



EDEE Doctoral Programs in Electrical Engineering

EE-600: Usability Engineering

Lecture #1 - Introduction

What we really mean for Usability?

In the context of this course,
“Usability”
is the
“*the evaluation of the
effectiveness use of products
and its safety*”

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What we really mean for Usability?

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What then is “Usability Engineering”?

In the context of this course,

“Usability Engineering”

is

*“obtaining the usability
by design”*



Courtesy, Virginia Lang (Hirlan Inc.)

Why Human Factors take a role?

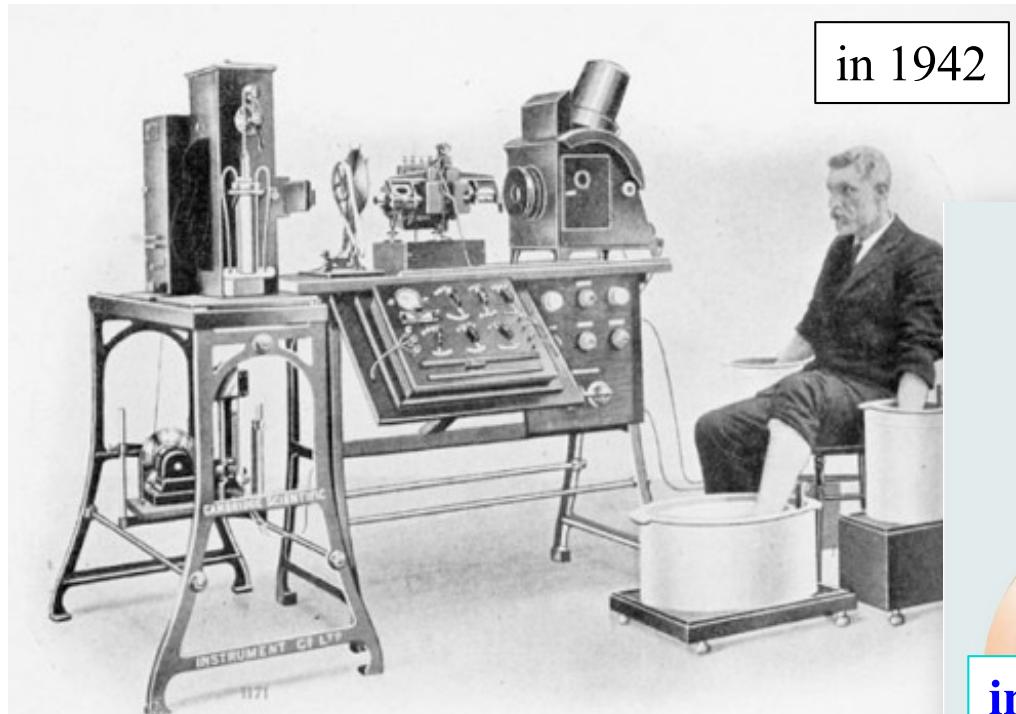
Why Human Factors take a role?

“Human Factors are in place as human behaviour, cognition (e.g., perception, attention, language, memory, etc.), and physiology in order to design and build products that are effective, safe, and profitable”

How to evaluate with Human Factors?

...easy in retrospective...

Usability of ECG devices



in 1942

in 2022



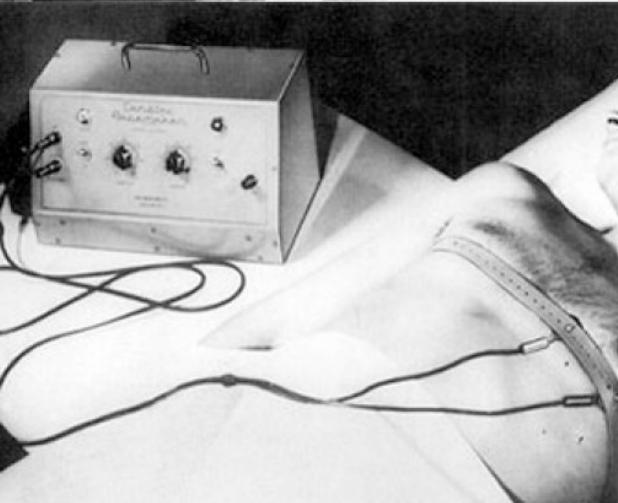
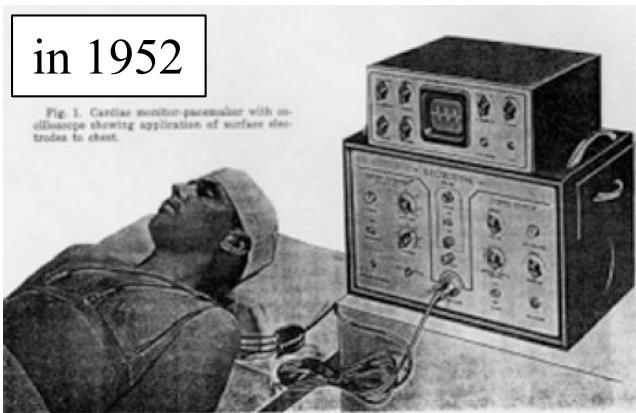
PHOTOGRAPH OF A COMPLETE ELECTROCARDIOGRAPH, SHOWING THE MANNER IN WHICH THE ELECTRODES ARE ATTACHED TO THE PATIENT, IN THIS CASE THE HANDS AND ONE FOOT BEING IMMERSSED IN JARS OF SALT SOLUTION

By Images Paediatr Cardiol. 8(2006): 17–81.

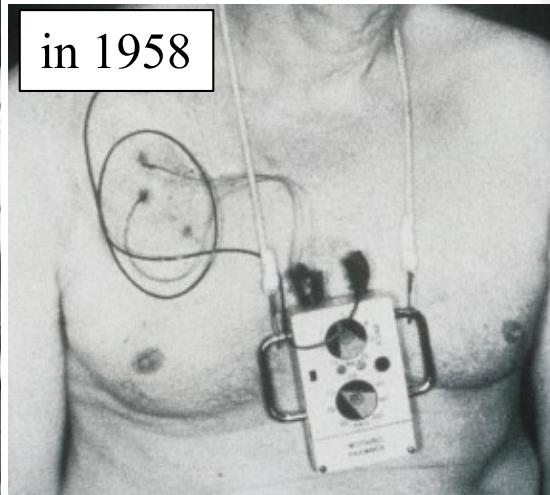
How the usability of ECG
changed over 7 decades

Usability of Pacemakers

in 1952

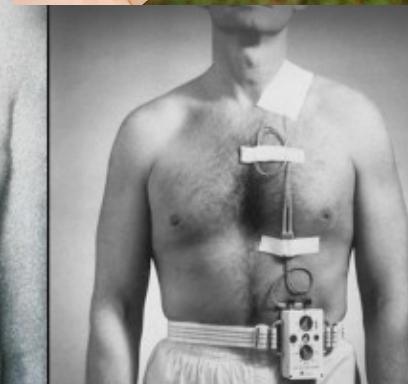
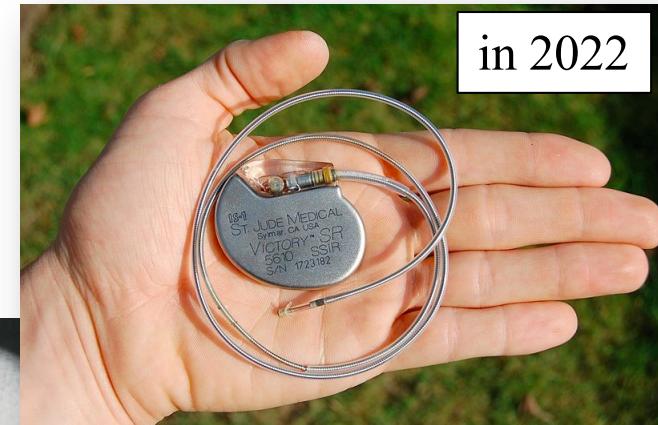


in 1958



By St Jude Medical

in 2022



By Images Paediatr Cardiol. 8(2006): 17–81.

How the usability of pacemakers
changed over 6 decades

How to evaluate with Human Factors?

...less easy in future perspective...

The TIME' forecast on Human++



[TIME, February 2011]

(c) S.Carrara

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Chips under the skin?



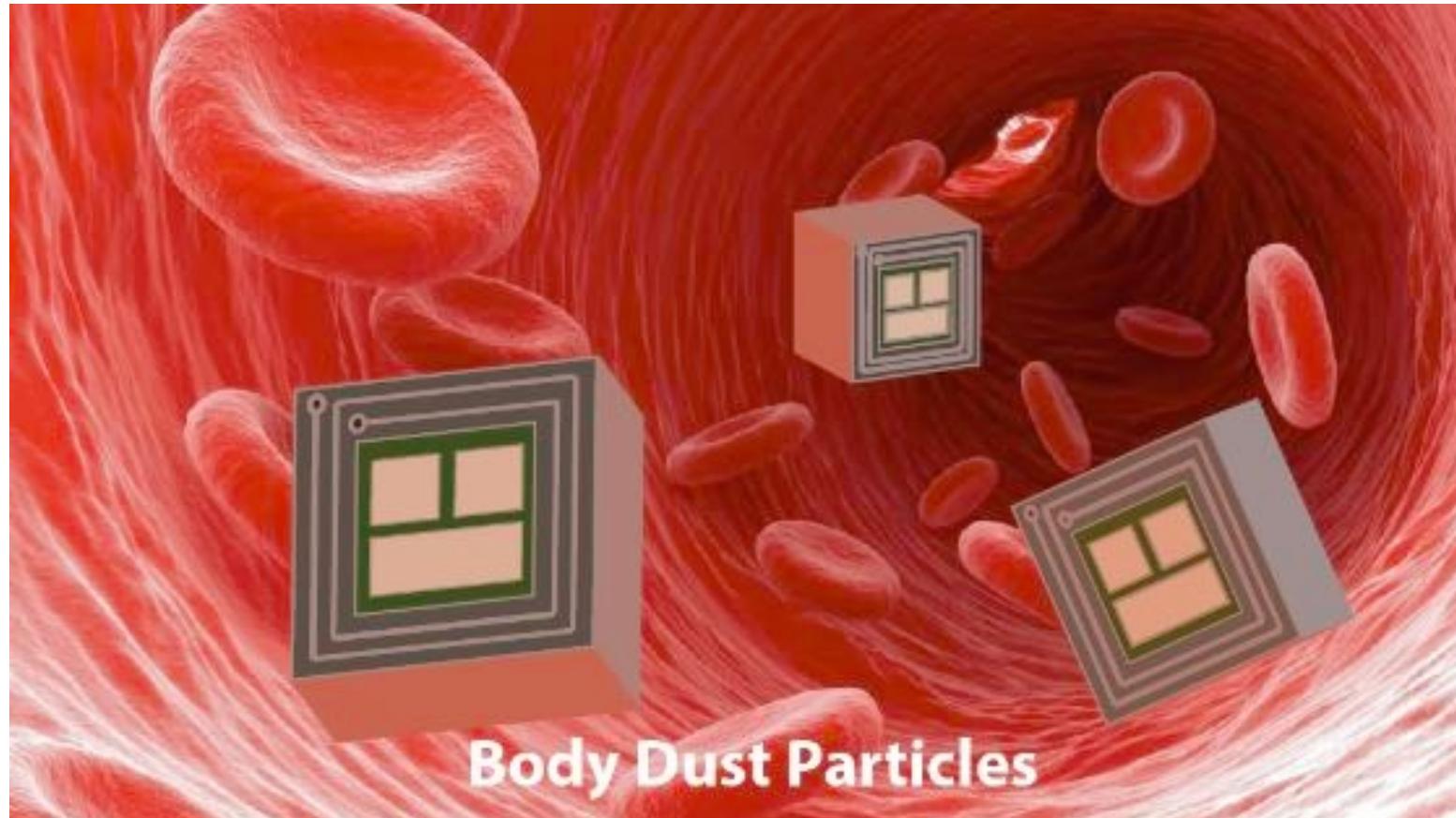
Under the skin: how insertable microchips could unlock the future

Volunteers in Melbourne have had microchips inserted for three months, designed to unlock doors and carry out other tasks. Will they really be any use?

THEGUARDIAN.COM

[The Guardian, October 2017]

Body Dust: Bioelectronics in Human Blood?



