pHealth 09, Oslo, Norway

24-26 June 2009

Microsystems and pHealth: Relevant activities under the Euroepan Commission-ICT program and forthcoming call for proposals 5

Andreas Lymberis
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Information Society Technologies and Media, Micro-systems
European Commission, Brussels

SEVENTH FRAMEWORK PROGRAMME

European Commission
Information Society and Media

LAYOUT

- **Micro & Nano technologies for better life**
- **Microsystems and Smart Systems Integration**
- **MNBS (Micro-nano-bio convergence systems)**
- **Microsystems for wearable personalised applications**
- **Forthcoming funding opportunities-call 5**

Technology transforms Medicine

- To a significant extent the improvement in lifetime expectancy can be attributed to Medical Technologies.
- 70% of the survival improvement in heart attack mortality can be attributed to changes in technology * e.g. introduction of the pacemaker and increasing use of minimally-invasive surgery enabled by advance medical imaging technologies.
- Heart pacemakers, blood pressure sensors, hearing aids and cochlear implants and biochips: total revenue of $ 5,2 billion (2001) **
- Strong market demand for microsystems and nanotechnologies in medical applications → continuous technological innovation

* D.M. Cutler and M. McClellan, *Is Technological Change in Medicine Worth It?*, Health Affairs 20, 11-29 (2001)

**J. M. Wilkinson, "Medical Market for Microsystems," International Newsletter on Microsystems and MEMS, No 4/02 p. 37, September 2002.

Convergence of MicroNano- Bio-ICT and Therapies Optimisation

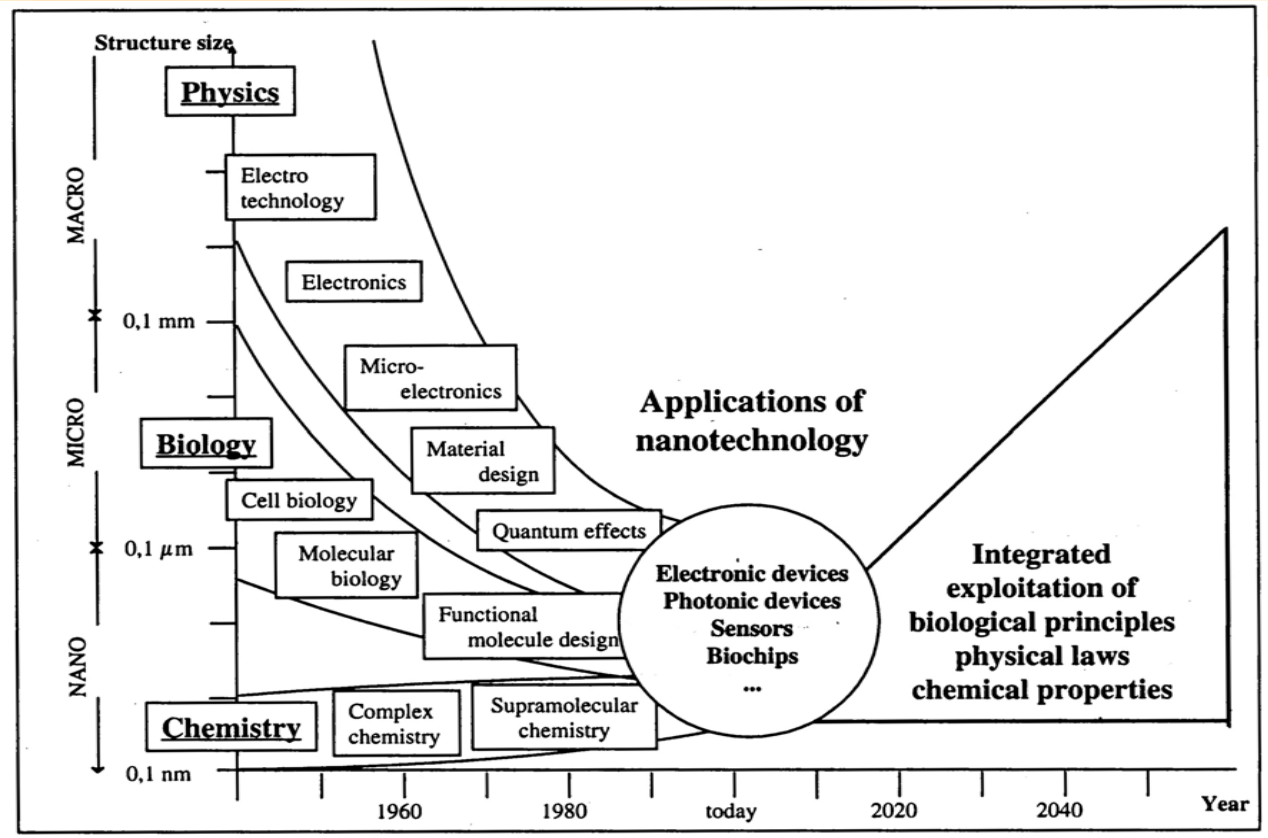
- Progress in many therapeutic areas until now through effective drugs treatment, surgical intervention and use of implants devices.
- In reality diseases still growing as more chronic and often degenerative (e.g. multi-drug resistant infections, chronic heart failure and pulmonary diseases.
- Therapeutic solutions today are not optimal.
  - Diagnosis lacks of sensitivity and specificity and remains invasive in most of the cases.
  - Pharmaceutical treatment has non-specific action and very often inadequate dosing and kinetics.
  - Surgical intervention is overly invasive, lacks of precision and causes damage to tissues.
  - Medical implants have relatively poor biocompatibility and connectivity with tissues, inadequate durability, clumsy power supply - size – weight, etc.

New concepts and integrated approaches and systems.

- Integration of diagnosis, treatment and monitoring
- Computer-assisted, image based intervention
- Drug-device combinations and targeted delivery of drugs and genes
- Sensor-activated (closed loop) drug delivery systems
- Integrated neuronal interfaces and muscular stimulators (epilepsy, appetite suppression, hemi- and quadriplegia, blind- and deafness…)
- Fast information about the patient's response to the treatment is essential for its success (complex combination of IVD, imaging and information technologies).

