

TSensors™ (Trillion Sensors) Initiative Support for the Abundance and IoX

Dr. Janusz Bryzek
Chair, TSensors Summit

MEMS Engineer Forum
Tokyo, April 25, 2014

Outline

- Introductions to Technological Revolutions, Abundance and TSensors Initiative
- Showcase of amazing sensor based products

Global Technological Revolutions*

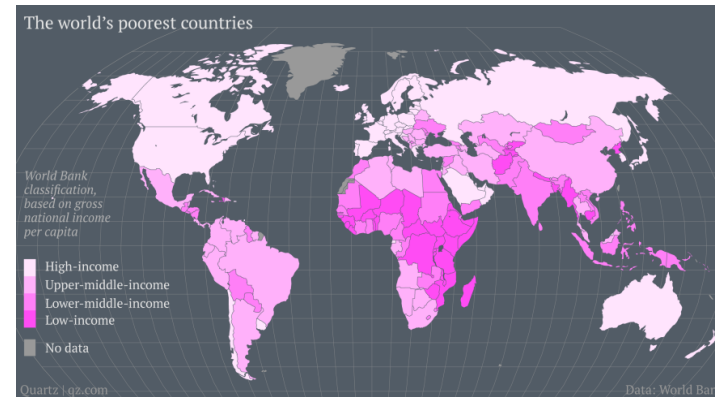
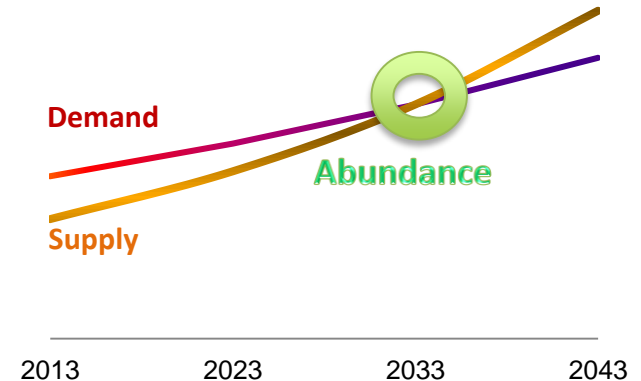
- Pre-Technology Revolution: GDP depended on size of population.
 - China and India dominated global DGP.
- 1st Revolution: steam, electricity, internal combustion, radio, aeronautics.
 - Europe started to dominate global GDP.
- 2nd revolution: transistor, computer, internet.
 - US and Japan started to dominate global GDP.
- Emerging 3rd revolution: fusion of computing, communication and sensing.
 - Enabled by a crazy idea of embedding a computer into the phone.
 - Drove infrastructure to enable ultra low cost and very high volumes, enabling in turn:
 - Mobile market, Wearables, Abundance, Internet of Everything, mHealth.
 - Frees people from manual labor and leaves for them creative work supported by AI and machine learning.
- Expected 4th revolution: machines take over the world, leaving for humans enjoyment in virtual world through a direct computer-brain communication.

* Concept of the first three Revolutions was introduced by Vijaj Ullal, President of Fairchild.

Introduction to Abundance*

- Abundance* movement is part of 3rd Technological Revolution.
- Forecasts elimination of major global problems in one generation (20 to 30 years) :
 - Hunger
 - Lack of medical care
 - Lack of clean water and air
 - Lack of energy
- Forecasts the need for (among others) 45 trillion sensors.
 - Many not yet developed.
- Historical sensor development cycles from prototypes to volume production were 30 years.
 - Left to historical cycles, slow new sensor commercialization would delay the Abundance.
- TSensors (Trillion Sensors) Movement aims at acceleration of new sensors development cycle.

Global Goods and Services



Bill Gates: No Poor Countries by 2035 = Abundance

* <http://www.abundancethebook.com/>

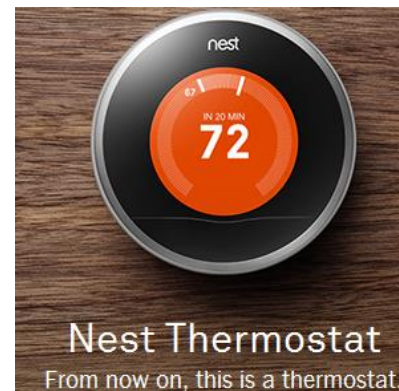
<http://qz.com/168341/bill-gates-predicts-there-will-be-almost-no-poor-countries-by-2035/>

Abundance Enablers

- Exponential technologies:
 - Biotechnology and bioinformatics
 - Medicine
 - Nanomaterials and nanotechnology
 - Networks and sensors (45 trillion networked sensors in 20 years).
 - Digital manufacturing (3D printing) and infinite computing
 - Computational systems
 - Artificial intelligence
 - Robotics
- Billionaire DIY (Do-it-Yourself) revolution:
 - Power of individual innovators capable of “impossible”.
 - E.g., flying into space (Burt Rattan) and sequencing human genome (Craig Venter), building electric car (Elon Musk), etc.
- Unrivaled in history billionaire technophilanthropic force:
 - E.g., Gates, Zuckenberg, Omidyars, etc.
- The rising billion:
 - Billion of the very poorest of the poor on earth is being plugged into global economy through a global transportation network, Internet, microfinance and wireless communication.
- Abundance becomes possible as a result of multiple emerging global economic tides, such as IoT and Digital Health.

Internet of Everything (IoE, IoX)

- World of connected all things around us.
- Enabled by:
 - Emergence of IPv6, providing 3×10^{38} IP addresses, one for every “thing” on Earth.
 - Major network providers decision to modify networks simplifying connection of things and everything.
 - Modified network architecture to include Fog and Swarm layers/computing.
- Bold forecasts for IoX:
 - Cisco: \$19 trillion by 2020, over 20% of the global 2020 GDP !!!
 - GE: \$15.5T by 2020.
- Networked sensors are expected to represent 5% of IoX, \$1T by 2020.
- First multibillion acquisition of IoE startup.
 - \$3.2B acquisition of Nest by Google.
 - New Era for startups?



mHealth (eHealth, Digital Health)