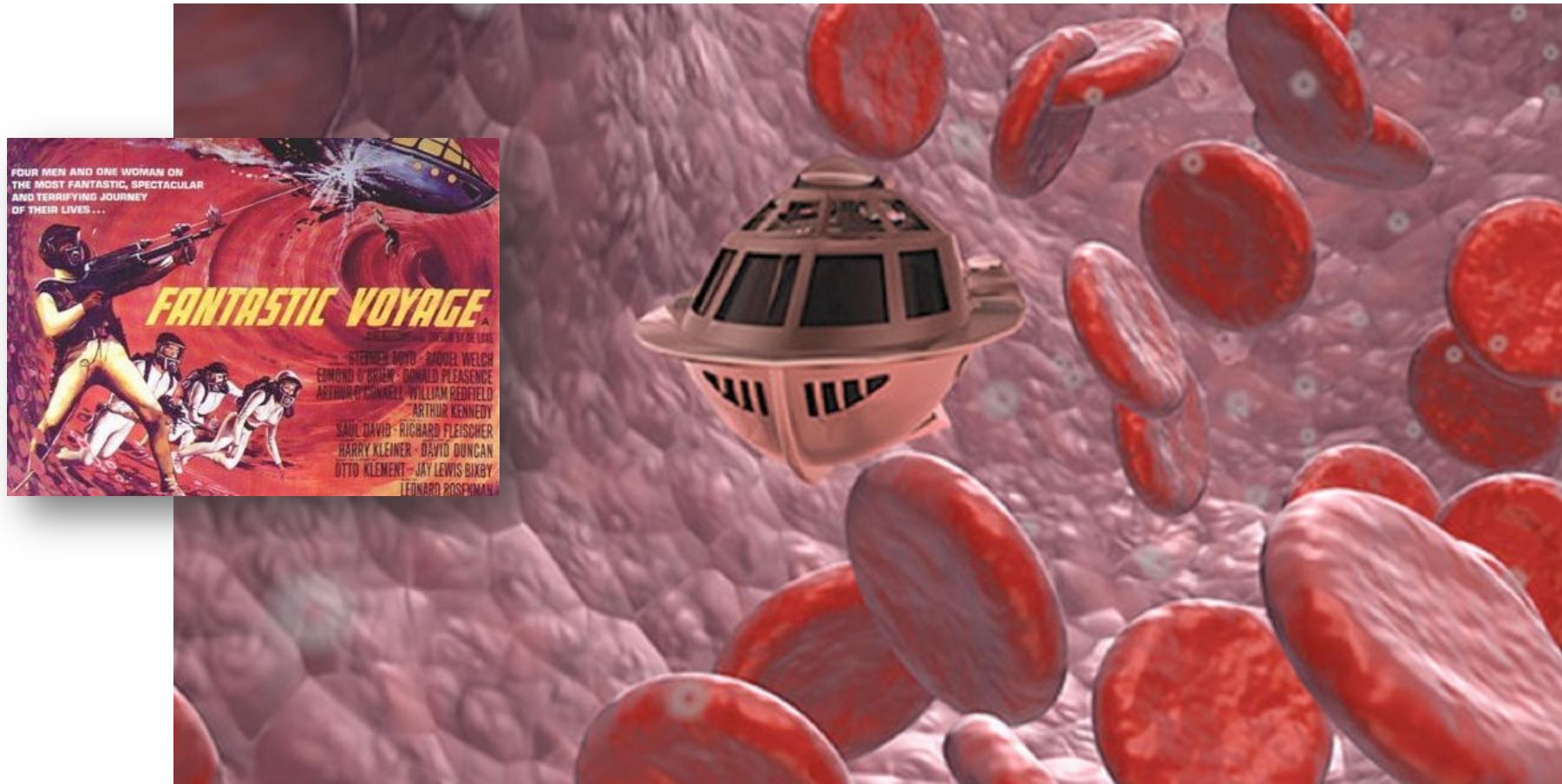
[ArXiv, May 2018]

Body Dust: Bioelectronics to Drink?



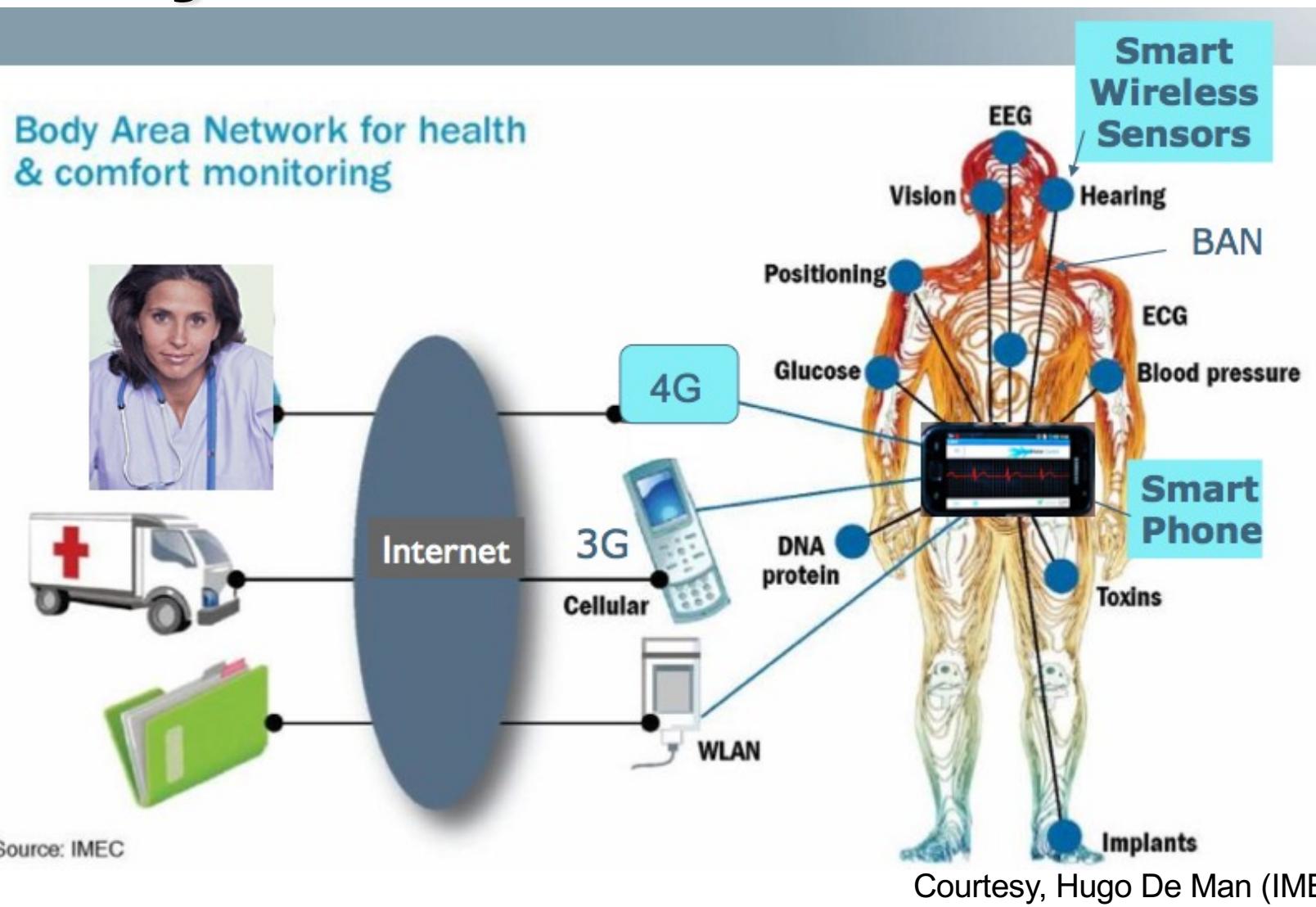
Imagine to drink a water that contain an electronic Dust that spread in your body and then provide diagnostics

How small Chips under the skin?



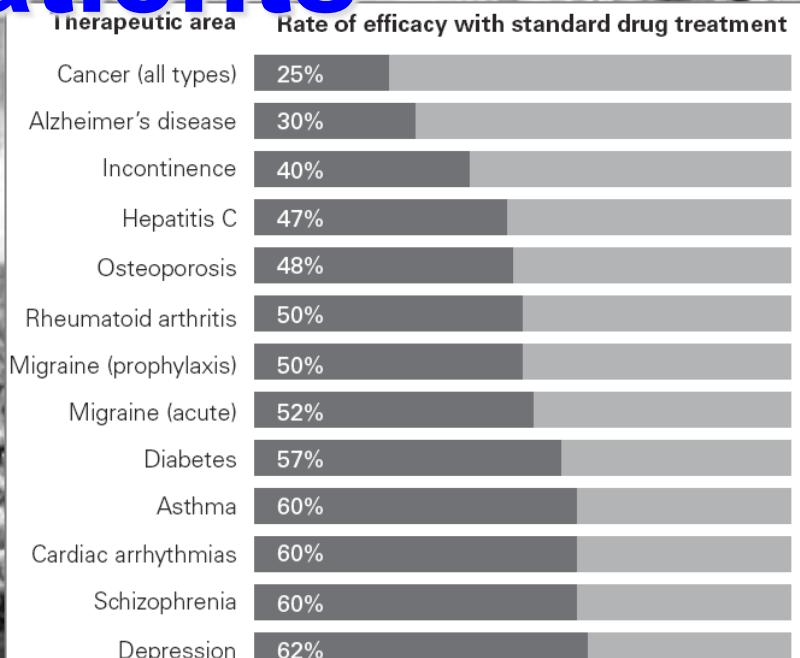
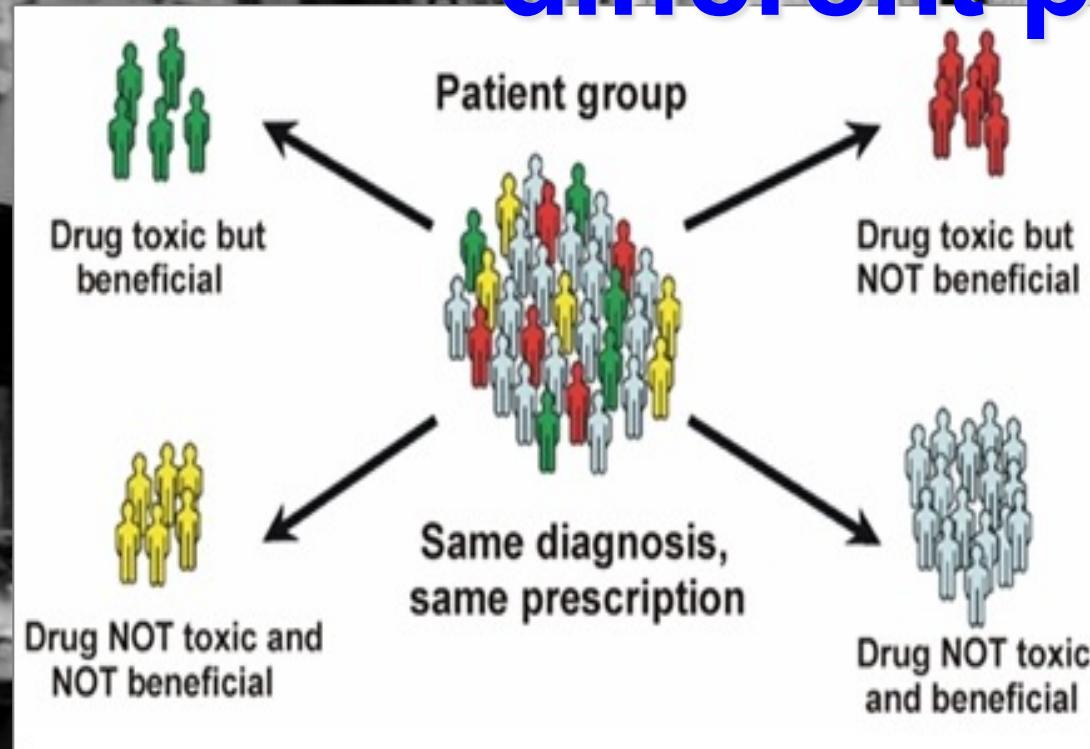
[1966 Sci. Fi. movie titled “Fantastic Voyage”]