❑ **Micro- nano systems are potent facilitators of integration.**

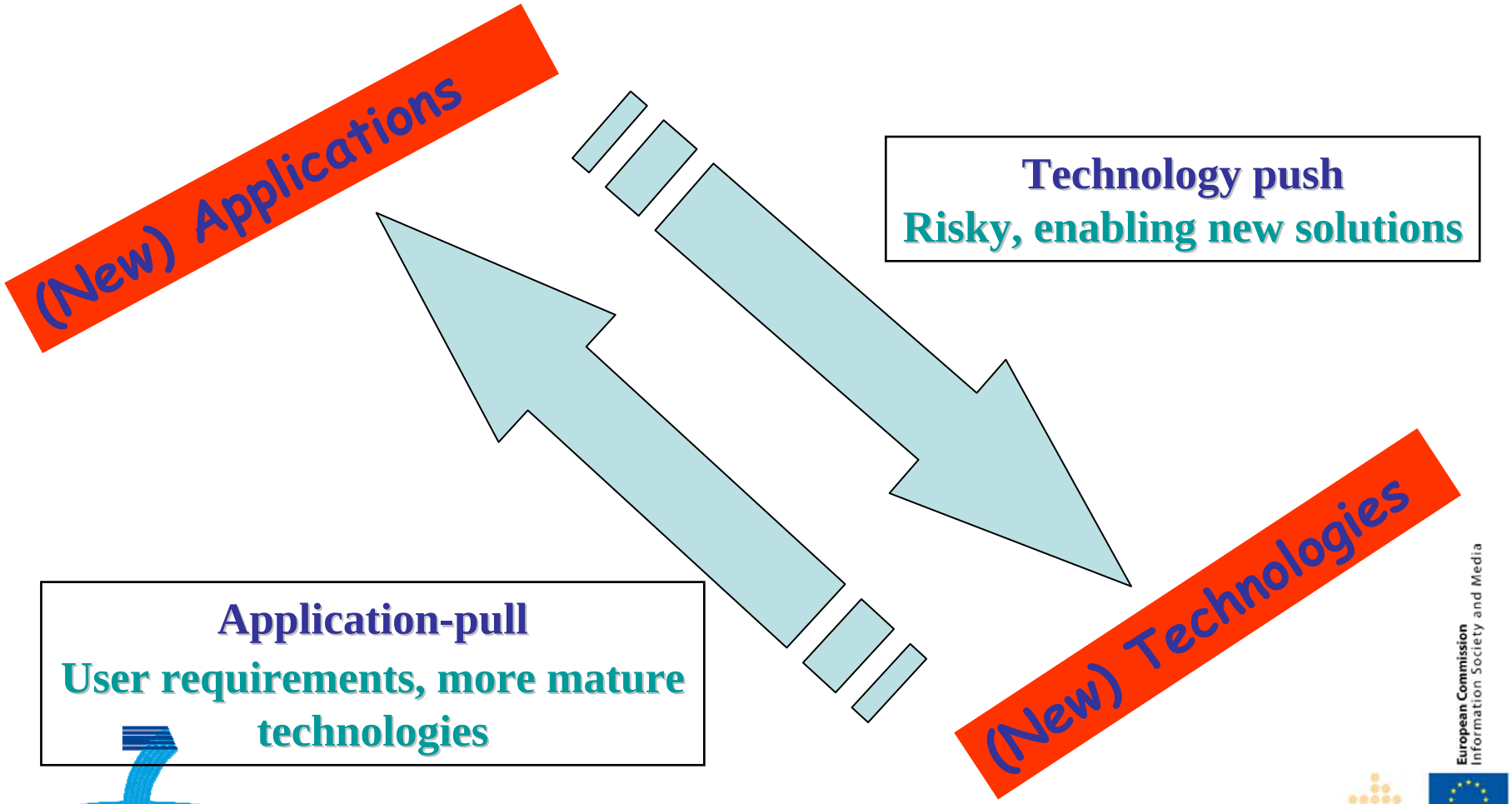
Innovation: Advances in Sciences & Technologies