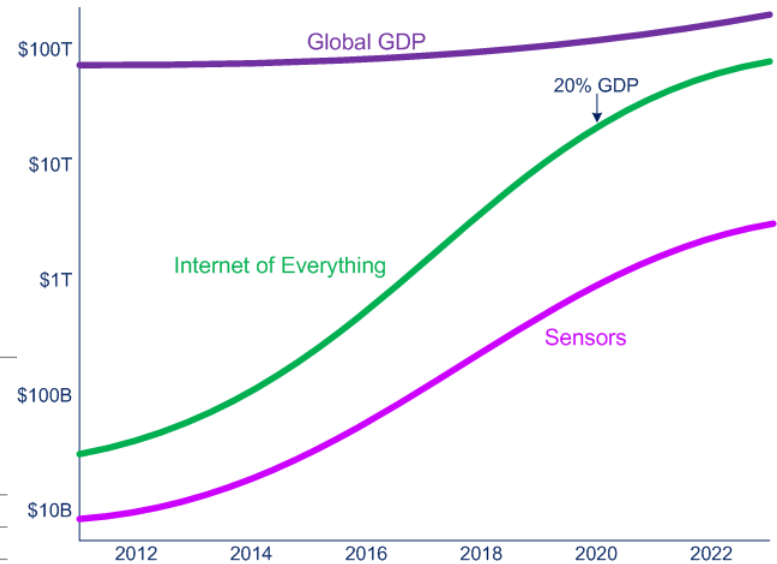
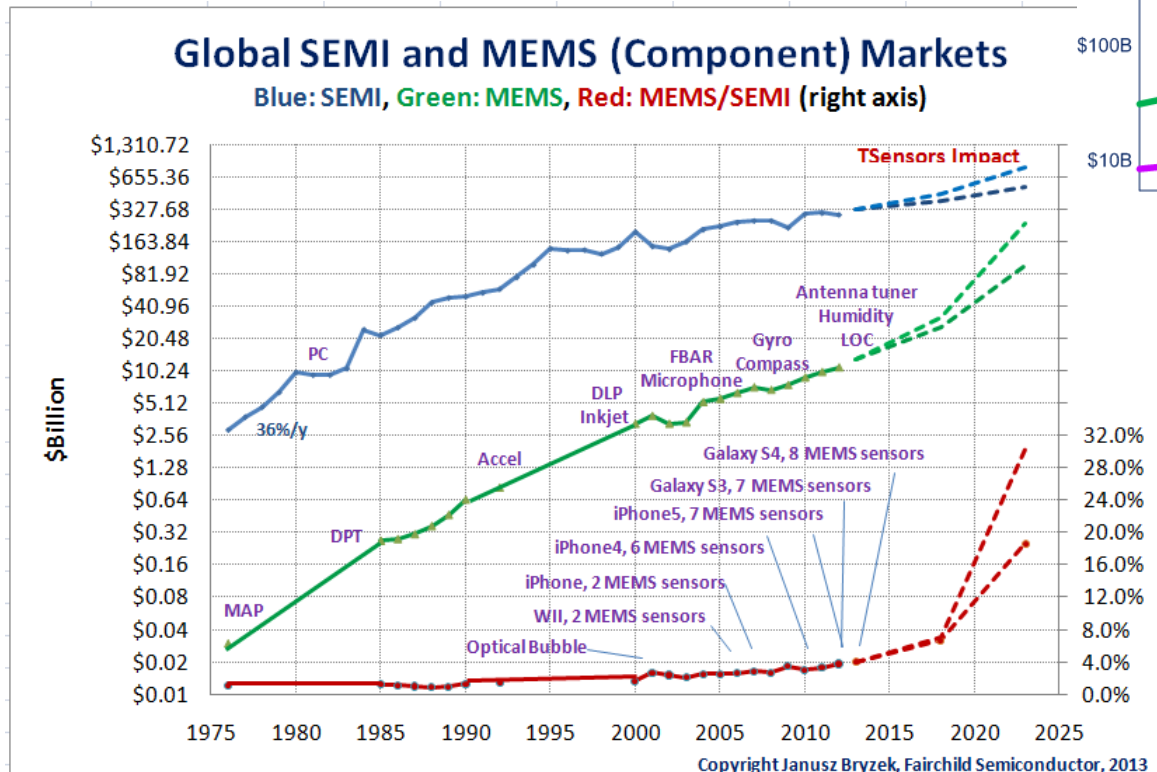
- US Healthcare spending was about 20% of GDP.
- mHealth is expected to save in coming years 35% of cost of treatment of chronic medical conditions, which represents vast majority of health care spending.
 - Selected low hanging fruits for mHealth in the US:
 - \$300B/y: patients don't follow their prescriptions.
 - \$44B/y: patients don't give doctors enough information.
 - \$300B/y: unhealthy diet and lack of exercise.
- mHealth is expected to bring healthcare to everybody on Earth.
- mHealth is expected to dramatically redefine medical industry and the function and responsibility of doctors.
 - Large number of traditional medical equipment medical companies will cease to exist.
 - Diagnostics will shift to computers.
 - Doctors will need to learn how to use Big Data generated by sensors and processed by supercomputers in patients' hands.

Inc Magazine, February 2014

TSensors Initiative

- Includes three phases:
 - [TSensors Summits™](#): conferences collecting visions for new ultrahigh volume sensor applications (TApps™).
 - Ultrahigh volume: >1 billion units/year, a requirement to make a global impact.
 - First events: 2013 TSensors Summits at UC Berkeley and Stanford University.
 - 2014 Summits: Tokyo (February), Munich (September 15-17), San Diego (November 12-13), Tokyo (December 8-9).
 - 2015 Summits under discussions: Abu Dhabi in March and Wuxi in May.
 - [TSensors Roadmap™](#): document characterizing most suitable sensor technology platforms for TApps™.
 - [TSensors Supply Chain development](#): infrastructure to develop and commercialize most impactful sensors.
 - Facilitating restructuring of academic and R&D programs to focus on TSensors Roadmap.
 - Facilitating spinoff of startups from leading research organization supported by target customers.
 - Facilitating JVs (Cooptition) between target customers, infrastructure companies, academia and research organizations.
 - Facilitating launching Incentive Competitions (similar to XPrize Foundation's).
 - Facilitating Governments funding.

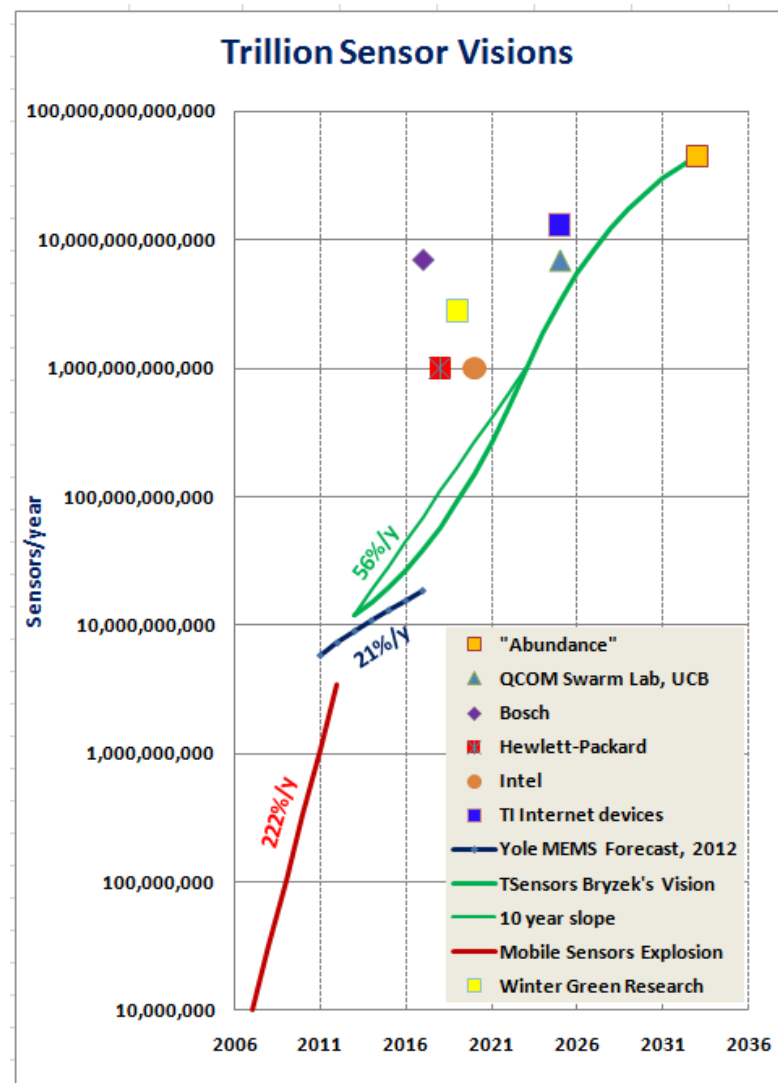
MEMS Migration into Mainstream



Concept of the slide developed by Dr. Kurt Petersen

Trillion Sensors (TSensors) Visions

- Mobile sensor market grew exponentially over 200%/y between 2007 and 2013.
- Several organizations created visions for a continued growth to trillion(s).
 - Explosion to trillion(s) is likely to be driven by new applications.
- Forecasting thus needs visionaries!



