



Some Trends in Health Technology

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Outline

- **Introduction**
- **Driving factors**
- **Health continuum**
- **Conclusion**



Introduction

■ Definition

medical device : instrument, apparatus, implant, *in vitro* reagent or similar or related article that is used to diagnose, prevent, or treat disease or other conditions

and does not achieve its purposes through chemical action within or on the body (which would make it a drug)

(Pharmaceuticals principal action: pharmacological, metabolic or immunological means)

Medical devices act by other means like physical, mechanical or thermal means.

Examples



- simple devices: tongue depressors, medical thermometers, disposable gloves, ...
- advanced devices: computers which assist in the conduct of medical testing, implants and prostheses



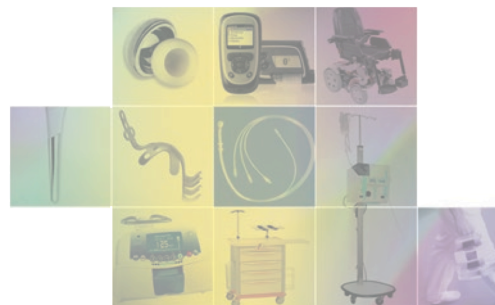
Introduction

■ Note 1

- Definition includes both hardware *and* software

■ Note 2

- Products which may be considered to be medical devices in some jurisdictions
 - aids for disabled/handicapped people
 - devices incorporating animal and human tissues
 - ...



Introduction

■ Health world market

€Blns 1116

- Pharmaceuticals €Blns 609
- Biotechnologies €Blns 160
- **Medical devices** €Blns 206
- **e-Health** €Blns 96
- Alimentary complements €Blns 45

■ Features

- Product cycle from idea to market: 10 to 15 years
- Complex regulatory approval process for market entry
- R&D investments >10 % of annual turnover + Mergers & Acquisitions ('every day' affair)
- Only 15 % of health expenditure → pharmaceuticals and medical devices (rest is personnel, buildings and other).

IMS Health, Eucomed, Market & Research, Analyse Développement & Conseil, 2011.



Medical drivers

- **Quality**
 - evidence-based medicine
 - efficient and adapted technological resources
 - continuous training of healthcare professionals
- **Optimality**
 - less invasiveness
 - “augmented doctor”
 - safe, efficient and accurate tools
- **Shared knowledge**
 - access to structured and validated medical knowledge
 - patients and healthcare professionals
- **Networking**
 - cooperation between GPs, specialists, para-medics, ...
 - and organizations for a better efficiency (ambulatory healthcare)
- **Patient empowerment**
 - decision sharing with an informed patient who is a actor of his/her health
- **Economy**
 - control of the healthcare costs, implement appropriate resources whatever the social or geographical aspects



Scientific drivers: from data to actions / from sensors to actuators

■ Data acquisition and processing

- design and integration of new sensors
- sensor miniaturization (from macro to nano)
- multi-modal (morphological, functional, metabolic) information fusion

■ From information to knowledge and decision

- structuration and sharing of clinical information and medical knowledge
- modeling (physiological systems, medical decision, healthcare delivery)
- data mining, big data

■ Health action

- individual action (e.g. computer assisted interventions, medical robotics, ...)
- collective action (e.g. hospital information systems)