© Gerd Bachmann, VDI-Technology Centre, Future Technologies

µ-chip

Wearable Technology & Systems: Dual Approach



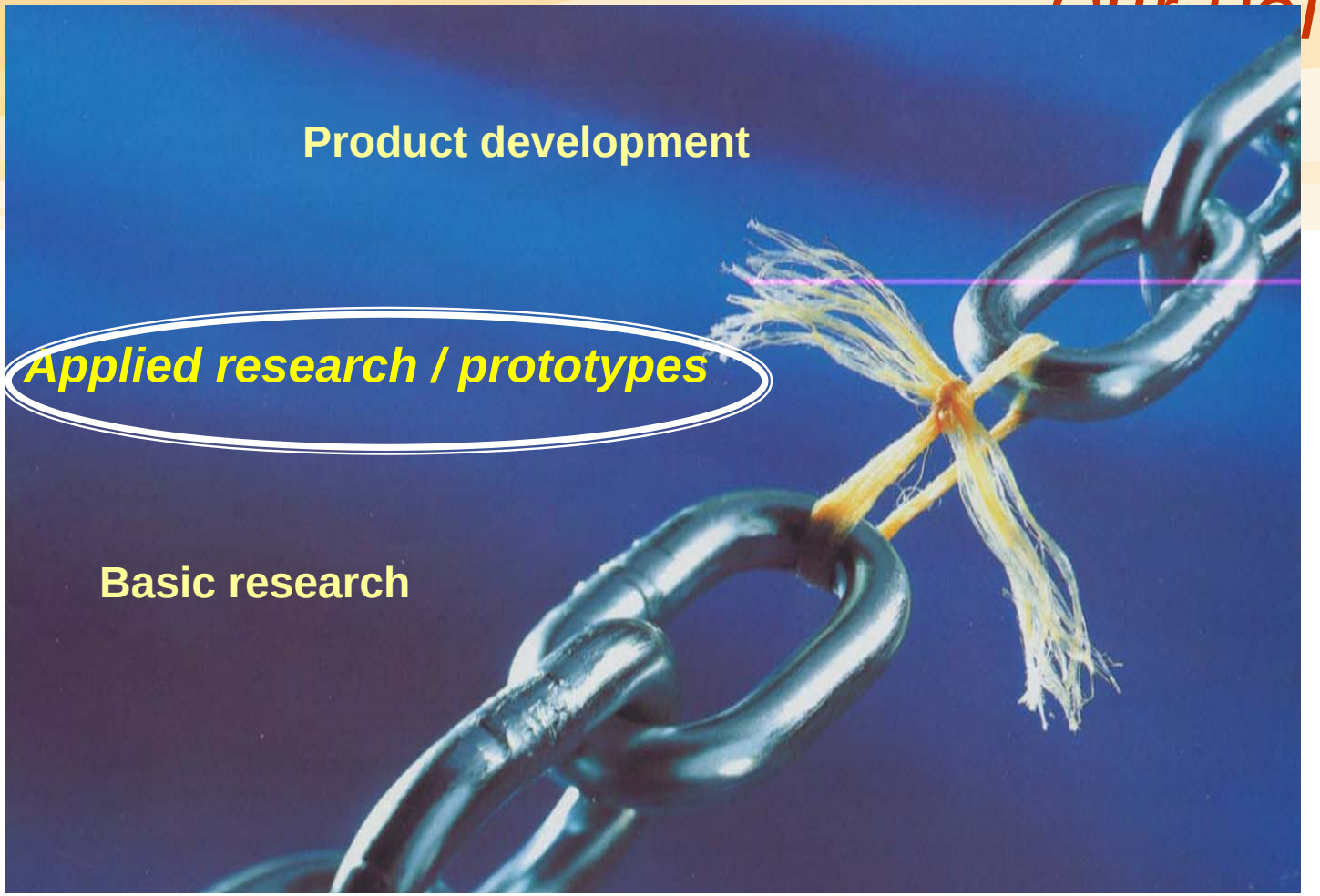
EU Policies: The renewed Lisbon agenda

- Markets & Competition: Europe – A more attractive place to invest & work
  - Extend & deepen the internal market
  - Improve European and national regulation
  - Ensure open & competitive markets inside & outside Europe
  - Expand & improve European infrastructure

- Knowledge & innovation for growth
  - Increase & improve investment in R&D
  - Facilitate innovation & uptake of ICT & the sustainable use of resources
  - Contribute to a strong European industrial base

- Employment & Skills: Creating more & better jobs
  - Attract more people into employment & modernise social protection systems
  - Improve the adaptability of workers & enterprises & the flexibility of labour markets
  - Invest more in human capital through better education & skills

Our Role



Any sufficiently advanced technology
is indistinguishable from magic
- - Arthur C. Clarke

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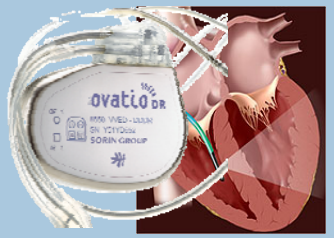
What are Smart Systems?

Smart Systems …intelligent miniaturised technical subsystems evolving from microsystems technology with ≥ 1 additional functionalities:

- **are able to diagnose a situation, describe it and qualify it,**
- **mutually address and identify each other,**
- **are predictive,**
- **are able to decide and help to decide,**
- **enable the product to interact with the environment.**

They are networked, energy autonomous and highly reliable.

R&D in advanced microsystems driven by application



Smart implants

Smart RFID

Smart antenna

Smart tire

Main Challenges

1. Multiple Research fields to combine

Mechanics, electronics, fluidics, biology, magnetism, photonics

2. Multiple Materials need to work side by side

Semiconductor, ceramic, glass, organic

3. Multiple Functions to integrate

Sensing, processing, logic, memory, communication

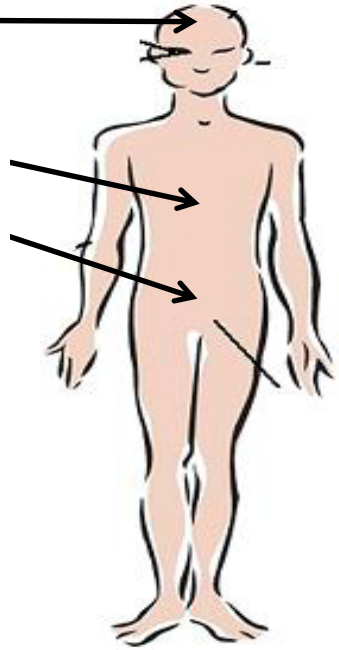
4. Multiple Integration of technological options

Monolithic, hybrid, multichip, wafer-level packaging

High growth potential in a broad range of application sectors

- Biomedical
- Transport
- Telecommunications
- Automotive
- Safety
- Environment
- Smart textiles
- Conformable, Flexible systems

Everywhere (almost !)



World market

- 2006: 32 Bn€ (only for Microsystem technologies)
- 2011 prediction: 57 Bn€

Microsystems in FP6: Thematic areas covered

Total budget [2002-2006] 301M€

- **Micro/Nano-bio ICT.**
  Biosensors, lab-on-chip, DNA & protein analysis chips, food safety & quality monitoring, implants, drug delivery, medical imaging
- Sensor-based systems and Storage.
  Integrated sensor systems, MEMS, handling of nano-objects, mass storage
- Organic/Large area electronics and Displays.
  Organic electronics, flexible electronic systems, flexible displays, large-area applications
- Systems for Ambient Intelligence (AmI).
  Mobile phone based platforms, networked multisensors system for elderly people, smart textiles, biosensing textiles
- Manufacturing and Process integration.
  Microsystems manufacturing technologies from design to packaging testing and reliability
- **Smart fabrics and interactive textile.**
  Integration of advanced fibres and materials at the fibre core. E-textiles
- **Support and coordination actions.**
  Networking, roadmaps