TApps™ from TSensors Summit at Stanford

- TSensors Summit at Stanford resulted in about 300 applications.
- I grouped them into:
 - Education
 - 10 TApps™ cross-referenced with 20 sensor technology platforms.
 - 5 infrastructure technologies (next page).
- The objective for working groups will be to select those combinations which will have the largest global economic impact.

TApps

2. Education: sensors and IoE

3. Noninvasive health monitoring

Non-contact
 Contact-based
 Breath-based
 Voice-based
 Emotion based
 Body fluid based
 Digestible pill based
 DNA/Genome/RNA/Protein based
 Chronic disease monitoring

4. Minimally invasive health monitoring

Body fluid analysis
 Chronic disease monitoring

5. Personal imaging

6. Computer senses

Taste
 Touch
 Smell
 Feel
 Vision
 Biometric authentication
 Autonomy brain for drones
 Autonomy brain for robots

7a. Environmental sensing

Air pollution
 Water pollution
 Agricultural pollution
 Radiation pollution
 Petrochemical pollution
 Explosives detection
 Smart City sensing

7b. Infrastructure sensors

Bridges, roads, buildings

8. Smart food production

Quality, pollution, freshness
 Livestock health
 Assets tracking
 Precision agriculture and aquaculture
 Plant health monitoring
 Water management

9. Smart energy generation and control

Home energy management
 Smart grid sensors
 Harsh environment sensors

9b. Emerging Automotive Sensors

Sensor Technology Platforms

Spectrometer
 Gas chromatograph
 Chemical sensors
 Lab-on-Chip
 Lab-on-CMOS
 Paper Microfluidics
 Disposable cameras
 Acoustic imaging
 Hyperspectral imaging
 Thermal imaging
 Ultrasound imaging
 X-ray imaging
 THz imaging
 Radiation sensors
 Brainwave sensors
 Graphene sensors
 High temperature sensors

Note: numbering relates to Chapters of TSensors Roadmap

Infrastructure Technologies for TSensors

10. 3D printed electronics and sensors.
11. Energy harvesting and ultra low power electronics enabling energy harvesters.
 - Flex batteries
 - Supercapacitors
 - Solar
 - Strain
 - Thermal
 - RF
12. Ultralow power wireless communication
 - 802.11ah?
 - Bandwidth sharing
 - Mechanical
 - unPad
- 13a. Network infrastructure for Internet of Everything
 - Swarm
 - Fog
 - Cloud
 - Security/encryption
- 13b. Analytics

Proposed TSensors Roadmap Schedule

December 31, 2014: Global availability of un-edited version of TSensors Roadmap

Jobs, Jobs, Jobs...

- Based on Cisco forecast (\$19T system/services and \$1T sensors) loX would create a total of 172 million jobs by 2020.
 - As a reference, the US created only 1.3M new jobs between 2002 and 2012, primarily in Government and medical sectors.
 - Total US employment in December 2013 was 144M.

Jobs Where?

- Sensor based systems require a high-tech work force.
 - Majority of created jobs will likely be for knowledge workers.
- An example of a sensor based system could be Apple's iPhone 4s, which had the following breakdown of 2011 selling price:
 - 3% (\$14) cost of assembly (China)
 - 32% (\$178) cost of components (global)
 - 66% (\$368) Apple's share (US)
 - 100% (\$560) selling price
- Most of sensor and IoX jobs will likely be in industrialized countries.

Fortune Magazine 2011

TSensors Movement Strategy

1. Invite visionaries to “invent” new sensor applications expected to drive ultrahigh volume demand for sensors.
 - Ultrahigh volume: >1 billion units/year, a requirement to make a global impact.
 - First events: 2013 TSensors Summits at UC Berkeley and Stanford University.
 - 2014 events: Summits in Tokyo, Munich, San Diego.
2. Group these applications into the common application platforms (TApps).
3. Develop TSensors Roadmap:
 - Document characterizing most suitable sensor technology platforms which:
 - Could meet the requirement of TApps.
 - Could meet the cost targets enabling deployment in >billion units/year.
 - Could support multiple TApps, if possible.
4. Develop strategy for selected sensor technology platforms development acceleration, e.g.:
 - Facilitate restructuring of academic programs to focus on TSensors Roadmap.
 - Facilitate spinoff of startups from leading research organization supported by target customers.
 - Facilitate JVs (Cooptition) between target customers, infrastructure companies, academia and research organizations.
 - Facilitate launching Incentive Competitions (similar to XPrize Foundation’s).
 - Facilitate Governments funding.
5. Facilitate funding of the acceleration effort.

Jobs Where?

- Sensor based systems require a high-tech work force.
 - Majority of created jobs will likely be for knowledge workers.
- An example of a sensor based system could be Apple's iPhone 4s, which had the following breakdown of 2011 selling price:
 - 3% (\$14) cost of assembly (China)
 - 32% (\$178) cost of components (global)
 - 66% (\$368) Apple's share (US)
 - 100% (\$560) selling price
- Most of sensor and IoE jobs will likely be in industrialized countries.

Fortune Magazine 2011

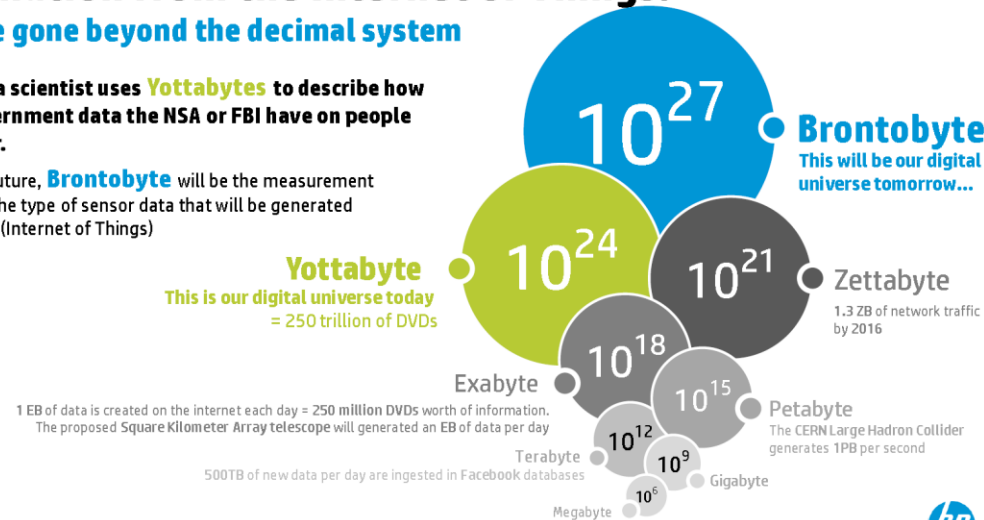
Challenges for TSensors

- User adoption.
- Cycle time for commercialization.
 - Bleeding edge technologies.
- Standardization.
- Development of algorithms enabling derivation of useful information.
- Bandwidth sharing wireless communication.
- Battery/scavenger sources enabling power for life.
- Network architecture enabling low latency control.
- Scaling network size enabling processing of sensor generated data at the level of Brontobytes.
- Available funding.