Fully-Connected Human++



(c) S.Carrara

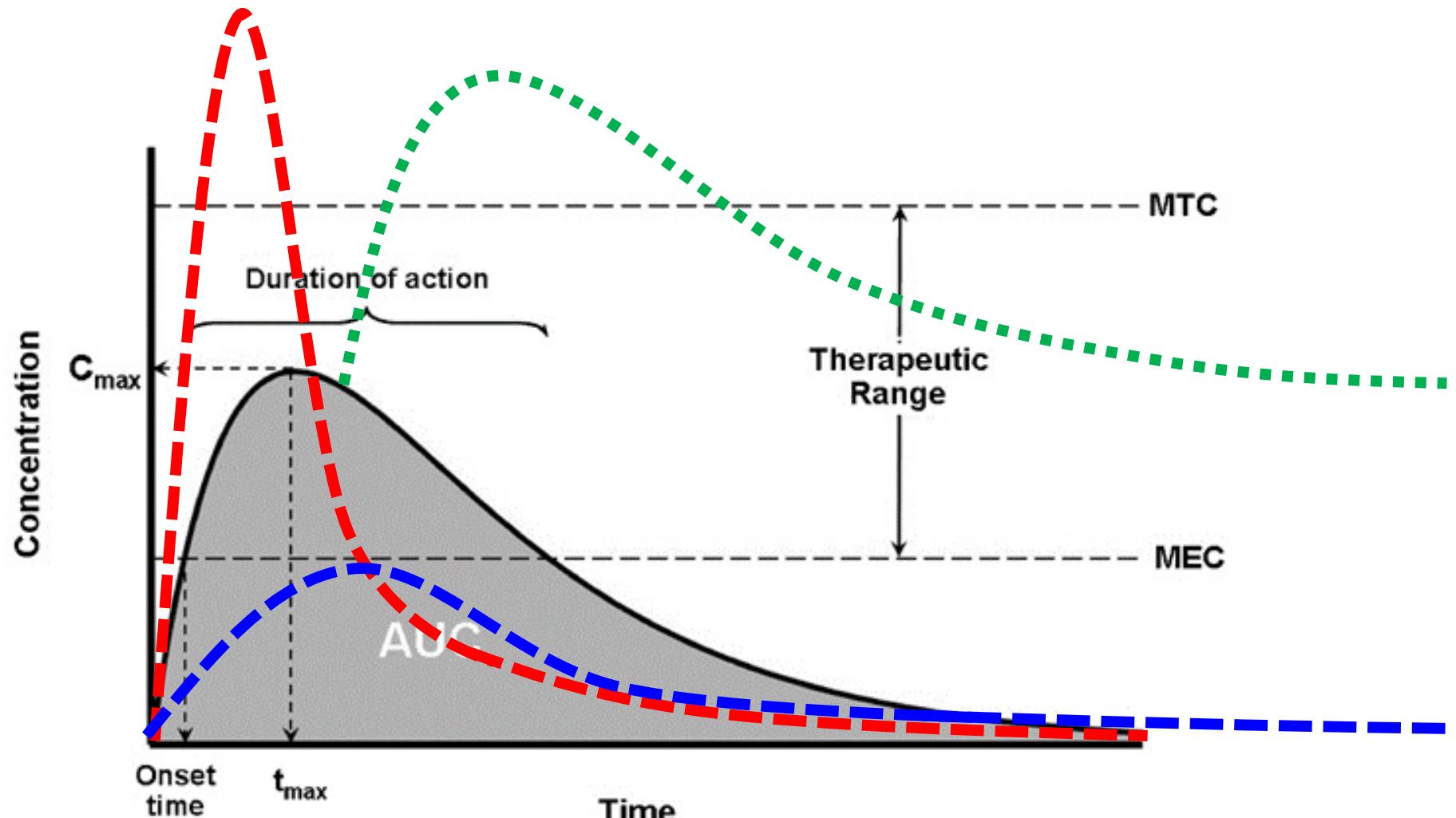
Different outcomes for different patients



For depression, the data apply specifically to the drug class known as selective serotonin reuptake inhibitors.

Source: Brian B. Spear, Margo Heath-Chiozzi, and Jeffrey Huff, "Clinical Application of Pharmacogenetics," *Trends in Molecular Medicine* (May 2001).

Patients' metabolism drive the Drugs effect in time!



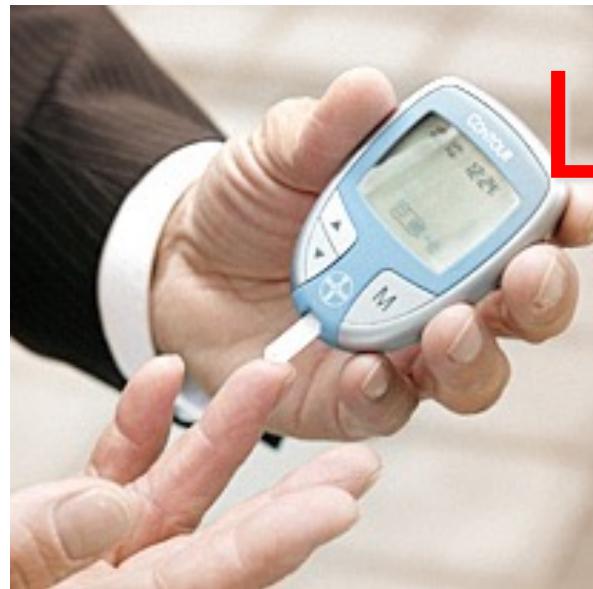
(c) S.Carrara

Usability: From Labs to Hands



Labeled

- 100.000 \$ (machinery)
- 1.000 \$ the single μ -array



Label-Free

- 50 \$ (machinery)
- 0.05 \$ the single strip



Bayer HealthCare

(c) S.Carrara

Next step: the future already begun



Glucose Personal Diagnostics on our iPhones

(c) S.Carrara

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Next step: the future already begun