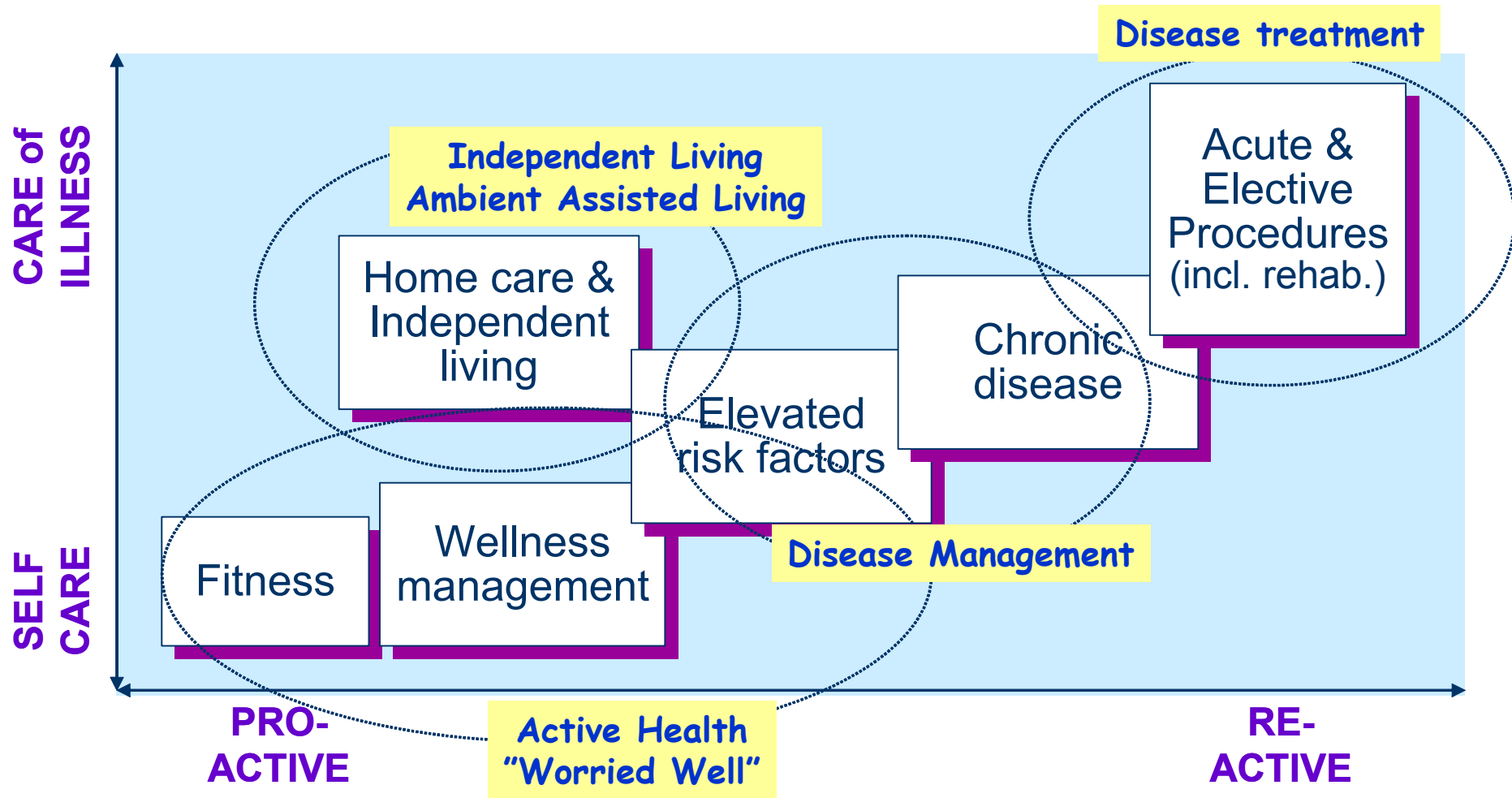


Industrial drivers

Active industrial participation in technology developments → impact on healthcare delivery

- **Participation in the definition of R&D projects**
- **Rapid prototyping following quality insurance standards for clinical validation**
- **Business models and standards**
- **Manufacturing and selling of validated healthcare technologies**

The health continuum *



* Niilo Saranummi, VTT Finland, former EiC, IEEE T-ITB



The health continuum

■ Main ideas behind the health continuum

- proactive action is better than reactive.
- people should be active in managing their health and illnesses
 - e.g. “Chronic degenerative diseases, such as diabetes and hypertension, are examples where care outcomes can be improved by recruiting patients into the care team.”