Information from the Internet of Things: We have gone beyond the decimal system

Today data scientist uses **Yottabytes** to describe how much government data the NSA or FBI have on people altogether.

In the near future, **Brontobyte** will be the measurement to describe the type of sensor data that will be generated from the IoT (Internet of Things)



7 | © Copyright 2013 Hewlett-Packard Development Company, L.P. The information contained herein is subject to change without notice.

Accelerating Development through Competition

- \$2.25M Nokia Sensing XChallenge
 - **Nanobiosym Health Radar** won \$525,000 Grand Prize award in 2013.
 - Enables testing of a drop of blood or saliva with a nanochip inserted into a mobile device. It detects the presence (or absence) of selected disease's pathogen in real-time, with gold standard accuracy.
 - \$120,000 Distinguished Award winners demonstrated game-changing technology:
 - **Elfi-Tech** - Using advanced optics in a device smaller than a penny, non-invasively measures skin blood flow, velocity, coagulation and vascular health.
 - **InSilixa** - Using blood, saliva or urine, created a single CMOS chip that analyzes proteins and nucleic acids to detect diseases and health status.
 - **MoboSens** - Water and biofluids can be analyzed rapidly with smartphone-based sensor that reports on the presence of chemical contaminants and bacteria.
 - **Owlstone** - Using a "digital nose" sensor, can detect the presence of chemicals in concentrations down to parts per trillion. identifying disease from user's breath or body fluids.
 - **Silicon BioDevices** - Using blood drawn from a small finger stick, sensor diagnoses and transmits results to mobile devices or electronic medical record (EMR) systems.
- Qualcomm's \$10M Xprize competition to detect 15 most common diseases and 2014 Nokia competitions are still open.
 - 32 teams from 9 countries are competing.

Social Impacts

- Availability of low cost sensors in cellphones and wearables to measure human fitness and health triggered **Quantified Self**^[1]:
 - Movement to incorporate self-monitoring and self-sensing technology into data acquisition on aspects of a person's daily life.
- The emerging **Quantified Us** extends self-monitoring and self-sensing to all of us on Earth.
- **Quantified X** extends sensing and monitoring to all things on Earth.

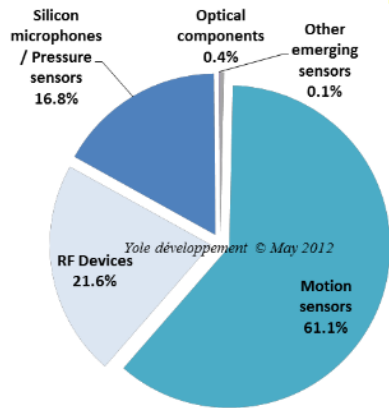
Showcase: The Amazing World of Sensor Based Products for All of Us

MEMS Studded Mobile Devices

\$CAGR: 35%/year!

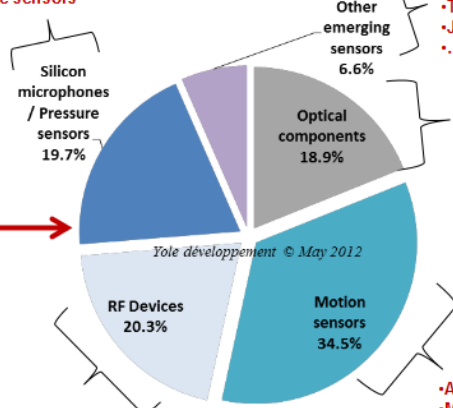
MEMS Product Mix Evolution in Mobile Device

MEMS in cell phones and tablets
Application segment breakdown
- 2011 - total = \$1.7B



MEMS in cell phones and tablets
Application segment breakdown
- 2017 - Total = \$5.4B

•Silicon microphones
•Pressure sensors



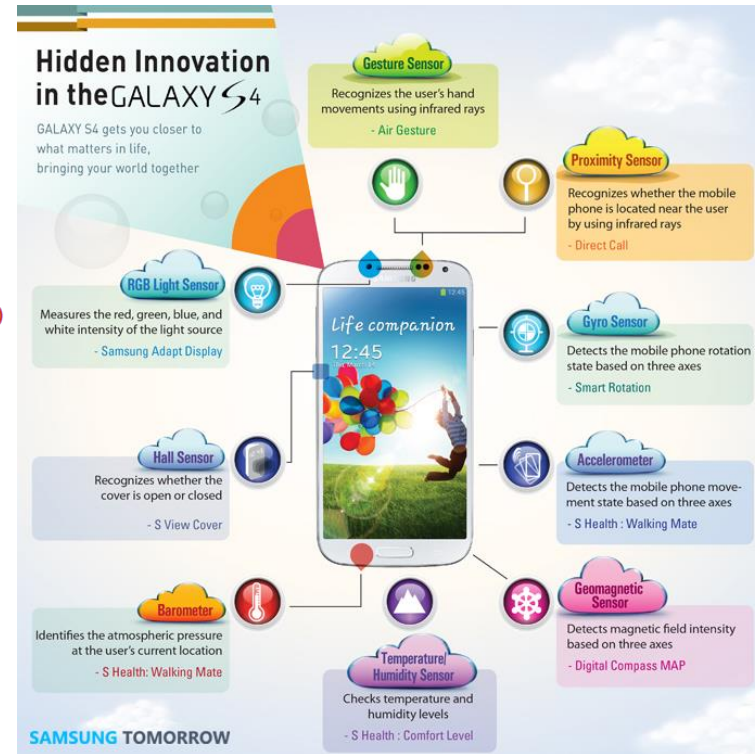
•Energy harvesting
•Environmental sensors (temperature, humidity...)
•Micro fuel cells
•Microspeakers
•Touchscreen
•Joystick
•...

•Auto-Focus
•Microdisplay
•Micro-mirror for microprojectors

•MEMS timing devices
•MEMS switch / variable capacitors
•BAW filters
•BAW duplexers

Yole 2012

•Accelerometers
•Magnetometers
•Gyroscopes
•6 to 9DOF inertial combos



Samsung Galaxy S4: MEMS usage leader. Additionally, it has:

- 3 microphones
- Over 30 FBARs filters

Turning a Body into a Computer



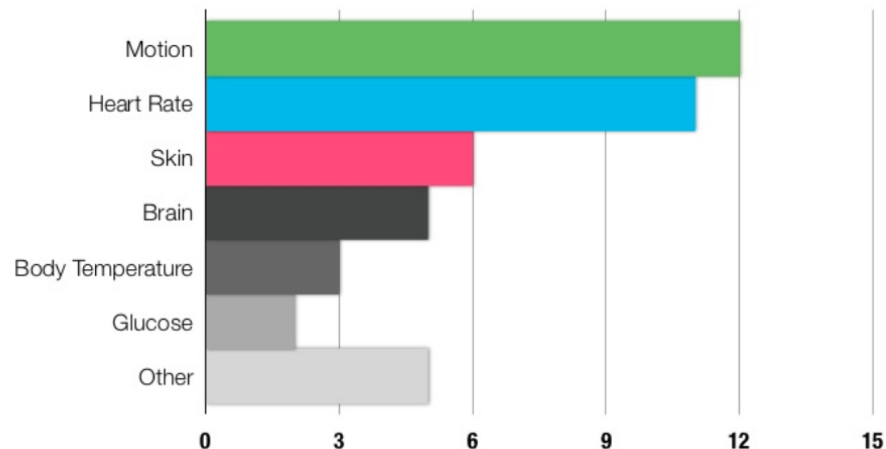
<http://www.inc.com/ss/ready-wear#0>

Pioneers

First Fitness/Health Startups



What are they measuring?



