sensors precision, accuracy, stability, repeatability, reliability have considerable impacts on:
  - transducer technologies
  - integration value added (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 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

ABB	<b>DELPHI</b>	<b>JTEKT</b>	<b>SENSOR</b>
<b>ADT</b>	<b>DISPROCUM</b>	KAVLICO	SENSOPART
<b>AHLBORN</b>	DJB Instruments	KELLER	SENSOR TECHNICS
<b>AIRINDEX</b>	<b>DOERLER</b>	KISTLER	<b>SENSOREX</b>
<b>AKOTRONIC</b>	E+E ELEKTRONIK	<b>KLOE</b>	SENTRONIC
ALLEGRO	<b>E2V technologies</b>	KOBOLD	<b>SERCEL</b>
<b>ALLIANCE Instrument</b>	EFE	<b>KROHNE</b>	<b>SETNAG</b>
<b>ALLIANTECH</b>	EFS	KULITE	SICK
<b>AMG microwave</b>	<b>ELECTRICFIL</b>	LaVision	Siegfried & Vester
<b>AMM</b>	<b>Electronique Contr™le Mesure</b>	LEM	Siemens Building Technologies
ANALOG DEVICES	ELMOS	<b>LESCATE</b>	Siemens Automation & Drives
<b>ANDILOG</b>	ELOBAU	LEUZE Electronic	SMARTEC
ASC Instrument	<b>EMERSON</b>	LINOS	<b>SNR</b>
<b>ASCO INSTRUMENTS</b>	<b>ENDRESS + HAUSER</b>	<b>LITTOCLIME</b>	<b>SOFRADIR</b>
ASCO Joucomatic Numatics	<b>ENERDIS</b>	<b>LOREME</b>	<b>SOFRASER</b>
ASHCROFT Instruments	<b>Environnement SA</b>	<b>MARTEC</b>	SOLARTRON
<b>ATEQ</b>	EPCOS	MCB Industrie	SONOTEC
<b>ATEXIS</b>	<b>ERCIAT</b>	<b>MCC</b>	<b>SOPHYSA</b>
<b>ATMEL</b>	E-T-A	<b>MEGATRON</b>	<b>STEDAM</b>
<b>AUTOCRUISE</b>	ETAMIC-HOMMEL	<b>MEIRI</b>	<b>STERELA</b>
<b>AUXITROL</b>	<b>EURO PHYSICAL ACOUSTICS</b>	MELEXIS	<b>STIL</b>
<b>AXOM</b>	<b>EUROFARAD</b>	<b>MEMSCAP</b>	<b>STMicroelectronics</b>
BALLUFF	<b>FGP sensors</b>	<b>METRAVIB</b>	<b>THALES AVIONICS</b>
<b>BEI IDEACOD</b>	FIRST Technology	MICREL	<b>THERMOCOAX</b>
BERTHOLD	FOGALE nanotech	<b>Micro-contr™le Spectra-Physics</b>	<b>THERMO-EST</b>
<b>BERTIN Technologies</b>	<b>FREESCALE</b>	Micro-Epsilon	<b>TME</b>
BIACORE	Fritz Kϕbler	Moving Magnet Technologies	TRAFAG
<b>BOSCH</b>	<b>FUJI Electric</b>	<b>N°oSENS</b>	<b>TRONICS</b>
<b>BOURDON - HAENNI</b>	<b>GAROS</b>	NGK / NTK Technical Ceramics	<b>TRW</b>
BRONKHORST	<b>GEFRAN-CORECI</b>	NIVUS	TURCK BANNER
BURKERT	<b>GEORGIN</b>	<b>NKE</b>	TYCO
<b>CADDEN</b>	getAMO	Ocean Optics	<b>ULIS</b>
<b>CAPACITEC</b>	<b>GRUTER ET MARCHAND</b>	<b>OLDHAM</b>	VAISALA
CAPTEC	Hamamatsu	<b>OMICRON</b>	<b>VALEO</b>
<b>CAPTELS</b>	HBM	OMRON	VEGA
Carlo Gavazzi	<b>HEITO</b>	<b>OPTEL THEVON</b>	<b>VISHAY</b>
CEDES	HUBA Control	<b>ORION TMI</b>	<b>WABCO</b>
CHERRY	<b>HUMIREL</b>	PANASONIC Electric Works	Wenglor Sensoric
<b>CIMEL Electronique</b>	IBS Precision Engineering	<b>PARATRONIC</b>	Yokogawa
<b>CITYSENSORS</b>	<b>IDIL</b>	PCB Piezotronics	
<b>CMR</b>	<b>IFM Electronic</b>	<b>PONSEL</b>	
<b>CODECHAMP</b>	IJINUS	<b>PRECILEC</b>	
<b>COFRATHERM</b>	IMPAC	<b>PROSENSOR</b>	
<b>COMPAUT</b>	<b>INDUSTECHNIC</b>	<b>PYRO CONTRILE</b>	
<b>CONTINENTAL</b>	ITECA SOCADEI	SAUTER REGULATION	
CORREGE	<b>IXSEA</b>	<b>SCAIME</b>	
CRANE Aerospace	<b>JPC</b>	<b>SCHLUMBERGER</b>	
<b>CROUZET</b>		<b>SCHNEIDER ELECTRIC</b>	