■ Target 1

- prevention by empowering individuals with knowledge and tools to address themselves proactively emerging health problems as early as possible

■ Target 2

- ageing people (assistance with tools and services to remain independent and integrated with the society as long as possible)

■ Challenges posed by th health continuum framework

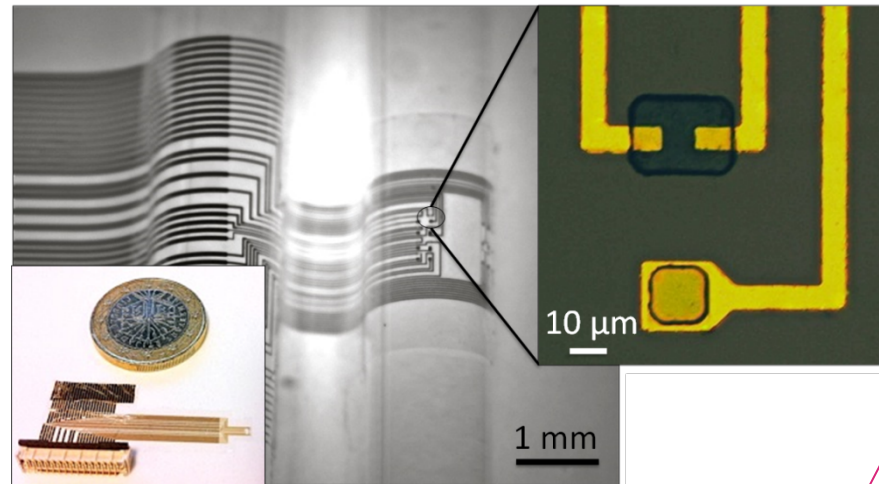
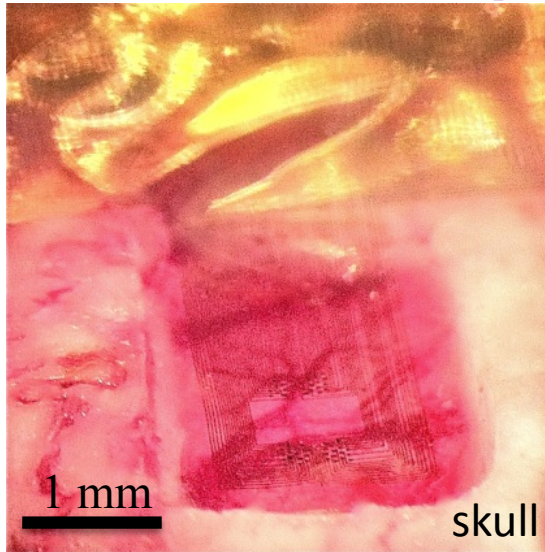
- **business models** for device manufacturers and service providers: how to bridge the wellness market (a consumer market with citizens/patients as entry points) and illness market (healthcare market with physicians as “gate keepers”)?
- **technical challenges** in developing sensors, systems and methods that allow meaningful acquisition of vital signs in uncontrolled environments. The devices and services should also be cheap, easy to use, self-motivating and connected to front and back end office services.



Technology disruption in Diagnosis

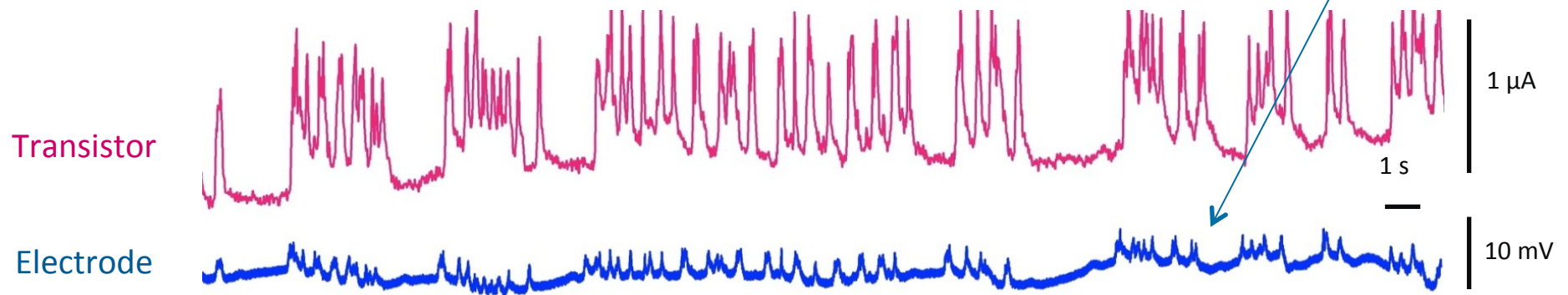
- **technical challenges in developing sensors, systems and methods that allow meaningful acquisition of vital signs in uncontrolled environments.**
- **Example 1**
 - Bio-electronics
Prof. George Malliaras, Ecole des Mines de St Etienne