Themes of the 36 sensor companies 2011

Sensing the Arms and the Legs...



»» monitoring in motion

- » Accurate
- » Easy to use
- » Robust



Biovotion VSM arm band allows continuous monitoring of blood oxygenation and cutaneous blood volume, skin temperature and heart rate using:

- Multi-wavelength optical reflection sensor
- Accelerometer
- Temperature sensor,

Myontec Ltd. embedded textile sensors that measure the Electromyography (EMG) signals from various muscle groups, quadriceps and hamstrings, on both legs to provide feedback on muscle performance for training or rehab. It also logs the heart-rate, speed and altitude

<http://www.myontec.com/>

Helping Women ...



Ravijour developed a bra with autolock. When True Love is detected, the bra unhooks automatically from the front to help save women from one-night stands with less-than-savory men.

The bra contains a heart-rate sensor. The app calculates the "true love rate," comparing the readings to activities like shopping, watching a horror movie, flirting, jogging, or receiving a surprise gift.

http://news.cnet.com/8301-17938_105-57617747-1/bust-lock-down-bra-only-unhooks-for-love-true-love/



Smart Bra concept is aimed at helping people ward off emotional eating (Image: Microsoft) using EKG and EDA, an electrodermal activity sensor measuring skin conductance (moisture) and movement (respiration rate).

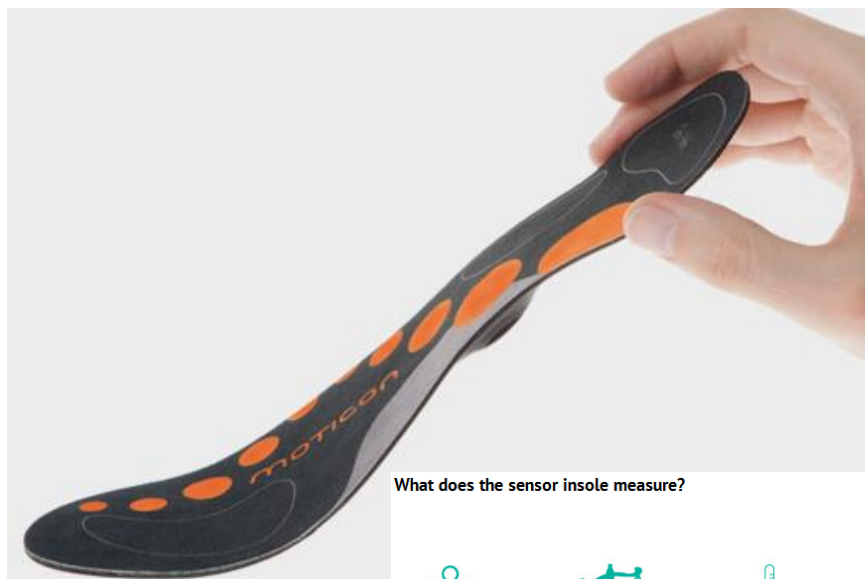
<http://www.telegraph.co.uk/technology/microsoft/10499811/Microsoft-developing-smart-bra.html>



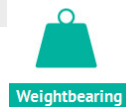
The sensor finds cancer by detecting tiny metabolic temperature changes caused by cancerous cells in a tumor. The temperature readings are sent to a global library where they're run through a proprietary algorithm. Then the results are sent back to a user's phone.

<http://mobihealthnews.com/32250/breast-cancer-wearable-sensor-company-raises-560k-plans-asian-launch/>

Sending Shoes to School...



What does the sensor insole measure?



Weightbearing



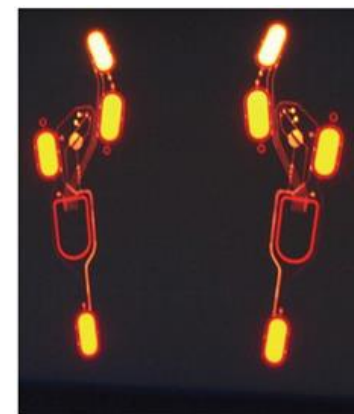
Balance



Temperature



Acceleration



8 sensors

OpenGo from Moticon claims to be the world's first fully integrated and wirelessly connected sensor insole with 13 capacitive pressure, 3D acceleration and a temperature sensor. It measures plantar pressure distribution for patient monitoring with respect to gait training and overload prevention.

Nike's smart shoe insert with 8 sensors measures jump shot, speed, performance

<http://www.moticon.de/en/system/sensor-insole>

Sensing Diversity



iSonea personal asthma wheeze monitor



Smart sock from Owlet Baby Care monitors infant's quality of sleep, blood oxygenation levels, and skin temperature



Breast lumps self-exams (mammogram) sensor from Eclipse Breast Health Technologies



SmartOne infant monitor measures temperature, baby orientation and breathing

Sensor based Clothing

Bio-sensing clothing for everyday life

Designed to be worn all day, every day

Continuously reads your biometrics and emotive state



Improves your life without getting in the way

Seamlessly connects to your mobile devices

Features



Heart rate

Taken from sensors directly against your skin, OMsignal is the most accurate measure of your heart beats per minute (bpm). OMsignal measures your Heart Rate Variability (HRV) and renders the data to determine your stress level.



Breathing

The revolutionary way to measure your breathing. Sensors embedded in the OMsignal shirt detect your respiratory rate and breathing balance using your respiration rhythms.



Activity

Track your daily steps and get inspired to be more active. OMsignal measures your activity all-day with a highly sensitive and accurate accelerometer.



Calories

Keep track of calories burned and see trends in your day and over extended periods of time. Our read on calories is taken directly from your heart rate, measuring how many calories you expend during your day both at rest and from activity.



Emotive State



Moments



Smart Apparel



Analytics

<http://www.omsignal.com/>



NTT Docomo and Toray announced *Hitoe* (Japanese for "one layer") cloth with coated nanofibers and a square patch that does the sensing, measuring heartbeat and even offering metrics resembling a cardiogram.