How to use the FreeStyle Libre System



1. **Apply sensor**
with applicator

2. **Scan sensor**
using FreeStyle Libre Reader

3. **Get reading**
on the reader

FOR FULL INSTRUCTIONS
www.freestylelibre.co.uk

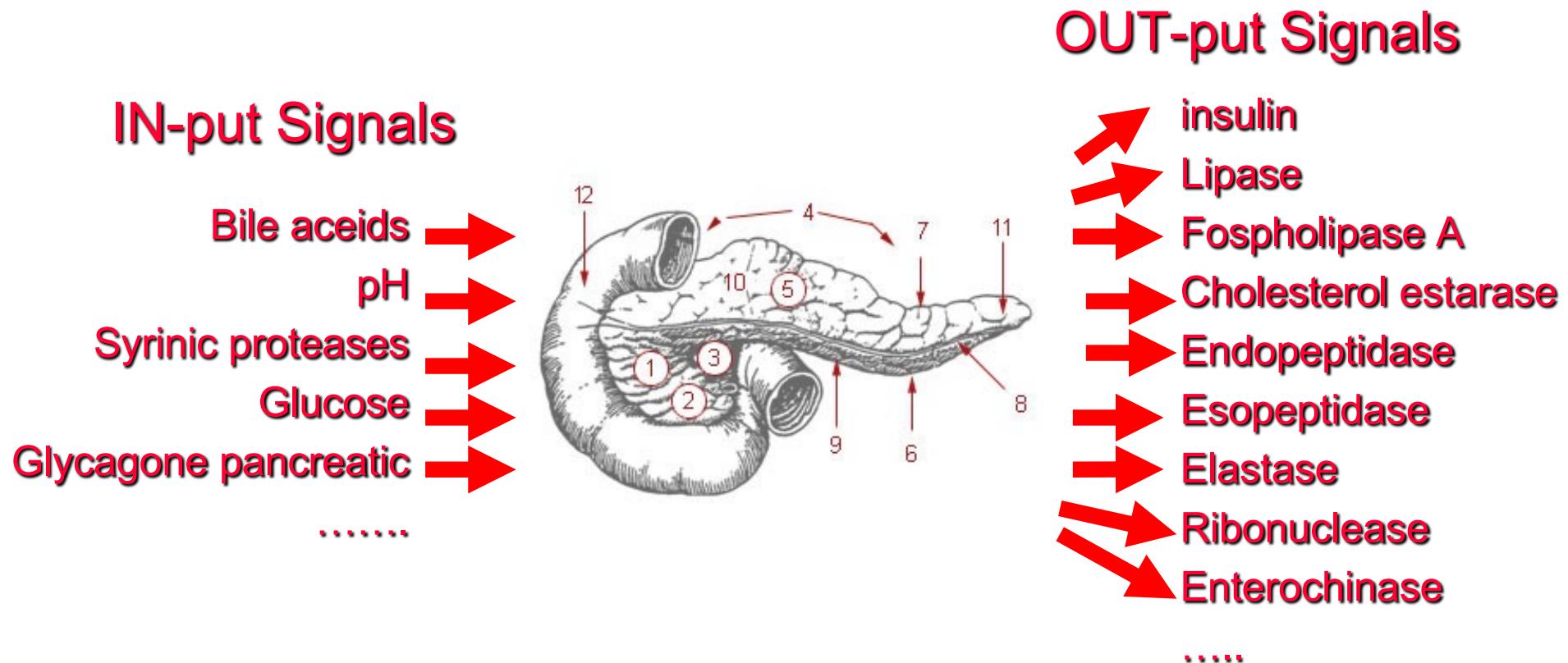
OVERVIEW
HOW TO USE
FIND OUT MORE

Glucose Personal Diagnostics on our Skin

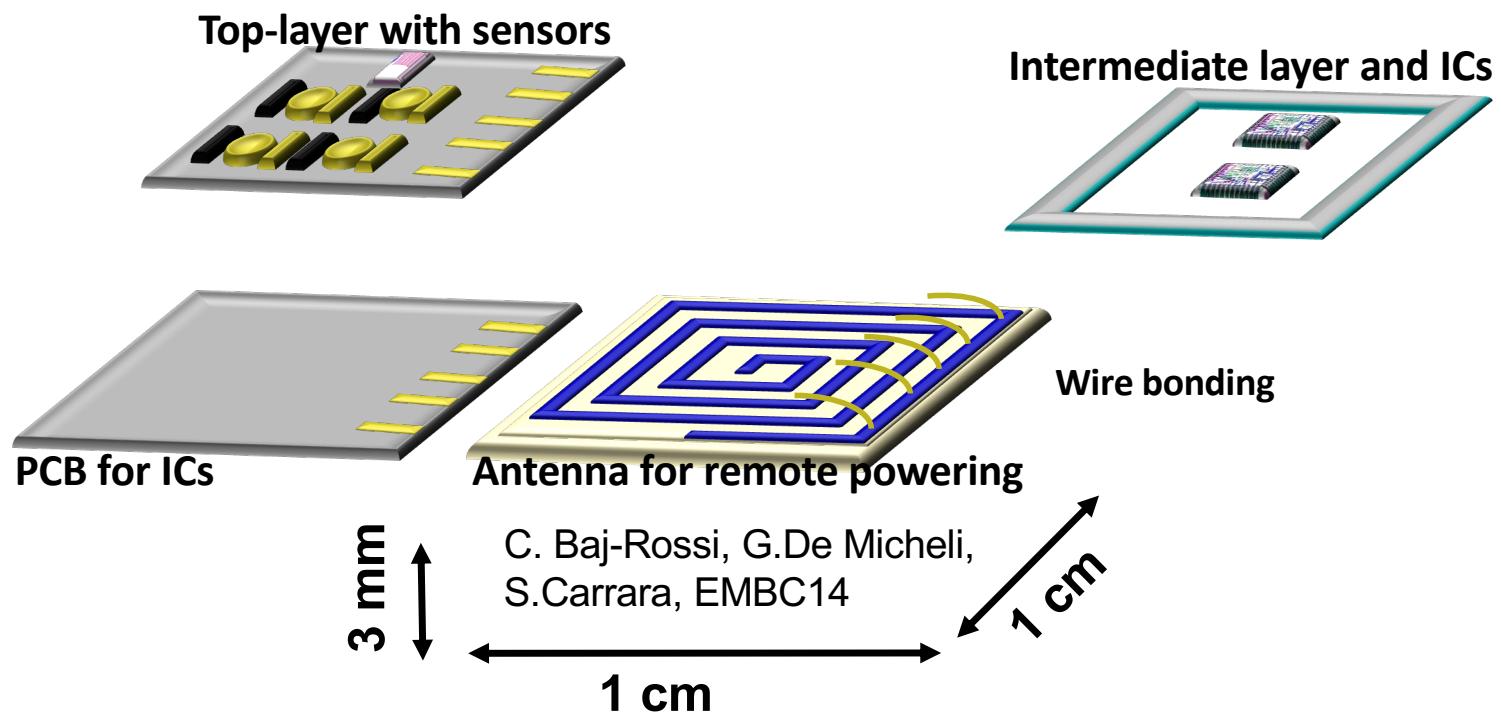
(c) S.Carrara

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The Pancreas Functions

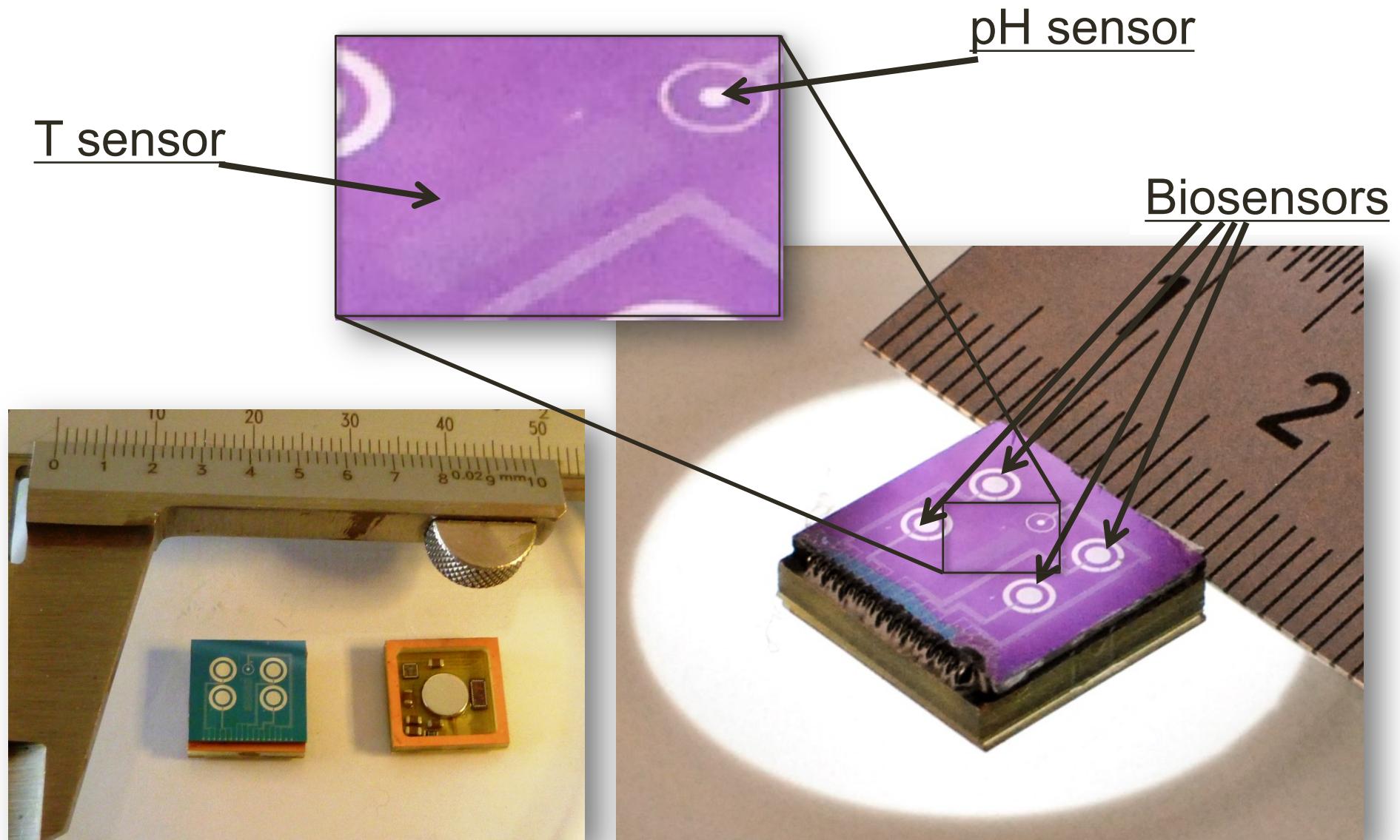


Under-the-Skin Device



(c) S.Carrara

The top-layer with sensors



(c) S.Carrara

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A subcutaneous biosensor chip to revolutionize tomorrow's medicine

May 29, 2015 9:26 AM

Relaxnews

Y + X

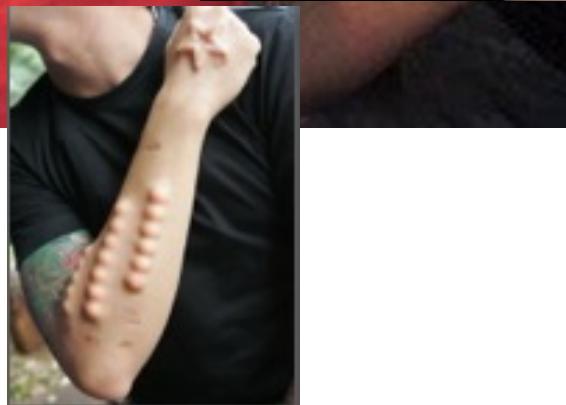
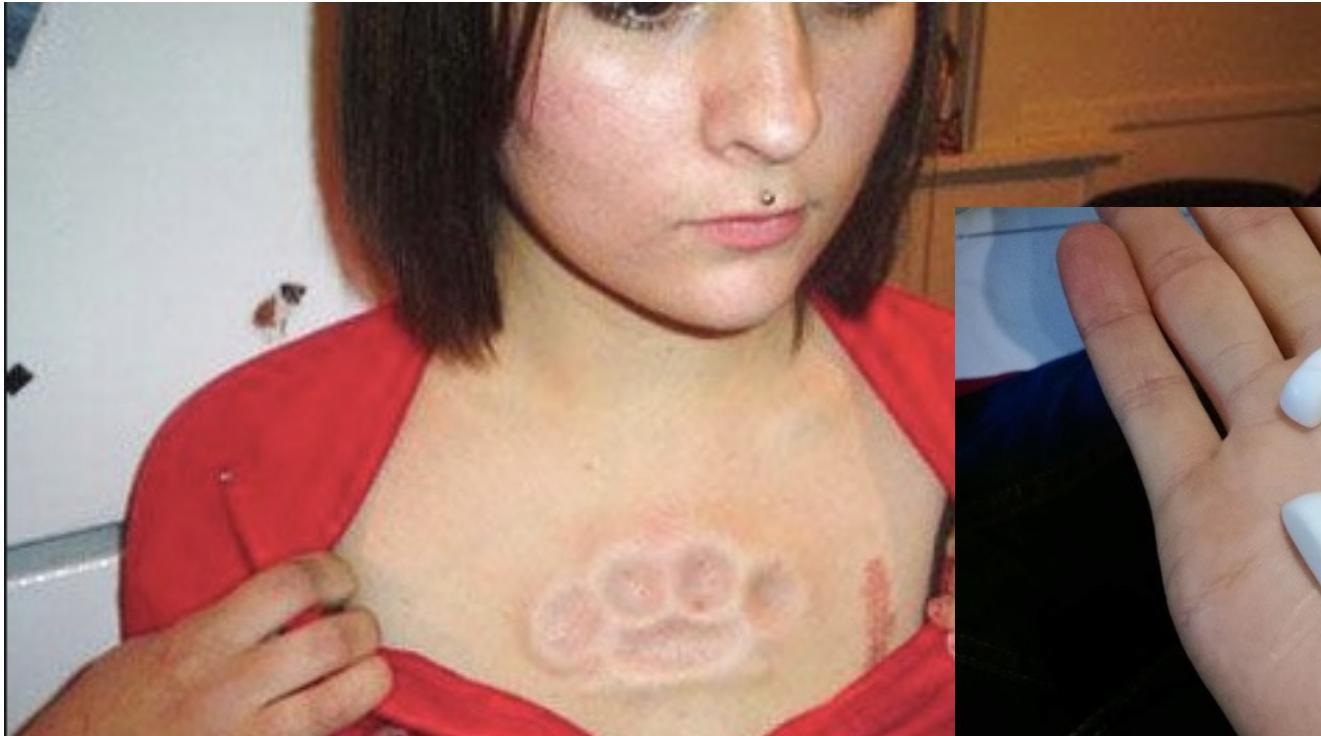
OUT OF THE MEDIA
ADVERTISING SCIENTIFIC
NOVELTIES, ARE THERE
SUBCUTANEOUS DEVICES
REALLY GOING TO BE USED?



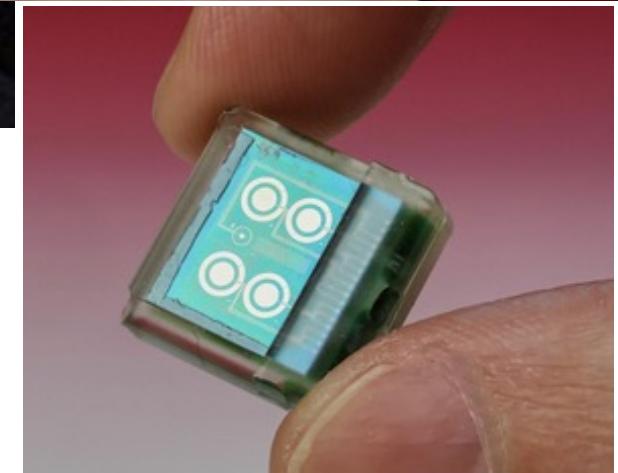
(c) S.Carrara

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Under the skin for body sculpting