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



*Introduction*

*An heterogeneous business*

# >European and French sensor markets



# European sensor consumption per application sector, 2007

Europe				
Sensor Type	#	In million euros	Market structure	CAGR 2007-11
Industrial	1.	2 643	26%	7%
Automotive	2.	2 304	23%	3%
Aerospace/Defense	3.	1 684	17%	8%
Laboratories/test	4.	952	9%	4%
Consumer	5.	724	7%	2%
Medical	6.	534	5%	16%
Security	7.	250	2%	5%
Transport	8.	226	2%	5%
Building	9.	204	2%	7%
Energy	10.	199	2%	4%
Home Appliances	11.	183	2%	2%
Environment	12.	160	2%	15%
IT infrastructure	13.	138	1%	4%
<b>TOTAL</b>		<b>10 198</b>	<b>100%</b>	<b>6%</b>

Source DECISION



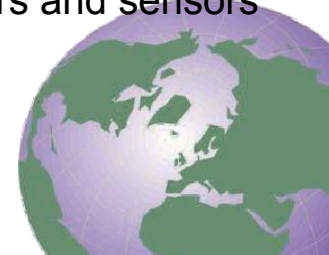
# Sensor market and average growth in Europe

- 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 1.5 billion euros in 2007, which represents 15% 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
  - with large and dynamic end markets in Automotive and Industrial machinery
  - and a strong sensor manufacturing base compared to France including transducers manufacturers and sensors integrators as well



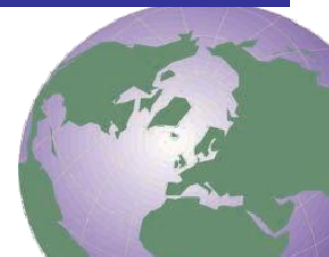
## Global European and French sensor market overview

- 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%

Source DECISION

- 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



# >Conclusion



- 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)
  - representing an opportunity to be in direct contact with final OEM (system level definition)
- From curative to palliative functions
  - structural health monitoring: new concepts of embedded monitoring in order to optimize maintenance schemes in historical markets such as aerospace and defense, industrial manufacturing, etc.
  - early warning (environment, medical, security), smart diagnostic functions as well as energy savings and control (intelligent building, distribution networks, consumer devices) heavily rely on sensors
- These market opportunities rely on new technologies and development in base materials, transducers, electronic processing, packaging and system integration
  - key research fields concern multiple measurements sensors (heterogeneous material integration and nanostructures), smart and interconnected sensors (sensor networks, self-diagnostic and configuration capabilities), energy autonomy (low power consumption and energy harvesting techniques), etc.
- ....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 sectors, 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 rather than transducer technologies
- e.g. position/displacement, pressure, temperature, humidity sensors etc.

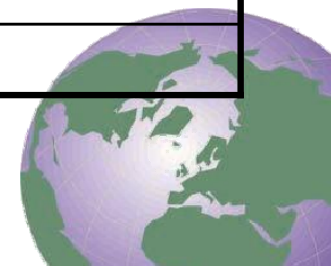
- **Sensors consumption analysis based on**

- European industrial and electronic production in depth analysis and associated sensor content
- consumption figures, i.e. market estimates correspond to the place where the sensor is actually being integrated within the equipment or infrastructure
- more than 50 interviews in Europe and France with sensors manufacturers, integrators, end-users and laboratories in order to cross-check and validate market estimates and forecasts



# Application sectors 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



- For any additional information please contact **Sebastien Rospide** at the following address [rospide@decision.eu](mailto:rospide@decision.eu),  
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- The complete survey (>100 pages report) is available at **3900 euros**