<http://www.engadget.com/2014/01/30/ntt-docomo-toray-smart-cloth/>

Wrist based Sensor Systems

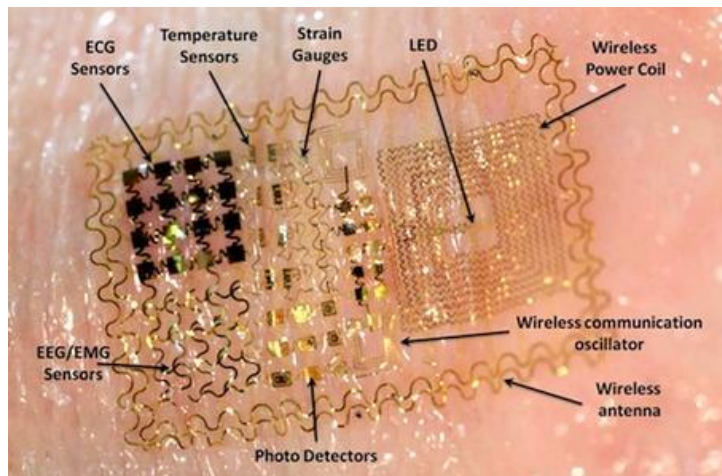


Wellograph Wellness Watch
9DOF + Heart monitor



Netatmo's June bracelet with UV sensor

Tattooed Sensor



UC San Diego



MC10

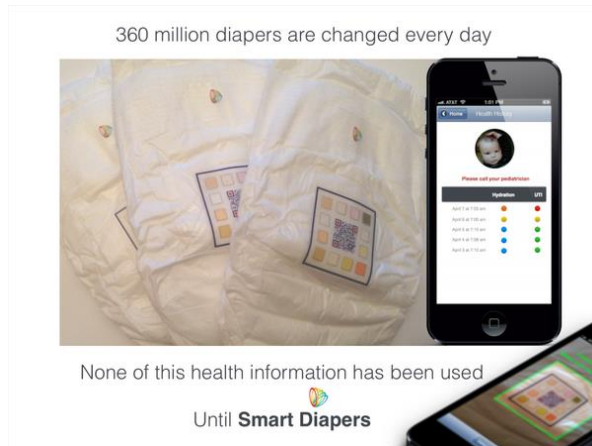
Expressing Emotions



Brainwaves driven ears and tail from Necomimi (\$69) express your emotional state before you start talking.

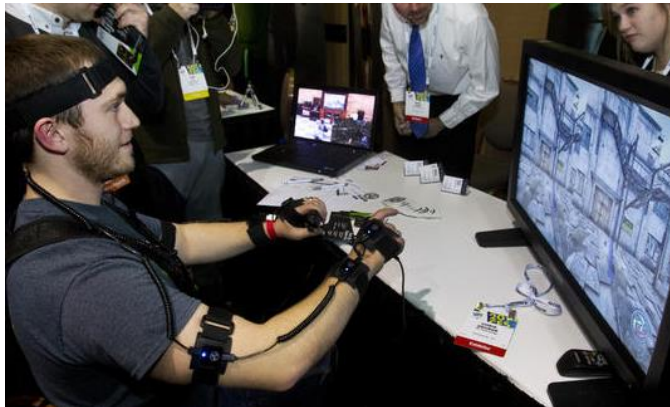
<http://www.necomimi.com/>

Sensing All the Way...



Smart diapers will monitor urinary tract infection, prolonged dehydration, developing kidney problems.

<http://www.indiegogo.com/projects/pixie-scientific-smart-diapers>



YEI Technology virtual reality sensors capture player movement

<http://www.cbsnews.com/pictures/wearable-technology-ces-2014/5/>



FitBark pet activity tracker

<http://www.cbsnews.com/pictures/wearable-technology-ces-2014/9/>



MTM RAD watch includes integrated Geiger-Müller tube for measuring ionizing radiation

<http://www.gizmag.com/mtm-rad-watch-geiger-counter/28389/pictures>

Sporting Along

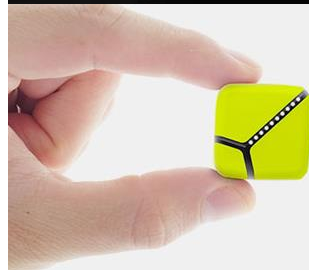
**ANALYZE YOUR SWING
IMPROVE YOUR GAME**



ZEPP BASEBALL » **ZEPP GOLF** » **ZEPP TENNIS** »



Sensor based tennis racket from Babolat



**YOU PLAY.
IT TRACKS.**

Meet the Zepp Sensor. It captures, measures and analyzes your swing in three dimensions and records 1,000 data points per second.

Zepp sensors create 3D representations of a player's swing
<http://www.zepp.com/>

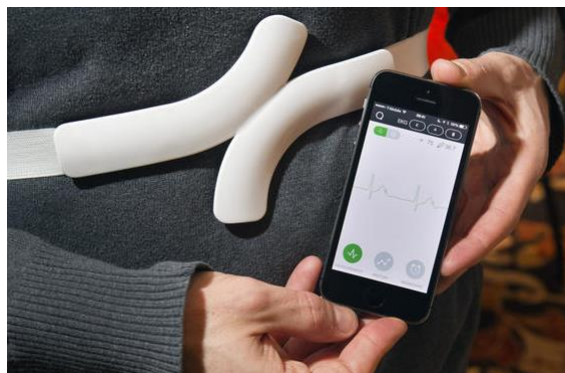
Onewheel: the self-balancing electric skateboard
that gives you the feeling of flying



Sending Cellphone to Med School...



EKG monitor from AliveCor



EKG monitor from Quardio



Preventice's smart bandage constantly tracks cardiac ECG and rhythm monitoring



Uchek (MIT) detects 25 diseases, such as diabetes, urinary tract infections, and pre-clampsia, levels of glucose, proteins, ketones, and more.



Fraunhofer's glucose, lactate and cholesterol sensors, pulse oximeter, and a fluorescence sensor for detecting biomarkers



Lapka can detect radiation and organicity of food.