Organic transistors for in vivo electrophysiology



SNR = 52.7 dB

SNR = 30.2 dB



w/ Christophe Bernard (INSERM)

Nature Comm. 4, 1575 (2013)
Nature Comm. 4, 2133 (2013)
Nature Neurosci. 18, 310 (2015)





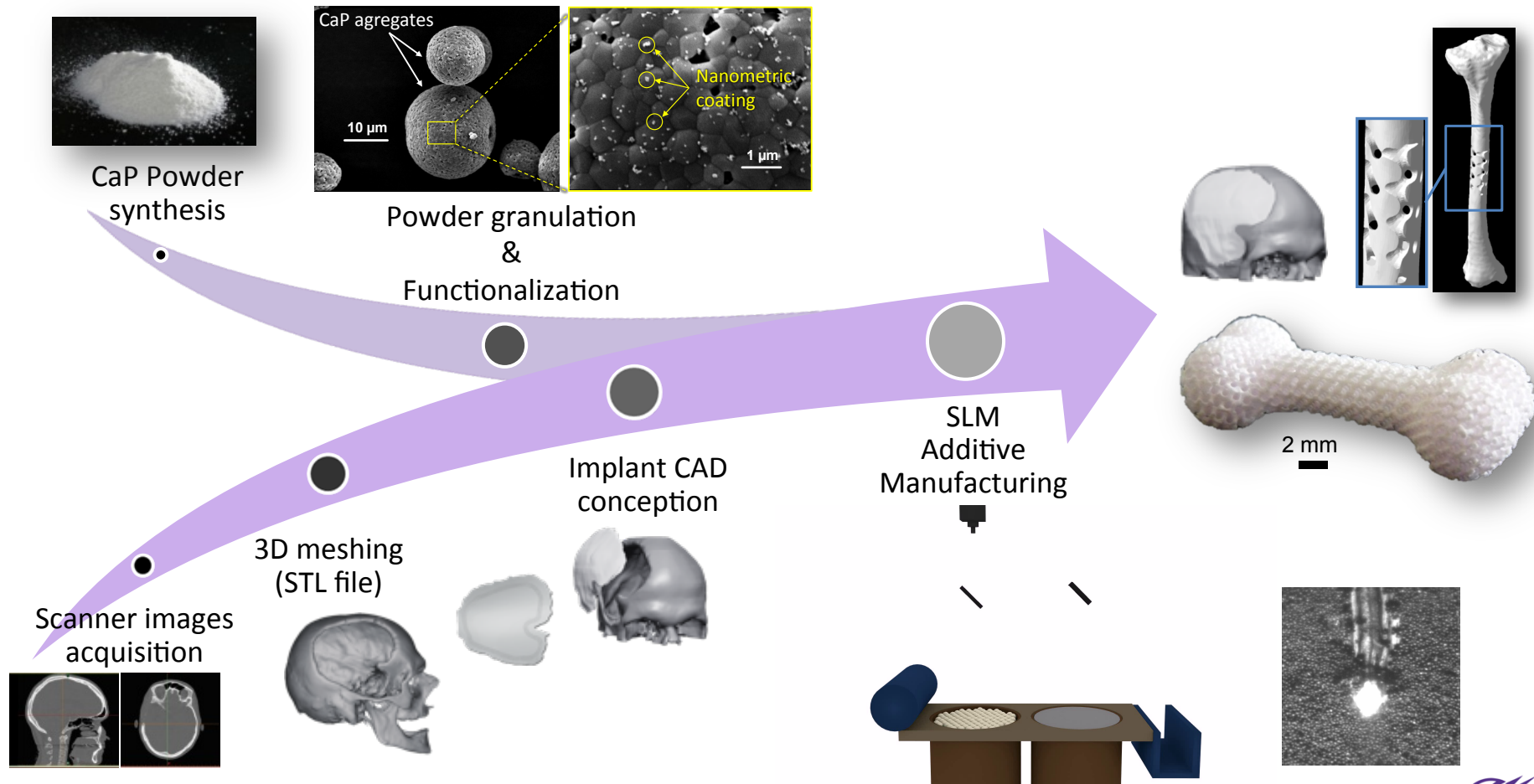
Technology disruptions in Therapy

- **technical challenges in developing new therapeutical strategy**

- **Example 2**
 - Additive manufacturing for bone tissue engineering
Dr. David Marchat, Ecole des Mines de St Etienne

Additive Manufacturing for Bone Tissue Engineering

CaP Bioceramic - Selective Laser Melting (SLM)



European Patent EP13161880

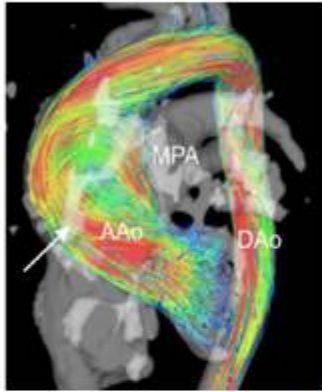


Technology disruptions in Prevention

- **technical challenges in developing innovative prevention frameworks**

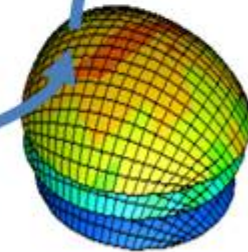
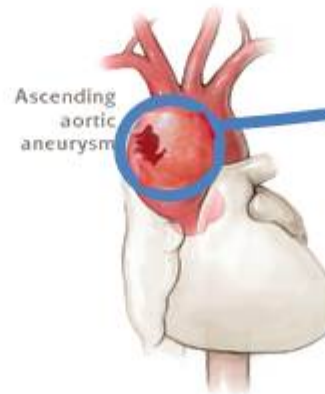
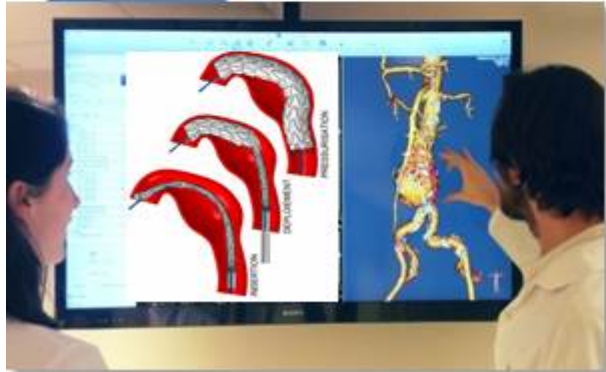
- **Example 3**
 - Biomechanical modeling for personalized prevention
Prof. Stéphane Avril, Ecole des Mines de St Etienne

Biomechanics of aortic aneurism



Our strengths
Multi-scale experimental and computational biomechanics

Our vision
Predictive modelling to design therapies





Conclusion

■ Vision

- a future where individuals proactively manage their health and where corrective action can be taken early enough to allow individuals to maintain their life style

■ ICT, a major change driver

- **horizontally:** “IT everywhere”
 - anytime, anywhere access to information and knowledge and context aware decision making
- **vertically:** “health services”
 - effective and efficient health service environment.
- some signs of progress
 - standards and guidelines for interoperability developed and endorsed by governments and industry
 - investments into nation-wide backbone for health information exchange and Electronic Patient Records repositories
 - some business models emerging