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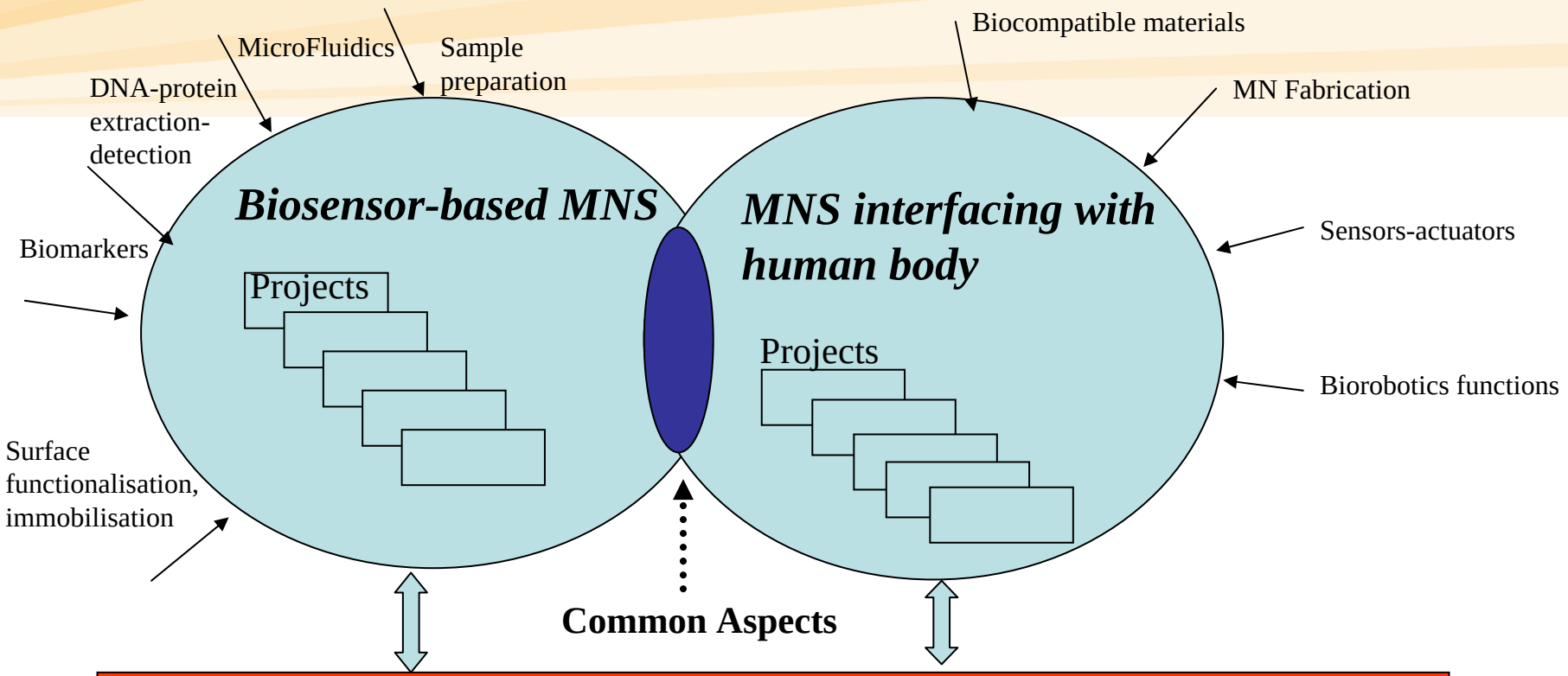
MNBS group of FP6 Projects: Structure, links and content



- 36 Projects, 2 Service Actions
- 110 M€, 390 Organisations, 27 MS & AS + China, Australia, USA, Korea, Mexico
- 60 Universities, 50 R&D Centers & Institutes, 70 companies (Research & product evelopment)

✓MNBS: R&D on Biochips & Arrays

- Integrated Biosensor for Label Free in vitro DNA and Protein Diagnosis
- *Wearable biochemical sensing (BIOTEX)*
- DNA analysis: with enclosed microfluidics, integrated detectors and control circuitry using polymer and silicon materials

✓MNBS: R&D on MicroTAS and Lab-On-Chip /Card

- *Smart integrated biodiagnostic systems for healthcare (SmartHealth)*
- Food safety and Quality monitoring with Microsystems
- Lab-on-chip based protein profiling for Cancer diagnostics
- Mass produced Optical diagnostic Labcards
- Cell-On-Chip biosensor for detection of cell-to-cell interactions
- Integrated Microsystem for magnetic isolation and analysis of Single circulating tumour cells for oncology
- *Deep Vein Thrombosis –Impedimetric microanalysis Systems (DVT-IMP)*

MNBS: R&D on Body sensors, implants, neural probes and biorobots

- **SENSATION** – Advanced sensor development for attention, stress, vigilance, & sleep/wakefulness monitoring
- **VECTOR** – Versatile endoscopic capsule for gastrointestinal tumour recognition and therapy
- **NEUROPROBES** – Multifunctional microprobe arrays for cerebral applications
- **INTELLIDRUG** – Intelligent intraoral medicine delivery microsystem to treat addiction and chronic disease
- **IMANE** – Implantable Multicontact Active Nerve Electrode
- **HEALTHY AIMS** – Nanoscale materials and sensors and microsystems for medical implants improving health and quality of life
- **P.CEZANNE-** Development of an implantable biosensor for continuous care and monitoring of diabetic patients

Nanobiotechnology Markets: Europe should become more competitive

- World total $1 trillion market for nanotechnologies in 2015
- 350-500 $billion is allocated to healthcare and pharmaceutical applications
- Nanobiotechnology market: $4b (2002), $8b (2005), $20b (2010), $70b (2015)
- Gap between USA and EU: In 2005, $8b (5.1 USA, 1.5 EU); in 2010, $20b (12 USA, 4 EU); in 2010, $ 70b (35 USA, 21 EU)
- US government recognised the future potential of nanotechnology and academia/research centers move ahead but industrial segment still relies on venture capital

Nanobiotechnology: A Jain Pharmabiotech Report

HOW IS THE EU DOING?