Helping People

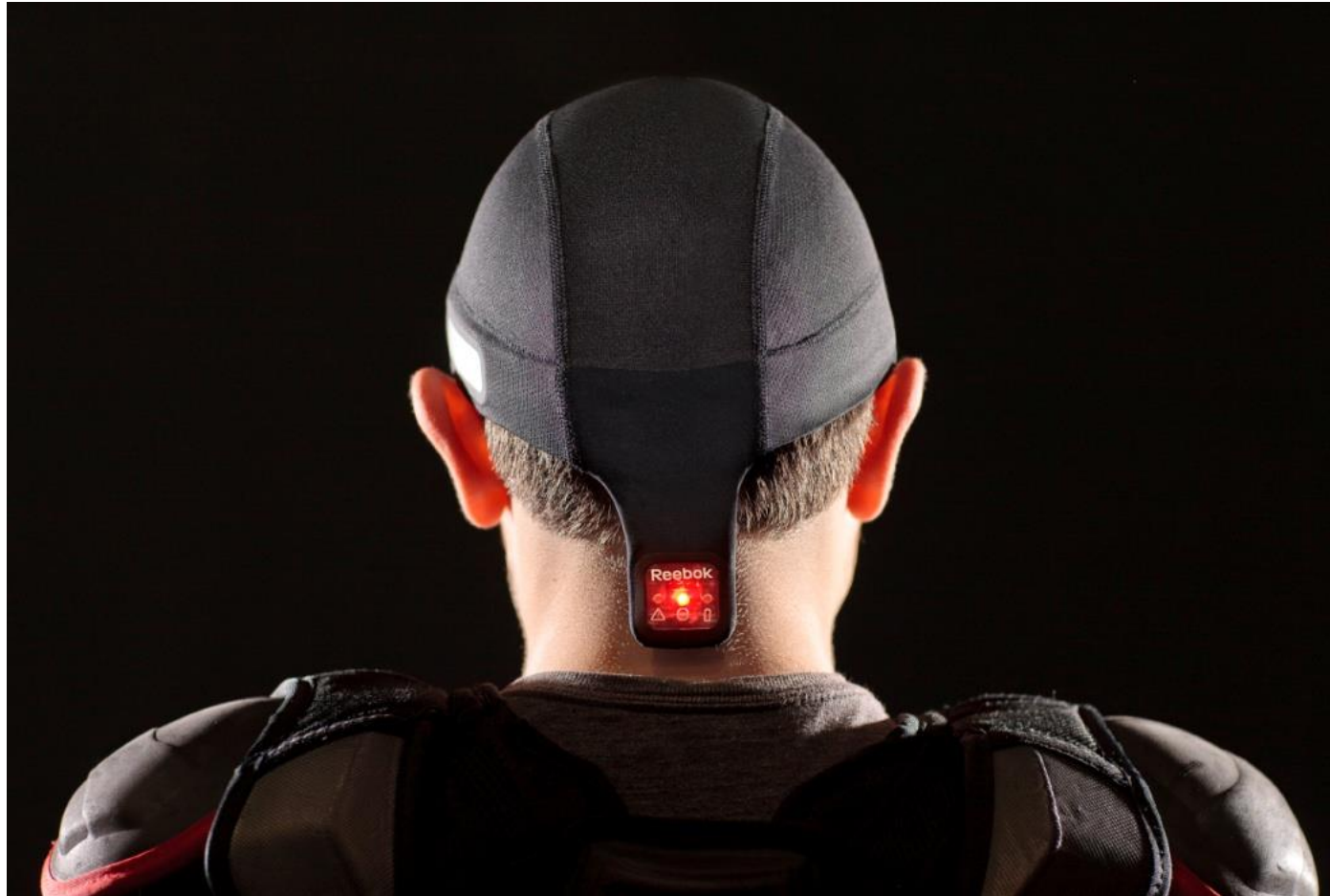


Shake stabilized spoon for Parkinson disease patients from Lift Labs



Text to sound converter for blinds based on optical sensor with processing unit wrapped around hand and wrist. Also enables translation to other languages and to determine if it is day or night and recognize colors.

Detecting Players' Brain Injury



A green, yellow and red lights indicate moderate, medium and severe impacts, respectively.
The system also logs the total number of impacts.

<http://www.mc10inc.com/>

Brain Sensing System

- Wireless neuroheadset based on 14 sensors plus 2 references to detect from brainwaves the real time user's:
 - Thoughts
 - Feelings
 - Expressions.
- Enables a fantasy of controlling and influencing the virtual environment with your mind.
- Amazing range of advanced algorithms allow these headsets to detect :
 - Subconscious emotional states
 - Facial expressions
 - User-trained mental commands which can control existing and custom applications and games as if by magic.
- Allows computers to react to your moods and deliberate commands in a more natural way.



<http://www.emotiv.com/epoc/>

Cuffless Blood Pressure Measurement



Sotera Wireless' non-invasive measures continuous blood pressure, along with pulse rate, skin temperature, electrocardiogram, blood oxygenation and respiration rate and temperature.



Cnoga's device spectrometrically measures noninvasively blood pressure, blood oxygen, and pulse.



HealthStats watch measures blood pressure using applanation tonometry.

Noninvasive Glucose Monitoring



Integrity Applications' employs a combination of ultrasound, electromagnetic, and thermal technologies to obtain blood glucose readings



Echo launched a non-invasive continuous glucose monitoring system based on proprietary skin permeation



Biosensors' approach is based on electromagnetic impedance spectroscopy (EIS) and electromagnetic impedance tomography (EIT).



Cnoga's device measures glucose, heartbeat, skin resistance, quality of skin collagen, skin health and identifies nervous people based of color change of RGB lights passing through skin.



C8 MediSensors developed Raman spectroscopy based glucose sensor, raised \$120M (\$43M in 2012) and closed in 2013 after finding measurement instability. Apple hired several of former employees

Personal Glucose Monitors



Contact lens embedded glucose monitor in tears being developed at Google, wirelessly communicates with mobile devices



Toilet embedded sensors measure blood glucose and albumin, free protein, urea, bilirubin, and others, for tracking health condition for type 2 and pre-diabetes, based on mid-IR spectroscopy

<http://www.pyreos.com/>

Increasing Sophistication Level...



Ultrasound scanner from Mobisante

<http://www.mobisante.com/>



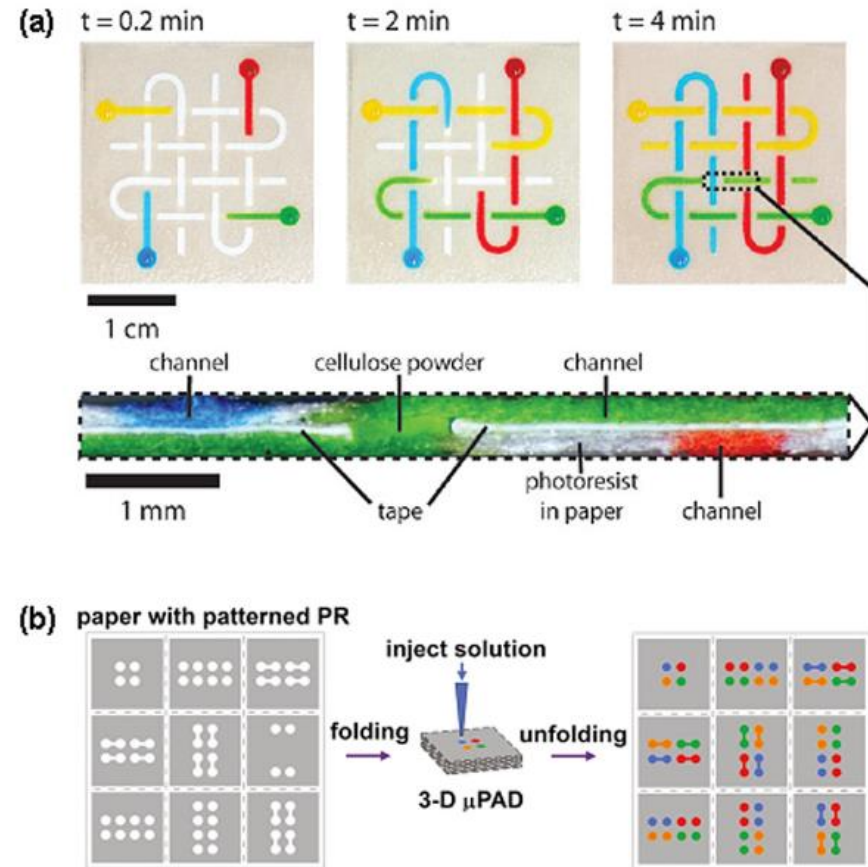
Mobile Xray station from Tribogenics

<http://tribogenics.com/>

Printed Paper Microfluidics

- Lab-on-Chip can be multilayer printed on paper.
- Is low-cost, easy-to-use, disposable, and equipment-free.
- Promising technology particularly relevant to improving the healthcare and disease screening in the no- or low infrastructure developing world.
- Applications:

Health diagnostics (e.g., urinalysis, saliva analysis, sputum analysis, pregnancy test, blood type)
Biochemical analysis (e.g., enzyme activity)
Environment monitoring
Food quality control
Forensic (e.g., detection of blood)



<http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3365319/#c19>

Blood Testing based on Lab on Chip

Palo Alto startup Theranos rolled out blood testing (starting with Walgreens in Palo Alto) after \$100M+ funding:

- 1000x reduced blood volume for about 200 blood tests.
 - Likely enabled by Lab on Chip with fluorescent tags.
- Providing results in 4 hours
- With increased accuracy.
- At a fraction of lab cost.