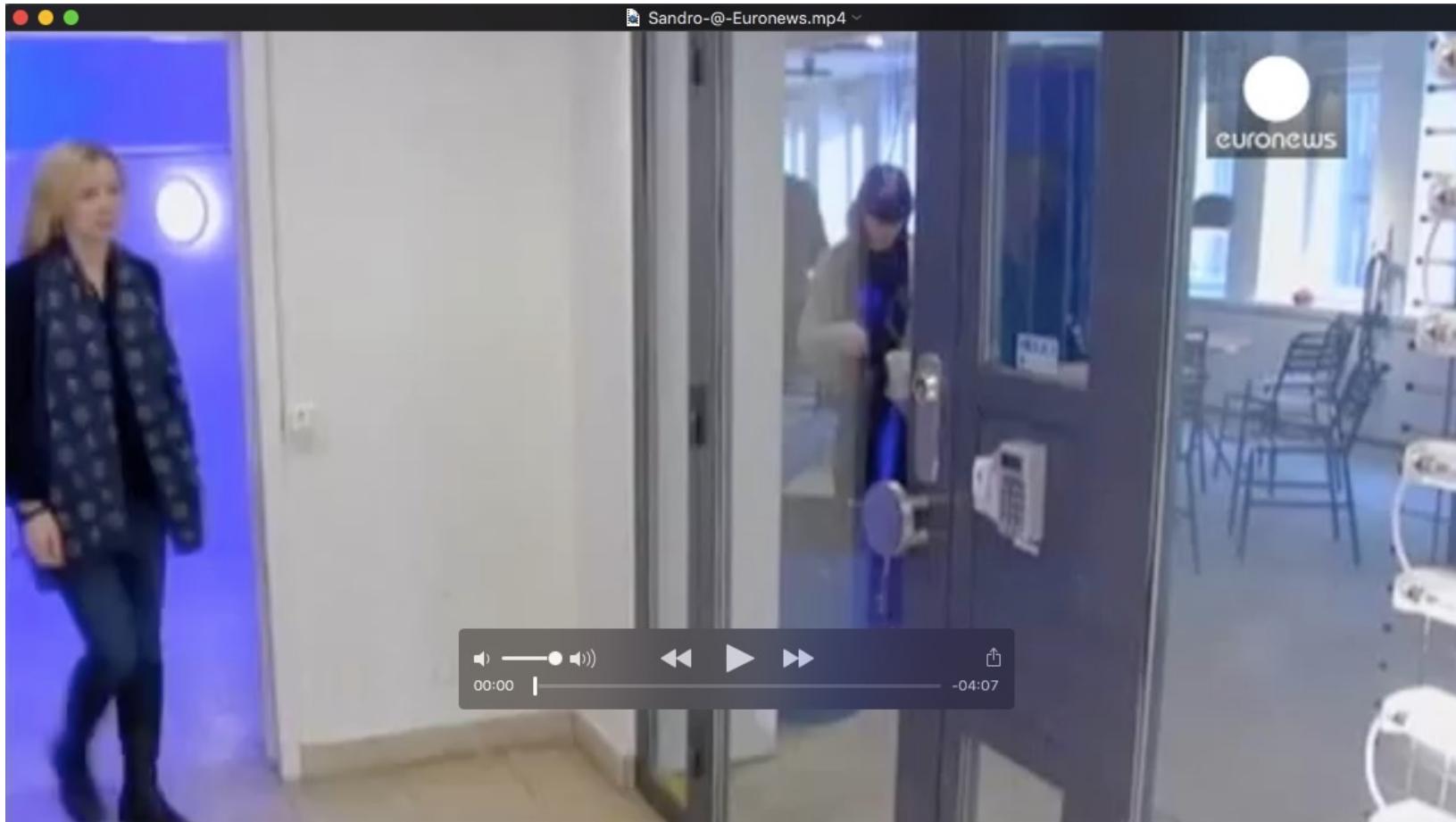
(c) S.Carrara



Enhancing human being

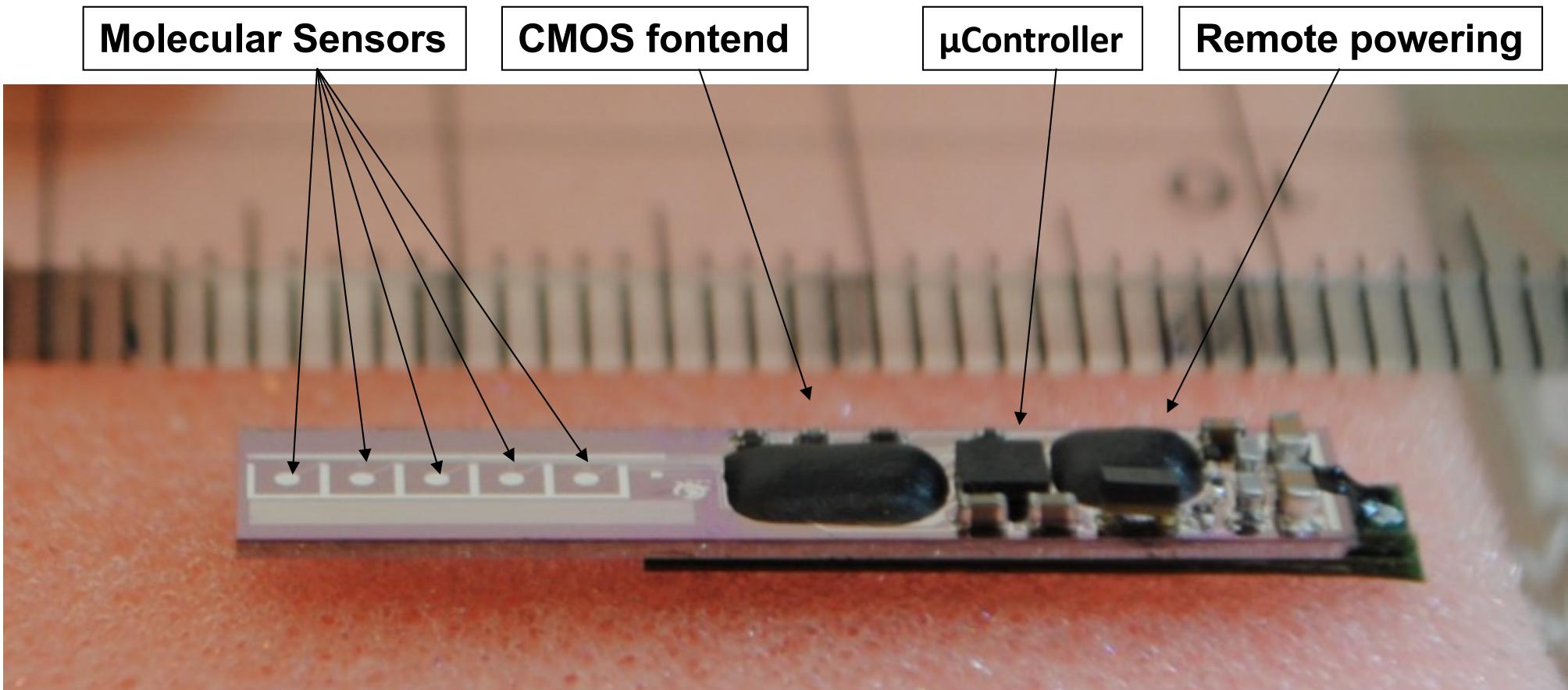


Chips under the skin?



[Euronews, June 2015]

Size and Shape to be injectable by a Needle?



The IC has been fabricated in UMC 0.18 technology and interfaced to the passive multi-panel platform

(c) S.Carrara

New injectable ECG monitoring by Medtronic



Mark Phelps by Medtronic, and the Reveal LINQ™ system

(c) S.Carrara

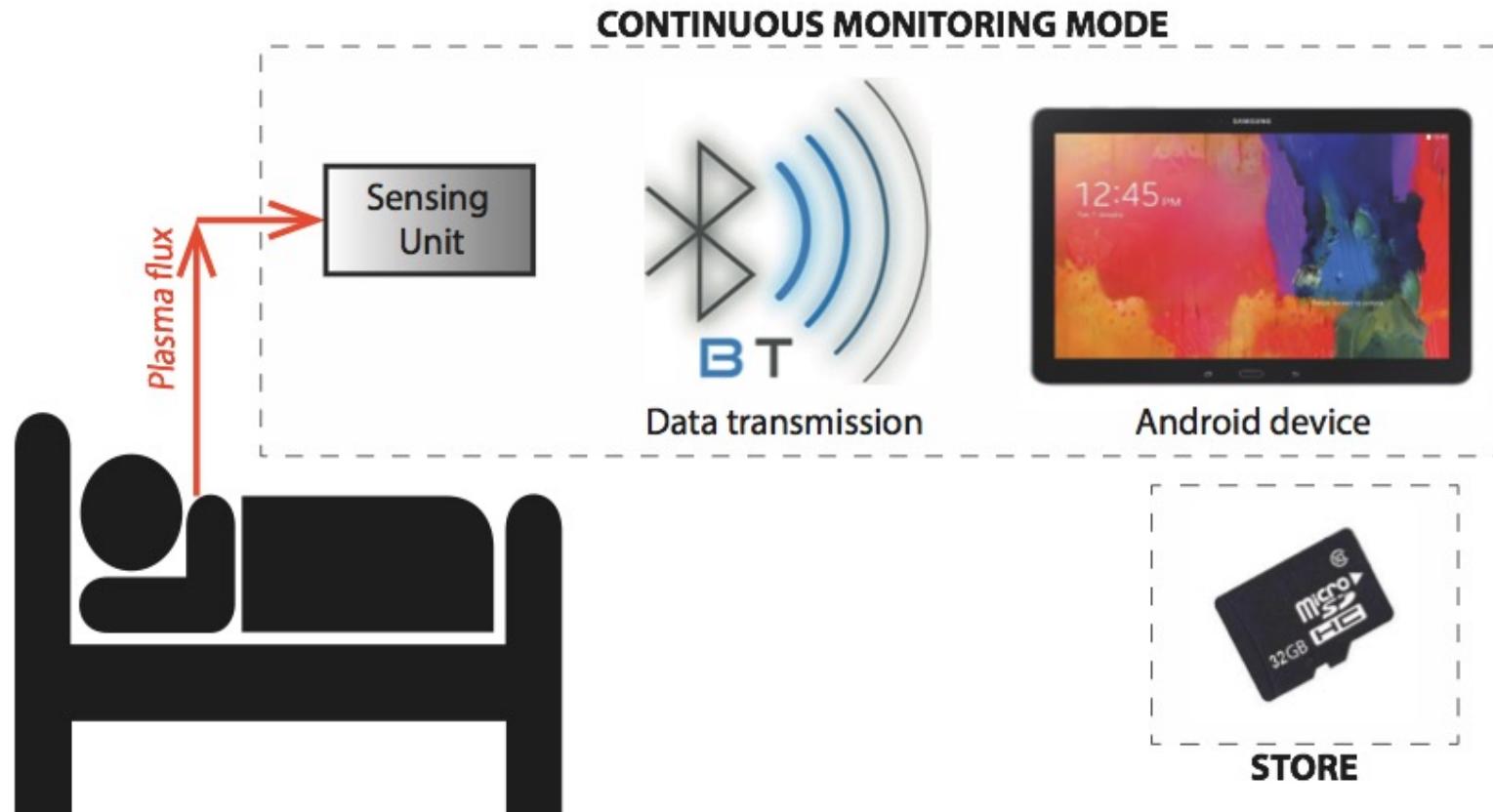
Intensive-Care-Units (ICU) Monitoring



The present monitoring scenario foresees lot of independent devices and input/output interfaces

(c) S.Carrara

Lab-on-a-chip for ICUs

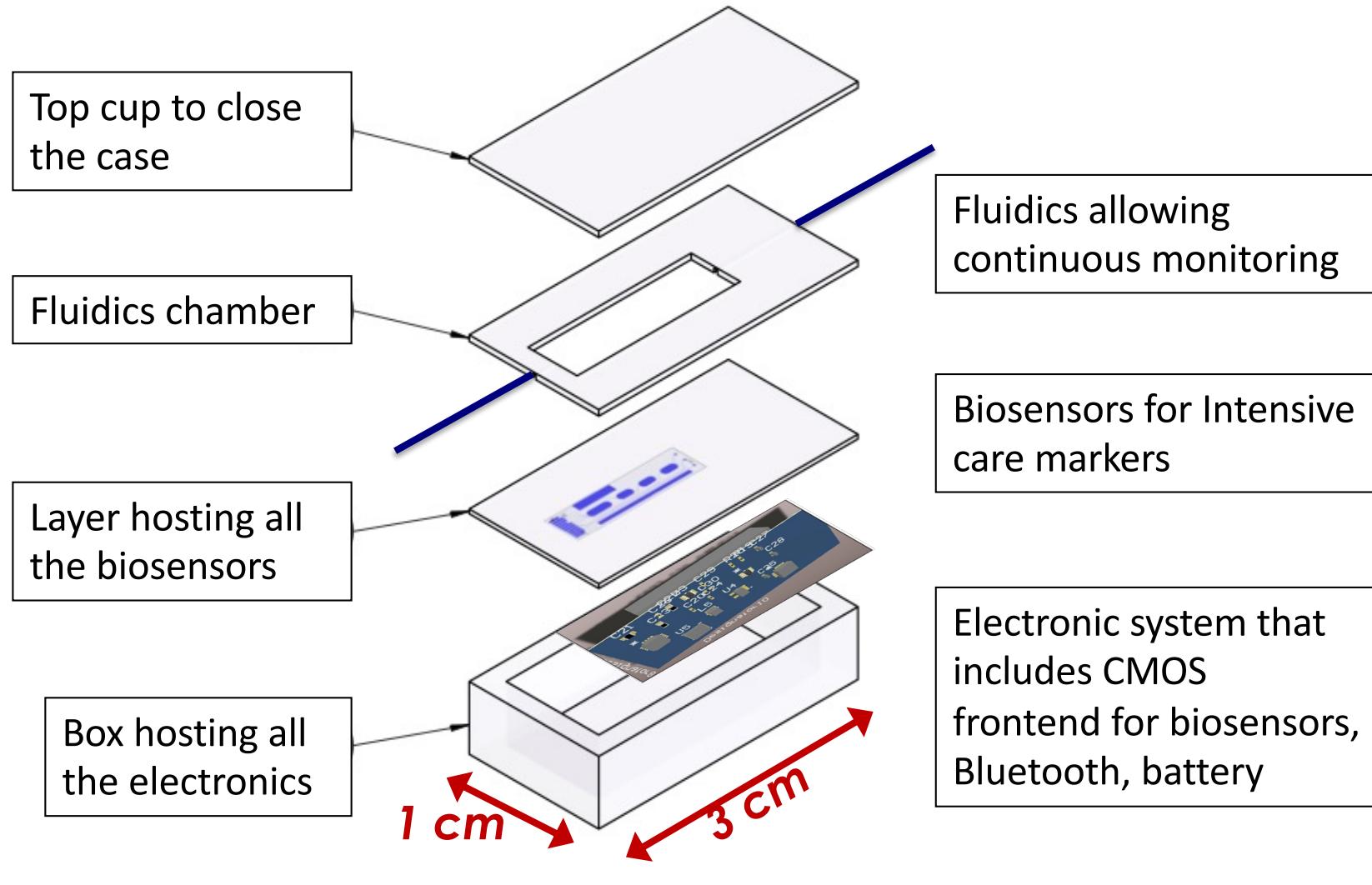


F. Stradolini, et al., *IEEE Sensors Journal* 16(2016) 3163 - 3170

Monitoring scenario where the main parameters of the patient are continuously displayed on an Android mobile device