Region	1997	1998	1999	2000	2001	2002	2003	2004	2005
EU	126	151	179	200	~ 225	~ 400	~ 650	~ 950	~ 1,050
Japan	120	135	157	245	~ 465	~ 720	~ 800	~ 900	~ 950
U.S.	116	190	255	270	465	697	862	989	1,081
Others	70	83	96	110	~ 380	~ 550	~ 800	~ 900	~ 1,000
Total (% of 1997)	**432** (100%)	**559** (129%)	**687** (159%)	**825** (191%)	**~ 1,535** (355%)	**~ 2,350** (547%)	**~ 3,100** (720%)	**~ 3,700** (866%)	**~ 4,100** (945%)

- **VERY WELL IN TERMS OF FUNDING (figures in M$), BUT …**

… could do better in publications, patents, uptake

- **About 20% of ISI publications (the US produces about 40%)**
- **Less than 20% of *Nature* and *Science* publications (the US produces 50%)**
- **Delay in commercialisation of technologies**

Yannis Katakis, Ciara O'Lullivan (Consulation WS, May 2006, Brussels

Market Questions

- Why doesn´t nano-bio-micro-it take off?
- There is a clear difference between the consumer market (POC, last chains in food distribution system, etc.) and the large players (Universities, Pharma, Hospitals, Clinical Chemistry labs).
  - "Successful" Biotech companies do not sell for a consumer market (yet? – except perhaps the diabetes sensors) !
- Who is a customer?
  Who makes the money?
  - The health care structure differences within EU
    - How about the regulations (food quality control, water quality, etc.)
- How large investment in R&D is needed?
- The role of EU
  - Better differentiation between Research vs. Development!
  - Scientific focus is important
  - Company involvement

Factors that hinder or Delay execution (worldwide)

- *Knowledge gaps* (e.g. biochemical pathways)
- *Technology gaps* (MNB at early stage, integration of building blocks, power management, etc)
- *Reliability* (complex and emotive)
- *Liability issues* (much beyond technology development and application)
- *Cost and affordability!*
- *User issues-ethics*

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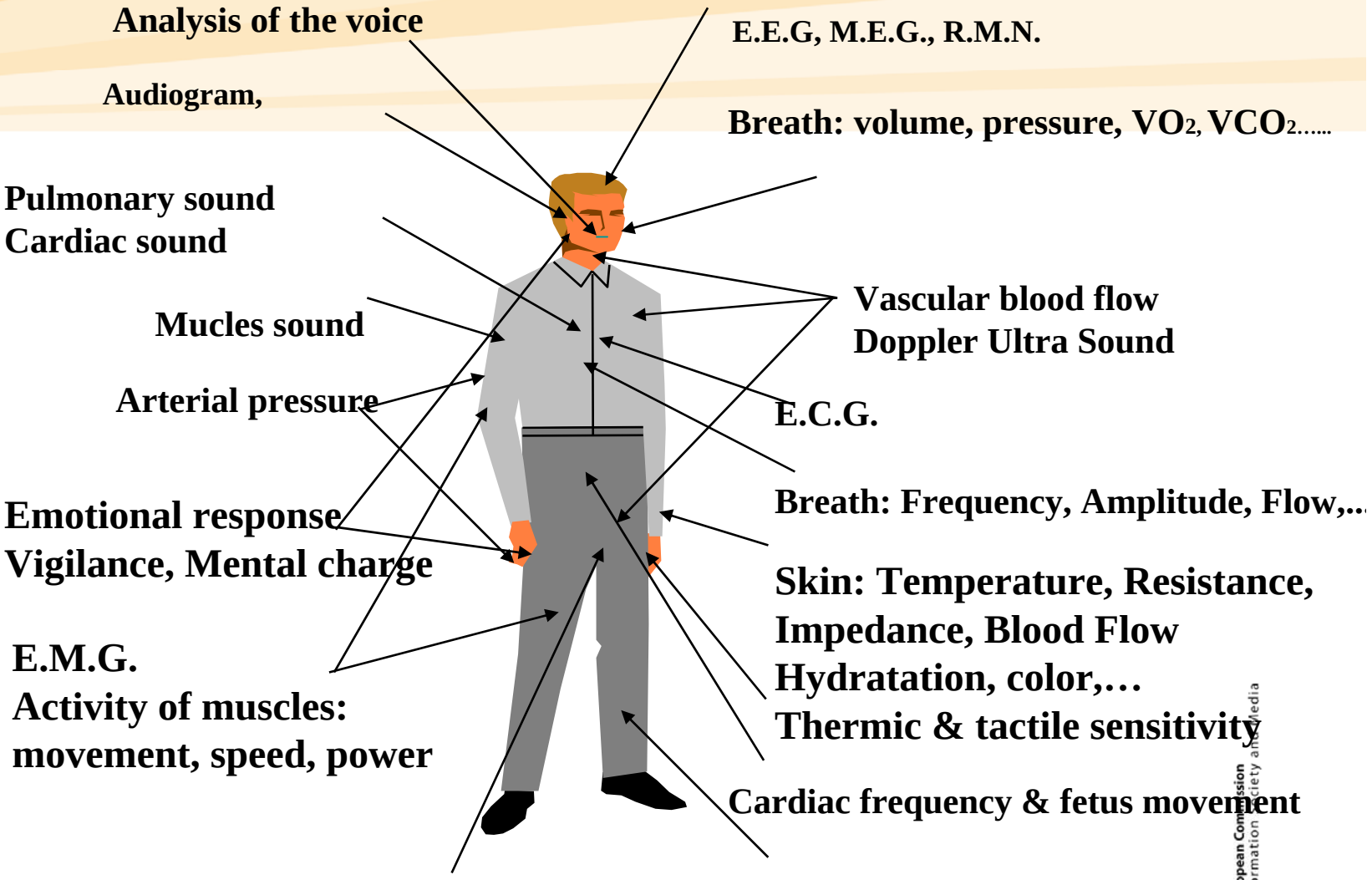
Non-invasive measurements: Plethora of possibilities



Courtesy A. Dittmar, Insa Lyon, Fr

Intelligent Wearable Systems: Meeting the User Needs?