(c) S.Carrara

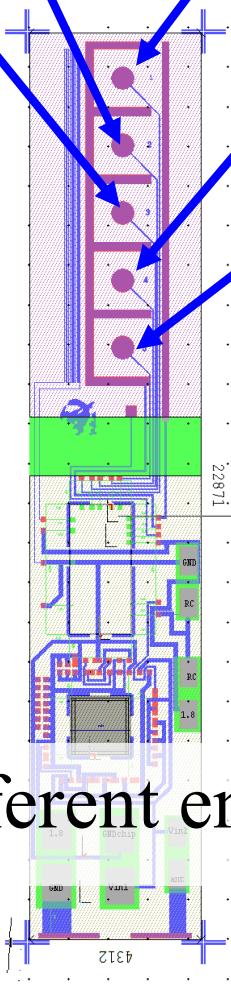
First Fully-Autonomous system for Continuous monitoring in ICUs



One Multi-Panel Device for Metabolism Monitoring

ATP-ase	Lactate oxidase	Glucose oxidase	Lipoxygenase
P450 11A1	P450 5A1	P450 4A11	Cholesterol oxidase

Probe enzymes



- Glucose
 - Lactate
 - Cholesterol
 - ATP
 - Drugs
 - Ions

Different enzymes sense different human metabolites

(c) S.Carrara

One Interface for Remote Monitoring of Patients in Intensive Care Units

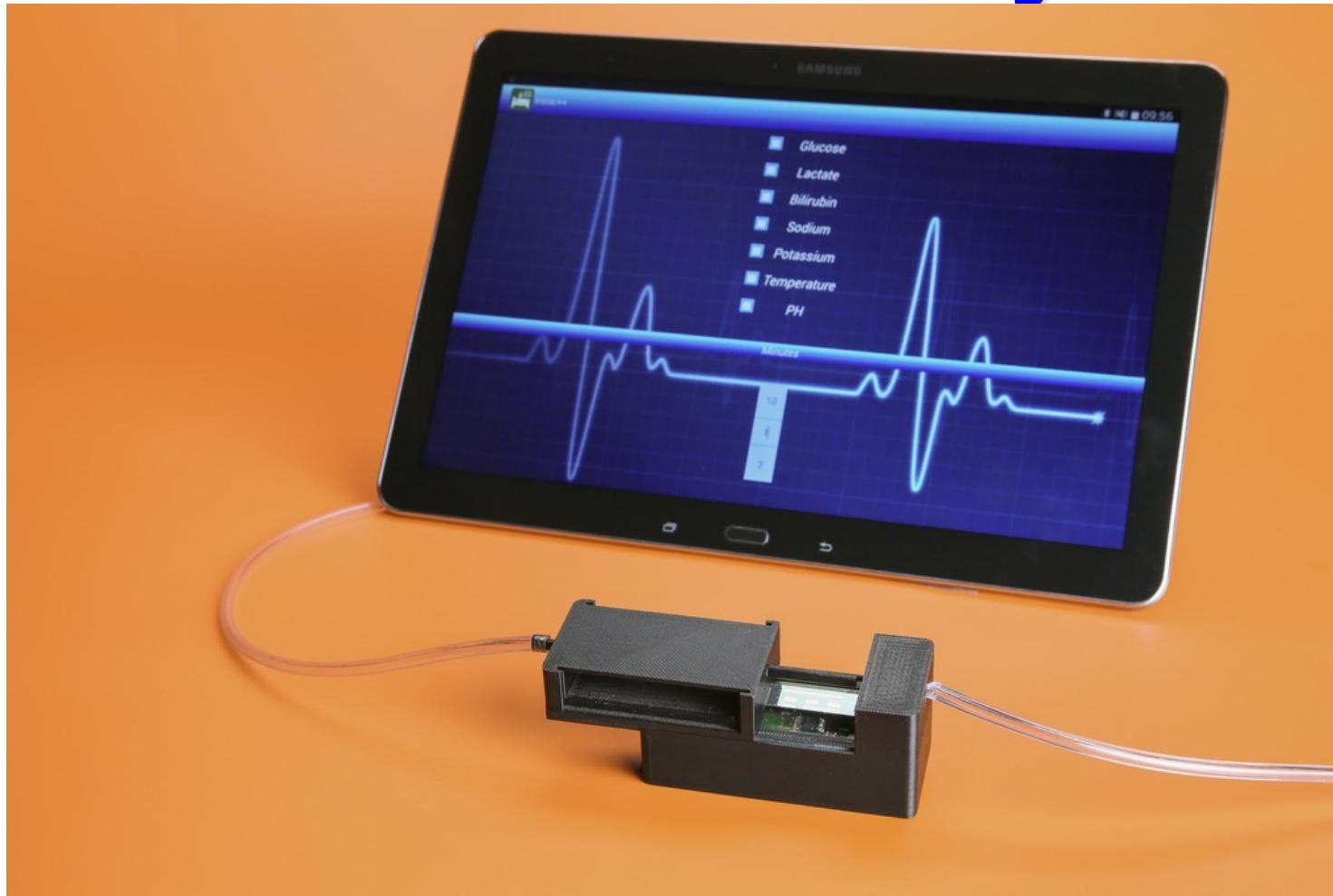


Image | Bam Labs

The whole system with the AndroidTM interface that allows connectivity too

S.Carrara (C)

The full connected system

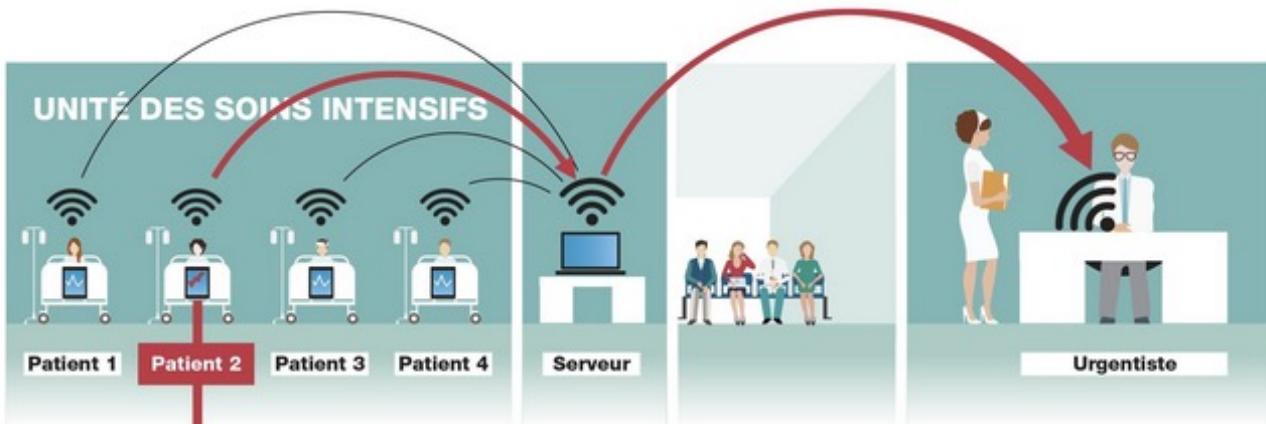


The whole system with the AndroidTM interface that allows connectivity too

Remote Patients' monitoring from Smartwatches

Des smartwatch pour alerter les médecins aux soins intensifs

Les patients admis en soins intensifs doivent être sous surveillance constante. Un dispositif de biocapteurs collecte en temps réel les données vitales du malade. Si une anomalie est détectée, une alerte prévient le médecin de garde.



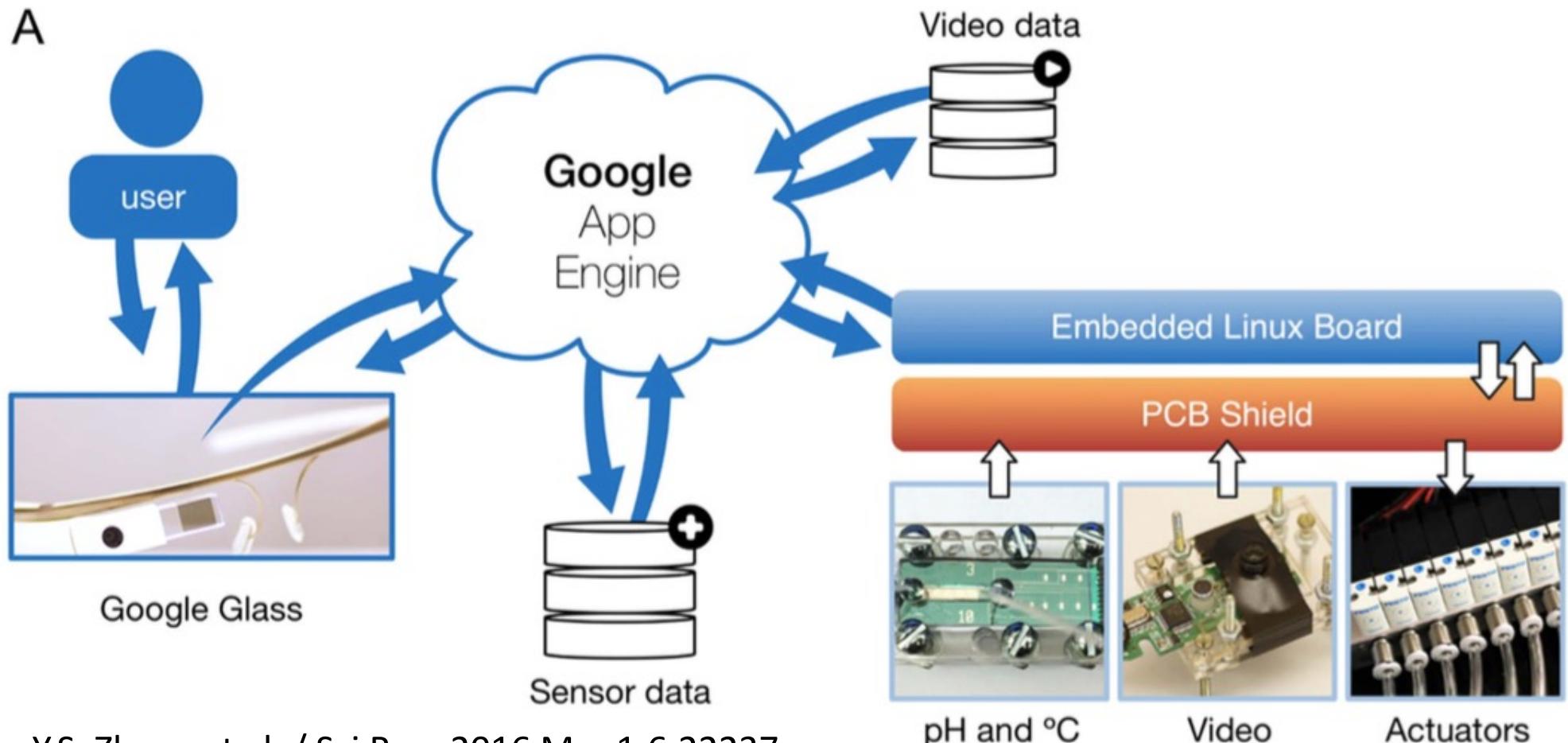
La smartwatch de l'urgentiste est connectée via le wifi au serveur central de l'unité des soins intensifs. Il renseigne en continu le médecin sur l'état de santé de ses patients et l'alerte en cas de problèmes.



...from Tablet to Smartwatches...