- √ Comfort with a capacity of operation by totally unskilled persons **(ANYONE)**
- √ Reasonable price and low power consumption **(AFFORDABLE)**
- √ Embedded processing and alarming capability
- √ Ability to keep an uninterrupted connection with a remote medical center 24 hours a day **(ANYPLACE, ANYTIME)**

Smart Fabrics-Interactive Textile and Flexible Wearable Systems

A cluster of Research & Technology Development Projects funded by the European Commission

Further integration of micro-nano technologies & flexible systems in textile material, aiming at the implementation of the "e-textile" paradigm, where sensing, actuating, communicating, processing and power sourcing are seamlessly integrated on a textile: a key future R&D area with large amount of potential applications and business opportunities

www.csem.ch/sfit

Technology Push: Development & Integration of innovative sensing, MNT, textile and ICT

Micro-communicating: sensor interface, processing and wireless

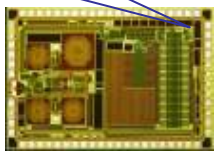
Microsystems physical sensors (attitude, fall, health, …)

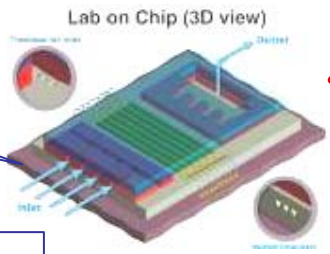
Flexible displays

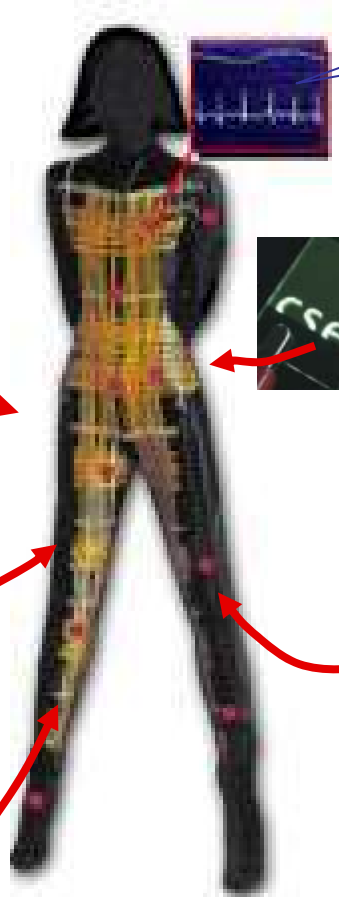
- **Nanoengineered surfaces**
- **Conductive fabrics**
- **Micro-interfaces**

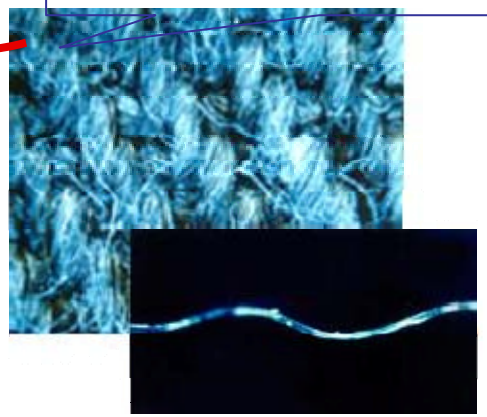
Point of care

Micro-energy generators









Courtesy CSEM, CH

An (expandable) group (7 Projects, 40 M€ Funding)

PROETEX: Protection e-Textiles: MicroNanostructured fibre systems for Emergency-Disaster Wear, (1/02/2006 - 31/1/2010)

STELLA: Stretchable Electronics for Large Area Applications (1/1/2006 – 31/1/ 2010)

BIOTEX: Bio-Sensing Textiles to Support Health Management (1/7/2006-29/05/2008)

CONTEXT: Contact less sensors for body monitoring incorporated in textiles, (1/01/2006-31/12/2008)

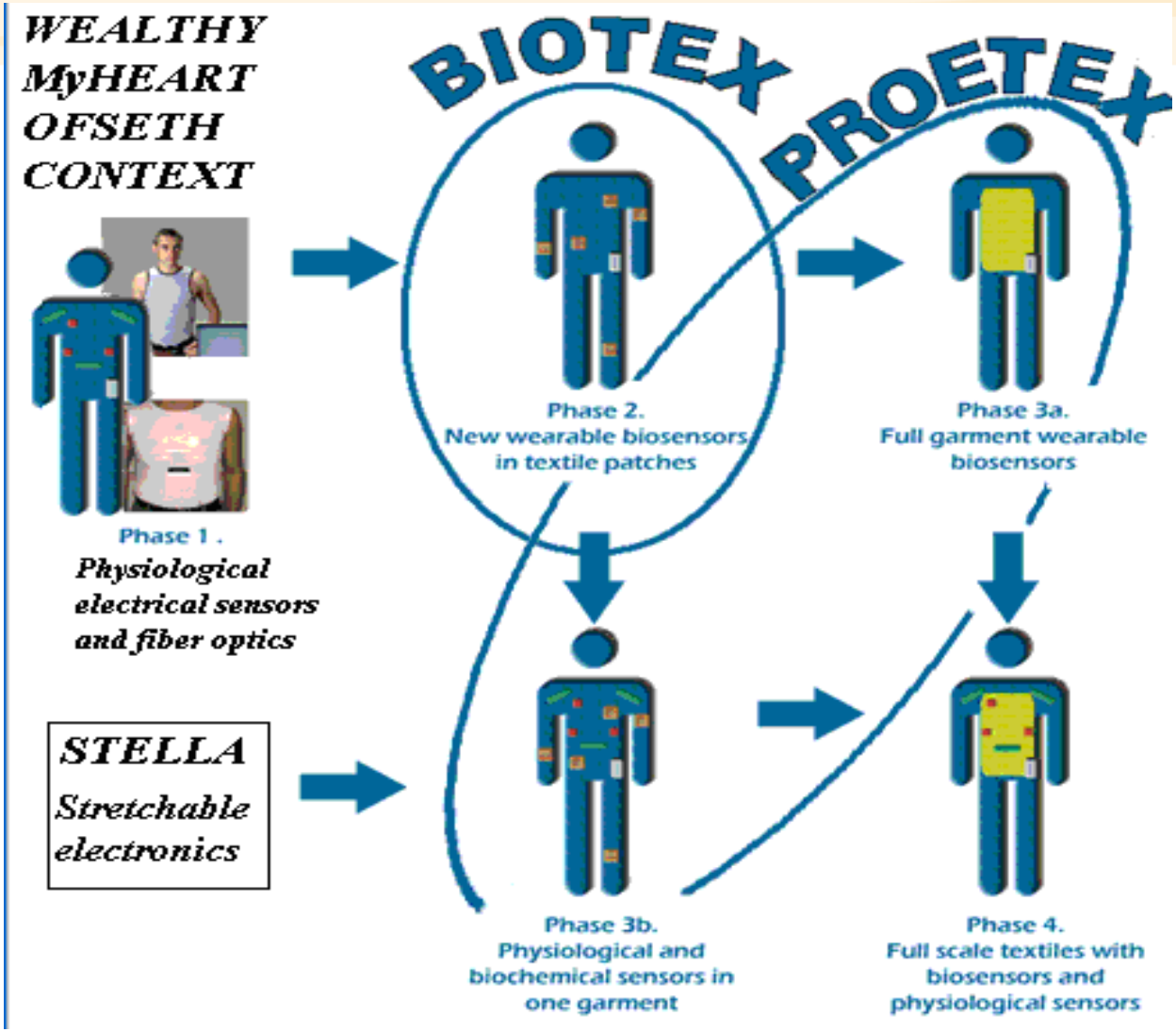
MyHeart: Fighting cardio-vascular diseases by preventive lifestyle & early diagnosis, (1/12/2003-30/8/2008)

OFSETH: Optical Fibre Sensors Embedded into technical Textile for Healthcare, (1/3/2006- 30/9/2009)

SYSTEX (FP7): enhancing the breakthrough of intelligent textile systems, Coordinated Action (1/5/08-30/4/2010)

Smart Fabrics-Interactive Textile and Flexible Wearable Systems

A cluster of EC-funded Projects (www.csem.ch/sfit)



SEVENTH FRAMEWORK PROGRAMME

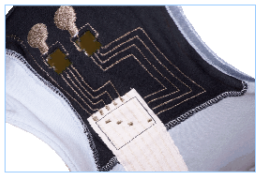
European Commission
Information Society and Media

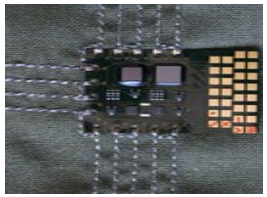
Remarkable Achievements in terms of feasibility and prototypes. e.g.

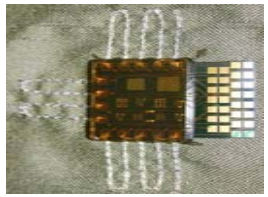
- Sensing patches for monitoring of body fluids (e.g. sweat rate, pH, electrolytes)
- Prototype of passive pump for sweat collection and handling (patended)
- Patented (1) technology for integration of optical fibres into elastic fabric

BIOTEX (FP6)

- Capacitive sensors for electro physiological monitoring.
- IntegratIon of electrodes, electronics and wiring in textile.







Embroidered interconnect Encapsulated electronics (hot melt)

Ongoing Major Integrated Project

PROETEX

Emergency Scenarios

Proetex addresses both Civil Protection and Fire-Fighters operators market:

They have different working conditions, needs and standards

Leading Idea: development of two different garments with some common features

1. Activity of the operator (movement)
2. Absolute position of the operator
3. Presence of toxic gases
4. Temperature of the environment
5. ECG and heart rate
6. Breathing
7. Body temperature
8. SpO2
9. Stress indicators
10. Dehydratation

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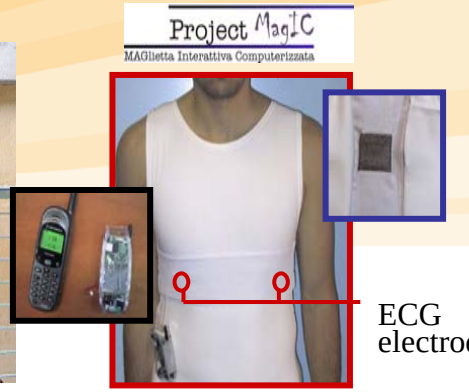
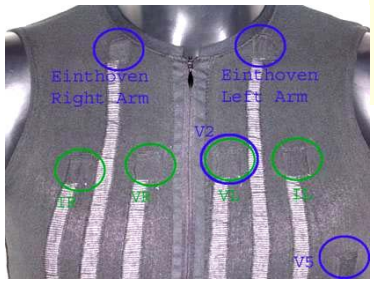
R&D in Smart textiles: Achievements and Gaps



ECG electrodes



2000 2005 2010

Wearable sensors/

computing

- Developing & testing yarns as sensors and electrodes
- Knitted integrated connections to measure resistance values in the same fabric
- Testing for several biophysical and mechanical parameters
- Piezoresistive fabrics → First integrated prototypes

-Innovative development and integration of sensing (bio, opto..) in patches, textile, garment.

-Improvement of power management for wearable applications

- Development & testing & integration of polymer materials for active functions

- Improved connectivity and short/long range communication

Towards full value chain development i.e. R&D, manufacturing, standardisation, lead markets

Prominent area of R&D. Need to address, along with future challenges, specific needs

- Interlink between technologies and applications is vital… for both
- Various business models, with different integration levels, are emerging
- Additional requirements on flexibility, stretchability, conformability, favour developments on new materials (plastic) and new manufacturing processes (roll to roll)
- Interdisciplinarity will open new opportunities by bringing closer together the living world and ICT
- Cost efficient, robust manufacturing technologies will succeed
- Research excellence needs to be accompanied by education and technology access actions

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FP7 [2006-2013] Specific Programme