... to Google Glass for Monitoring and Control



Y.S. Zhang et al. / Sci Rep. 2016 Mar 1;6:22237

“Usability” in any case

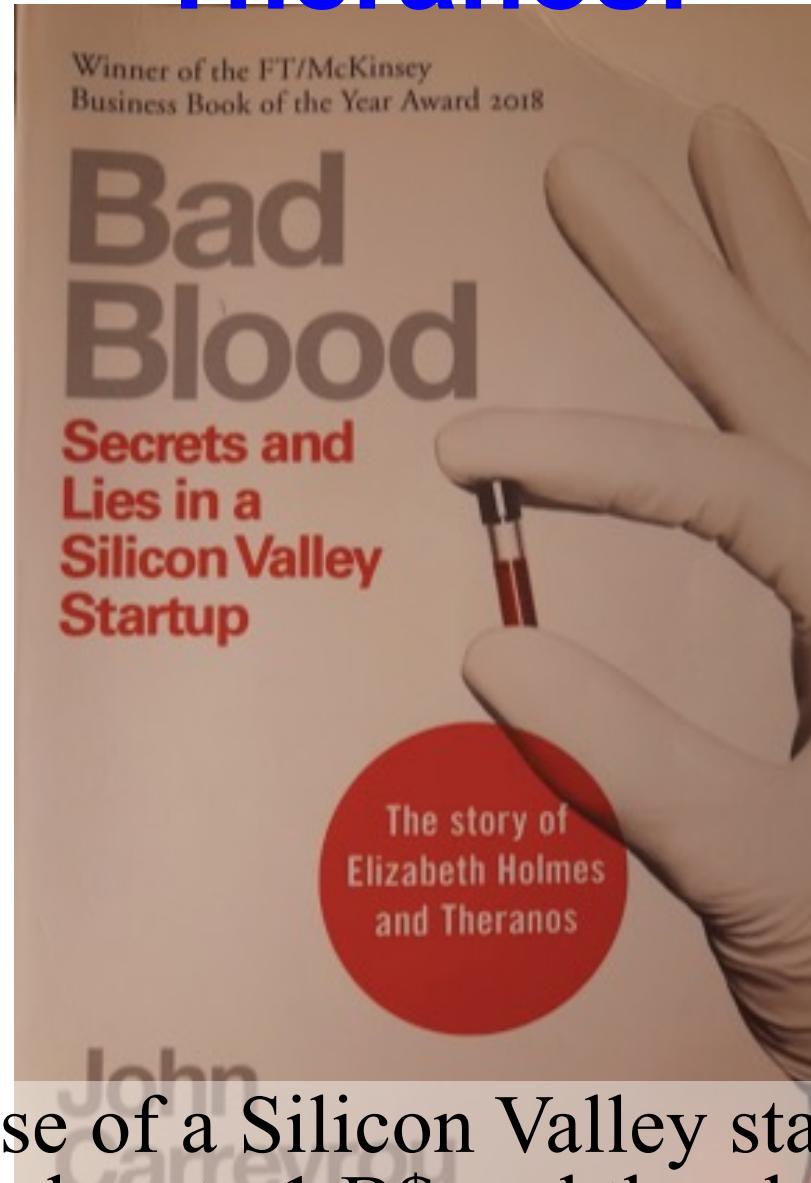
May we then obtain the right

“Usability in any case”

just

“*by the right design*”?

Theranos!



The case of a Silicon Valley start-up that collected up to 1 B\$ and then bankrupted

S.Carrara (C)

The Theranos case



On January 3rd, 2022, Elizabeth Holmes, former CEO of the Silicon Valley company named “Theranos”, is found guilty on four of eleven charges she was accused as supposed running “a years-long fraud scheme against investors while running Theranos Inc.”, the Wall Street Journal reported

The Edison by Theranos



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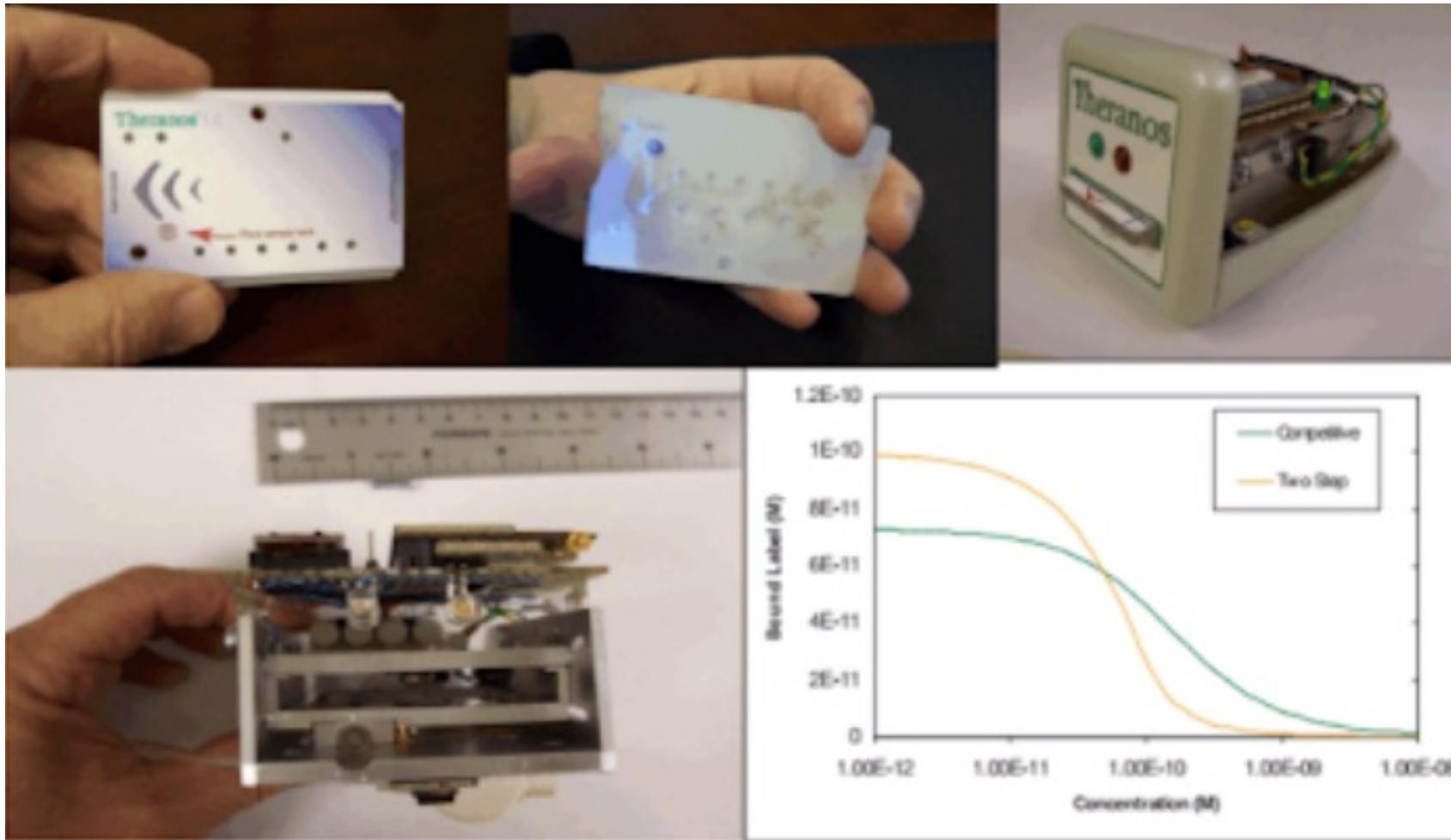
Edison



Device for Blood Testing

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Edison' Cartridge



The Edison Cartridge

S.Carrara (C)

Theranos



S.Carrara (C)

THE WALL STREET JOURNAL.

D DOW JONES | News Corp *****

TUESDAY, JANUARY 4, 2022 - VOL. CCLXXIX NO. 2

WSJ.com

★★★★ \$5.00

DJIA 36585.06 ▲ 246.76 0.7%

NASDAQ 15832.80 ▲ 1.2%

STOXX 600 489.99 ▲ 0.4%

10-YR. TREAS. ▼ 1 6/32, yield 1.628%

OIL \$76.08 ▲ \$0.87

GOLD \$1,799.40 ▼ \$28.10

EURO \$1.1299 YEN 115.32

What's News

Business & Finance

Theranos founder Holmes was convicted by a federal jury on four of 11 charges that she conducted a years-long fraud scheme against investors while running the company, which ended up as one of Silicon Valley's most notorious implosions. **A1**

◆ AT&T and Verizon agreed to delay their rollout of a new 5G service for two weeks, reversing course after previously declining a request by U.S. transportation officials. **B1**

◆ U.S. stocks rose, with the S&P 500 and Dow gaining 0.6% and 0.7%, respectively, to close at records. The Nasdaq added 1.2%. **B9**

◆ Apple briefly touched \$3 trillion in market value, making it the first U.S. company to do so. **B3**

◆ OPEC picked veteran Kuwaiti oil official Haitham al-Ghais to succeed Mohammad Barkindo of Nigeria as secretary-general. **B1**

◆ Thousands more U.S. flights were canceled as a winter storm and Omicron-driven staff shortages continued to disrupt air travel. **B1**

◆ Tesla has opened a showroom in Xinjiang, the Chinese region that has become

Theranos's Holmes Found Guilty

Onetime Silicon Valley star convicted on four of 11 counts in federal investor-fraud case

SAN JOSE, Calif.—A federal jury convicted Elizabeth Holmes, the startup founder who claimed to revolutionize blood testing, on four of 11 charges that she conducted a yearslong fraud scheme against investors while running Theranos Inc., which ended up as one of Silicon Valley's most notorious implosions.

By Sara Randazzo,
Heather Somerville
and Christopher
Weaver

The verdict caps a steep fall for the former Silicon Valley star who once graced magazine covers with headlines such as "This CEO Is Out for Blood" and emulated Apple Inc. co-founder Steve Jobs by wearing black turtlenecks.

At the 15-week trial, Ms. Holmes testified in her own defense, showing regret for missteps and saying she never intended to mislead anyone. She accused her former boyfriend and deputy at Theranos of abusing her, allegations he has denied.

Ms. Holmes said nothing when she left the courthouse following the verdict, ignoring questions from journalists. Her attorneys declined to comment



Theranos founder Elizabeth Holmes leaves court Monday after being convicted of running a yearslong scheme to defraud investors.

on the jury's decision or any plans to appeal.

Ms. Holmes was charged with nine counts of wire fraud and two counts of conspiracy to commit wire fraud under an indictment brought 3½ years ago. She was found guilty on three

of the fraud counts and one of the conspiracy counts.

She was acquitted on four counts related to defrauding patients—one charge of conspiracy to commit wire fraud and three charges of wire fraud.

The jurors failed to reach a

verdict on three counts related to investors, after saying earlier Monday they were having difficulty reaching consensus on those charges.

The 12 jurors looked impassively at the judge's deputy, Adriana Kratzmann, as she read the verdicts aloud.

Ms. Holmes, 37 years old, embraced her family and friends, who attended throughout the trial, before departing the courtroom. She looked composed after the verdict. *Please turn to page A2*

JOSH EDELSON FOR THE WALL STREET JOURNAL

Theranos Founder Finally Gets Her Due With 11-Year Sentence

TO THE CLINK

Elizabeth Holmes was found guilty earlier this year over her role in a massive fraud at the blood-testing startup.

**Noah Kirsch**

Wealth And Power Reporter

Updated Nov. 19, 2022 4:27AM ET / Published Nov. 18, 2022 5:17PM ET



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Theranos issue?

That has been a problem
of “*fraud scheme*” only
or a problem of
“*usability*” too?

Theranos issue?

Usability too!

Elizabeth Holmes' requirement for the Edison device by Theranos

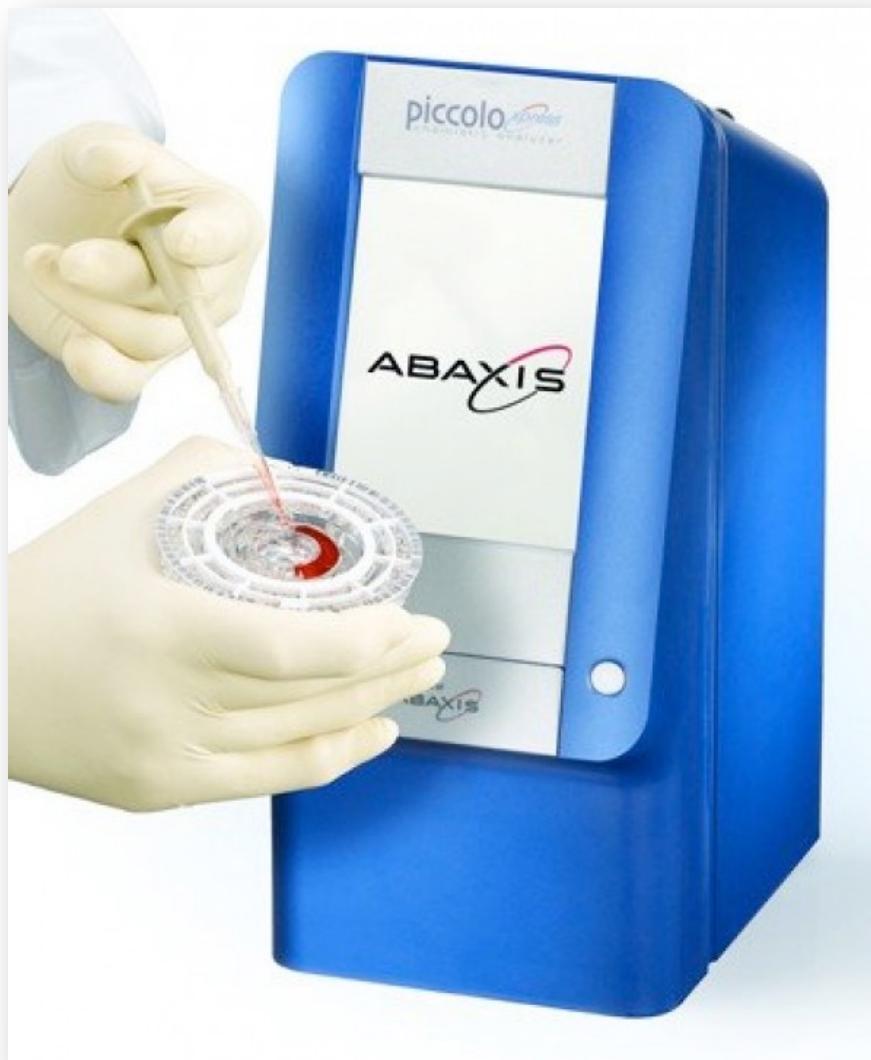
Do you see any problem of usability here?