"Cooperation"
Collaborative R&D, pre-defined themes, JTIs

"Ideas" NEW
Frontier research, competition, individual grants

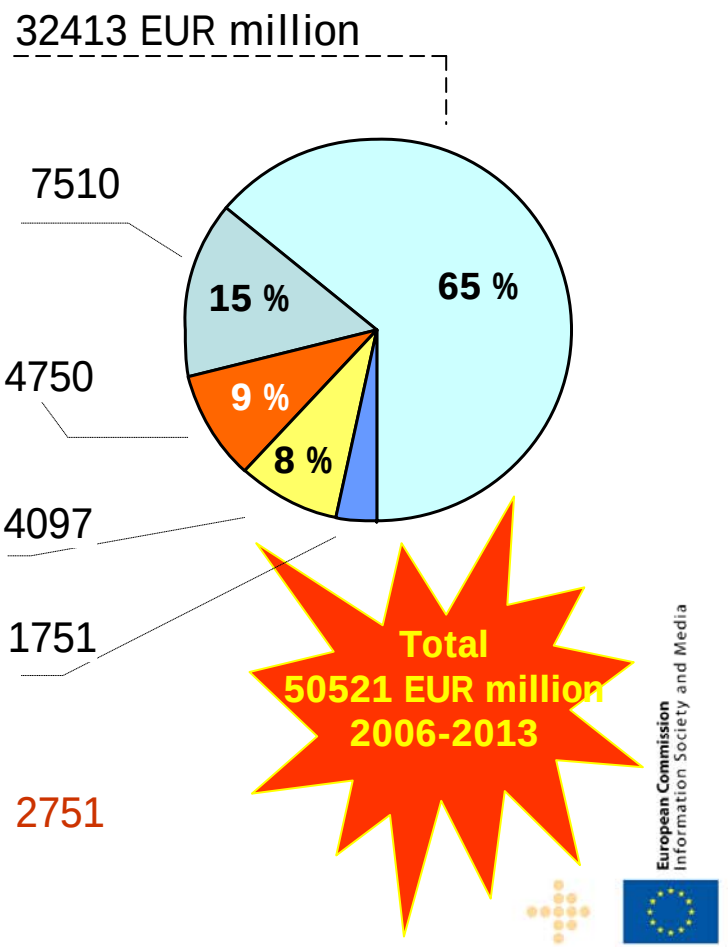
"People"
Human potential, mobility

"Capacities"
Infrastructure, SMEs, science and society

Joint Research Centre (non-nuclear)

+

EURATOM
EURATOM Programme



FP7 Cooperation: Themes

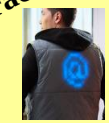
Budget [EUR million]

1.	Health	6100
2.	Food, Agriculture & Biotechnology	1935
3.	**Information & Communication Technologies**	**9050**
4.	Nanosciences, Nanotechnologies, Materials & new Production Technologies	3475
5.	Energy	2350
6.	Environment (including Climate Change)	1890
7.	Transport (including Aeronautics)	4160
8.	Socio-Economic Sciences & the Humanities	623
9.	Space	1430
10.	Security	1400
		32413

… including

- *Joint Technology Initiatives*
- *ERA-Nets*
- *International Co-operation*

FP7 Call 5, *Opening 31 July 2009 – Closing 3 November 2009*
Objective Microsystems, 3.9

Budget		"Instrument"
77 M€	(a) Heterogeneous Integration 	IP or STREP
	(b) Autonomous energy efficient smart systen 	STREP
	(c) Application-specific Microsystems Biomedical  Telecommunications  Environement Food/Beverage  Transport, Safety and Security  Smart Fabrics, Interactive Textile 	IP or STREP
3 M€	(d) Coordination and Support actions	CSA

(c) Application-specific Microsystems

Biomedical

Lab-on-chip platforms, from R&D to validation

(Drug discovery, diagnosis/therapy)

Microinstruments for cell manipulation and micro-injection

Microsystems interacting with the human body

Smart Fabrics, Interactive Textile

Multi-functional textiles and fabrics:

-Seamless integration of functions: *sensing*, *actuating*, *communication*, *processing*, *power sourcing*

- Integration of fibre-level components into textiles

- Stretchable and wearable electronics embedded in textiles

- Fully integrated Smart Fabric and Interactive Textile (SFIT)

Evaluation Criteria

SCIENTIFIC & TECHNICAL QUALITY 3/5	IMPLEME-NTATION 3/5	IMPACT 3/5
• Soundness of concept and quality of objectives • Acknowledgement of, and development beyond, the 'state-of-the-art' • Methodology and Work Plan • Quality of co-ordination • Innovative character • Quality and effectiveness of methodology and plan • Quality and effectiveness of the support action mechanisms and work plan	• Management structure and procedures • Quality, complementarity and balance of the consortium • Matching between consortium and proposal objectives • Appropriateness of allocation of – Budget – Staff resources – Equipment	• Expected impacts listed in Work Programme per topic • Measures for – Dissemination – Exploitation of project results – IPR management – Spreading excellence – Disseminating knowledge through stakeholder and public engagement

Overall Threshold = 10 > (3) + (3) + (3)

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EUROPEAN COMMISSION
Community research

SME support in FP7 "Cooperation" programme

- SME are encouraged to participate in collaborative research projects within this specific programme
- In order to form a favourable environment, a target of **15%** SME participation has been set
- This representing an amount of about 5 bn € until 2013
- Simplified financial and administrative procedures (e.g. 75% funding rate for SME, reduced requirements for audit certificates, no bank guarantees)
- Identification of areas and specific measures of particular interest to SME in the individual work programmes
- http://cordis.europa.eu/fp7/home_en.html

CAPACITIES

Getting help with your proposal

The ICT theme provides:

- Information events (like this one) - Information Desk
- A supporting website of advice, information and documentation http://cordis.europa.eu/fp7/ict/
- Model grant agreements, guides, checklists, etc. at: http://cordis.europa.eu/fp7/find-doc_en.html
- An ICT Information desk for proposers' questions ict@ec.europa.eu
- An IPR Helpdesk http://www.ipr-helpdesk.org/index.html
- A Helpdesk for electronic proposal submission support@epss-fp7.org

And a network of National Contact Points in Europe and beyond:

http://cordis.europa.eu/ist/ncps.htm

THANK YOU
for your Attention

- European research on the web:
  - http://cordis.europa.eu/fp7/home_en.html
  - http://ec.europa.eu/comm/research/future/
- Information Society and Media:
  - http://cordis.europa.eu/fp7/ict/programme/home_en.html
- Challenge ICT-2007.3.9:
  Microsystems and Smart Miniaturised Systems :
  http://cordis.europa.eu/fp7/ict/micro-nanosystems
- Challenge ICT-2007.3.2:
  Organic and large-area electronics, visualisation & display systems :
  http://cordis.europa.eu/fp7/ict/organic-elec-visual-display/home_en.html

Contact:
andreas.lymberis@ec.europa.eu

The views expressed in this presentation are the personal views of the author and do not necessarily reflect the official view of the European Commission on the subject matter.

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