The blood samples have been required to be by a single blood drop from patients, meanwhile the promise has been reading up to hundred blood biomarkers!

Elizabeth Holmes' requirement for the Edison device by Theranos

The blood samples have been required to be by a single blood drop from patients, meanwhile the promise has been reading up to hundred blood biomarkers!

Piccolo Xpress® Analyzer



The Piccolo Xpress chemistry analyser (by Abaxis) allows healthcare practitioners to perform routine multi-panels of **31 blood biomarkers** by using **0.1cc of whole blood, serum or plasma**

Siemens hematology analyzer



Taller like a person

Chemistry Analyzer by Siemens



ADVIA 1800

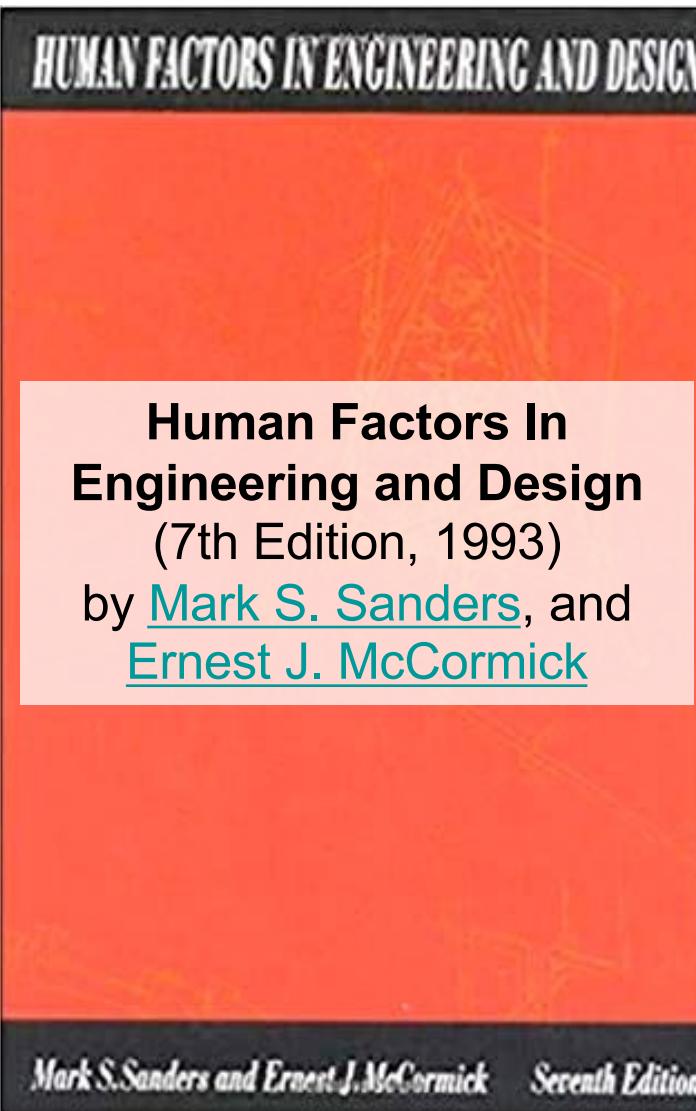
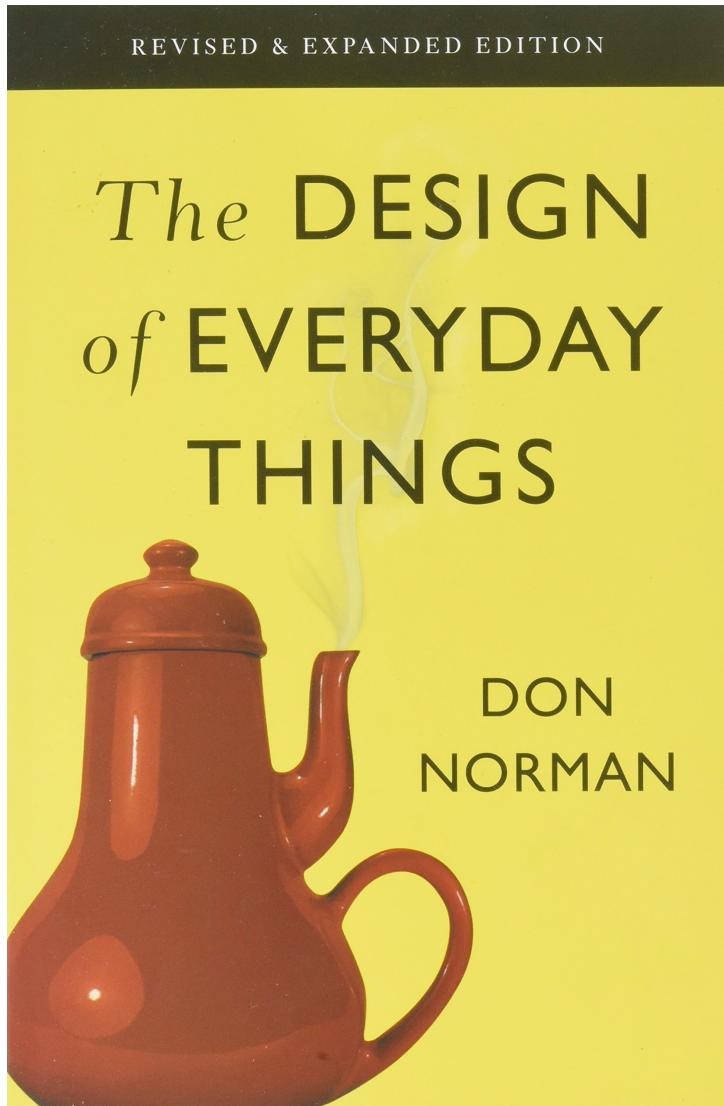
S.Carrara (C)

ADVIA 1800 by Siemens

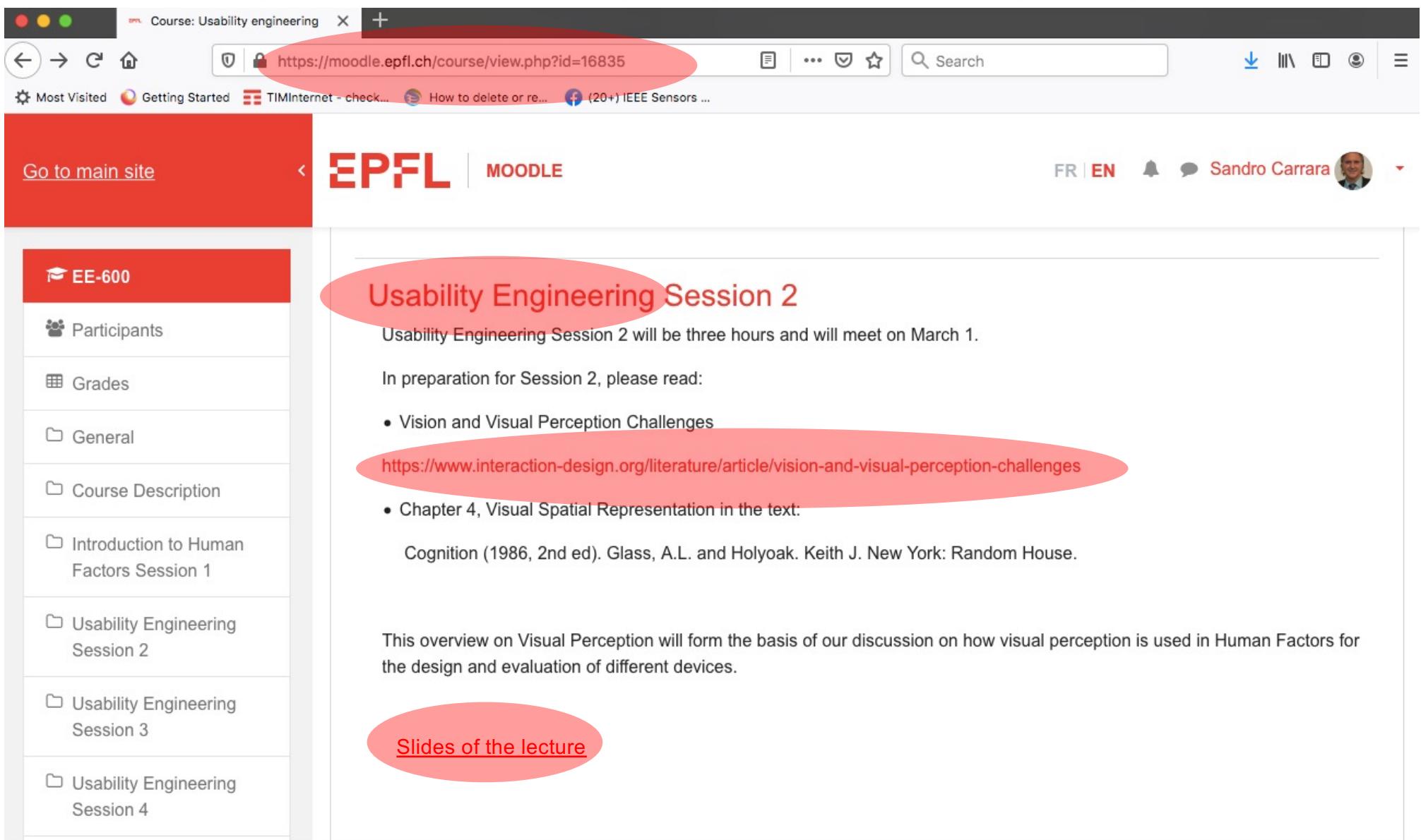


Multi-panel devices larger like adult' desks

The course books



To fruitful follow the course



Course: Usability engineering

https://moodle.epfl.ch/course/view.php?id=16835

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Sandro Carrara

EE-600

Participants

Grades

General

Course Description

Introduction to Human Factors Session 1

Usability Engineering Session 2

Usability Engineering Session 3

Usability Engineering Session 4

Usability Engineering Session 2

Usability Engineering Session 2 will be three hours and will meet on March 1.

In preparation for Session 2, please read:

- Vision and Visual Perception Challenges
- Chapter 4, Visual Spatial Representation in the text:

<https://www.interaction-design.org/literature/article/vision-and-visual-perception-challenges>

This overview on Visual Perception will form the basis of our discussion on how visual perception is used in Human Factors for the design and evaluation of different devices.

Slides of the lecture

Date	Topic	Kind	Theory	Lecturer
04.03.24	Introduction to usability by design	Theory		2 Sandro
04.03.24	Introduction to usability by design	Theory		1 Virginia
05.03.24	Visual Perception	Theory		3 Virginia
06.03.24	Cognitive Psychology and Attention	Theory		3 Virginia
07.03.24	Information Input	Theory(2h)+Ex(1h)		3 Virginia
08.03.24	Human Output and Control	Theory(2h)+Ex(1h)		3 Virginia
11.03.24	Human Factors and Environmental Conditions	Theory(2h)+Ex(1h)		3 Virginia
12.03.24	Human Factors: Standards, Guidances, Regulations	Theory(2h)+Ex(1h)		3 Virginia
13.03.24	Proposal of Projects	Project		
14.03.24	Data science and the V cycle of development	Theory		
15.03.24	Examples, case study	Theory		
18.03.24	Working sessions	Project		
19.03.24	Working sessions	Project		
20.03.24	Working sessions	Project		
21.03.24	Final Project Presentation	Project		3 Sandro
22.03.24	Summary feedback on each project	Exercise & Project		1 Francesca
22.03.24	Concluding exercises and summary of the course	Ex(1h)+Theory(1h)		2 Sandro

Your
individual
projects

Feedback



EDEE Doctoral Programs in Electrical Engineering
EE-600: Usability Engineering



Francesca Stradolini



Sandro Carrara



Virginia Lang