For the first time, Theranos is introducing CLIA-certified laboratory services with the ability to run its tests on micro-samples.

One drop. A world of answers.

Our laboratory can precisely analyze tiny samples. A few drops are all we need to perform most tests. So now, you can have your labs – from blood, urine, fluids, and more – done quickly, easily, and accurately.

Our technology »



Goodbye, big bad needle.

Instead of a huge needle, we can use a tiny finger stick or collect a micro-sample from a venous draw. It's practically painless and a lot less scary. In fact, we've made the entire lab testing process comfortable, accommodating, and less intimidating – for people big and small.

The experience »

A full range of tests. A fraction of the cost.

We offer a full range of laboratory tests, from common panels to specialized tests. All with speed and the highest levels of quality. And all at costs that make lab testing affordable and more accessible.

Our tests »

Albumin	\$4.99
Albumin, Total	\$4.99
Carbon Dioxide	\$3.36
CBC / auto diff	\$5.35
CBC / no diff	\$4.45
Chloride	\$3.16
Cholesterol	\$2.99
Temp. Metabolic	\$7.99

Intelligent Pills

Digital Medicines



FDA

CE

proteus[®]
DIGITAL HEALTH

Tiny, Safe Ingestible Sensor

Grain-of-sand sized sensor made from dietary minerals, manufactured in drugs

Medicines Signal When Ingested

Unique, pill-specific signal inside body with no battery, radio or antenna

Monitor Therapy & Outcomes

Wearable patch measures ingestions & full panel of physiologic response metrics

Deliver Mobile User Experience

Applications translate data into knowledge, incentives and collaboration

Chemical Sensors: the Next Revolution?

The domestic sector



Combustibles, smart diaper, cooking aid, ...

The medical sector



Diagnostics, compliance, patient monitoring

The automotive, industrial, and aerospace sector



Cabin air, process optimization, distribution integrity, ...

Agriculture and the environment



Fire detection, pollution, crop monitoring, ...

The security sector



Traces of explosives

The food industries

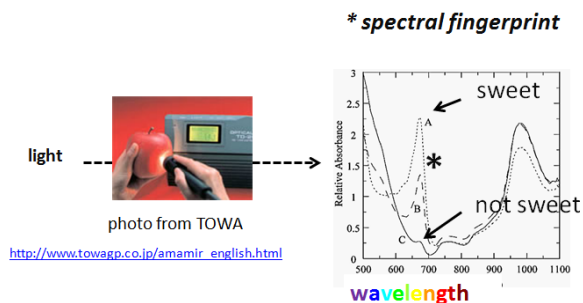


Logistics, perishables, ...

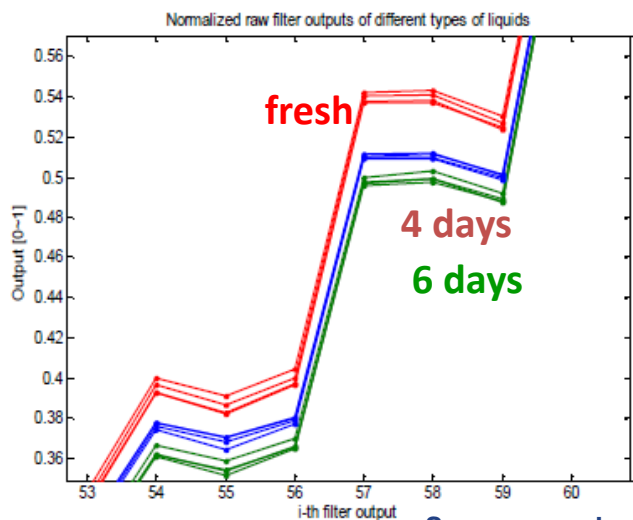
Miniaturized, low cost, high performance, low power

Spectrometer: the Next Gyro-like Tornado?

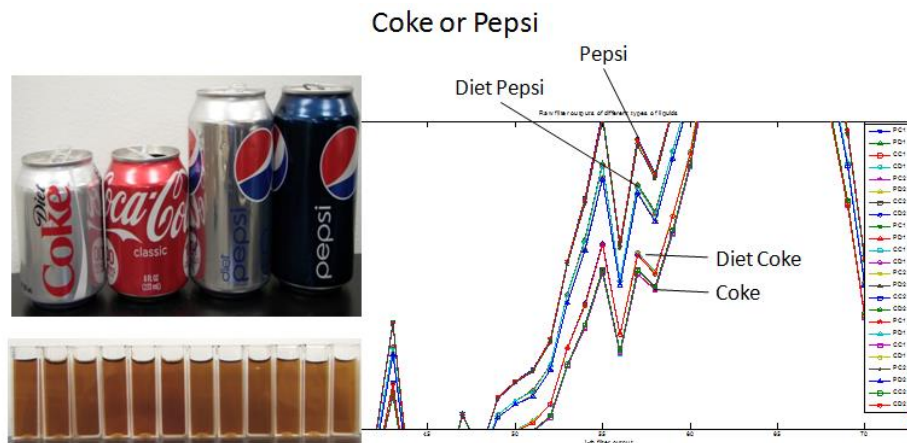
Testing Sweetness of AAPL?
yes, optical spectroscopy can tell



*** fructose (glucose) absorbs specific wavelengths of light**
fresh milk vs. old milk



Source: nanoLambda



Tellspec food quality monitor based on spectrometer processing sensor data in the Cloud (Indigogo)

<http://www.indigogo.com/projects/tellspec-what-s-in-your-food>

Hyperspectral Imaging

HANDHELD APPLICATIONS TARGETED BY IMEC HSI

Food quality grading (e.g. sugar content in fruits, monitoring calorie intake, etc...)



Cosmetic / Skin tone measurement (e.g. make-up advice, etc...)



Skin-care / personalized medicine (e.g. melanoma, diabetic ulcers, wound care...)



Anti counterfeiting spectral tag readers



+ many new ideas / application to be generated when HSI handled platform ready!

Breath Diagnostics

- Dogs are trained to detect medical problems based on breath due to their extreme smell sensitivity:
 - Low sugar level in diabetics or cancer.
- What can be smelled with chemical sensors:
 - Cancer
 - Cholesterol
 - Asthma
 - Lipid peroxidation
 - Metabolism
 - Neonatal jaundice, intestinal distress
 - Cystic fibrosis/bronchitis
 - Periodontal disease
 - Infectious disease (flu)
 - Etc.
- Stony Brook University in New York have developed a breath analyzer (right)
 - Technology utilizes single crystal nanowires that are created by electrospinning.
 - Configuration of metal and oxygen atoms in the nanowires defines which molecules are captured by the chip



Source: Dr. J. Stetter, SRI



Breathometer

\$49 accessory plugs into the base of the iPhone and functions like a field sobriety test.



Shareable

Breathometer is designed so you can share it with your friends. No accessories or tubes needed for safe, sterile, accurate use. Breathometer is not just for you!



Portable

Breathometer is designed to be with you, so you can make more informed decisions wherever you are. Ideally, before you get back to your car!



Accurate

Breathometer is a FDA-registered device which boasts accuracy that compares favorably to other high-end breathalyzers.



Make more informed decisions

The Breathometer app provides more than just your current blood alcohol level — it allows you to make smarter decisions by giving you access to local cab services and providing guidance for how long until you'll be sober.



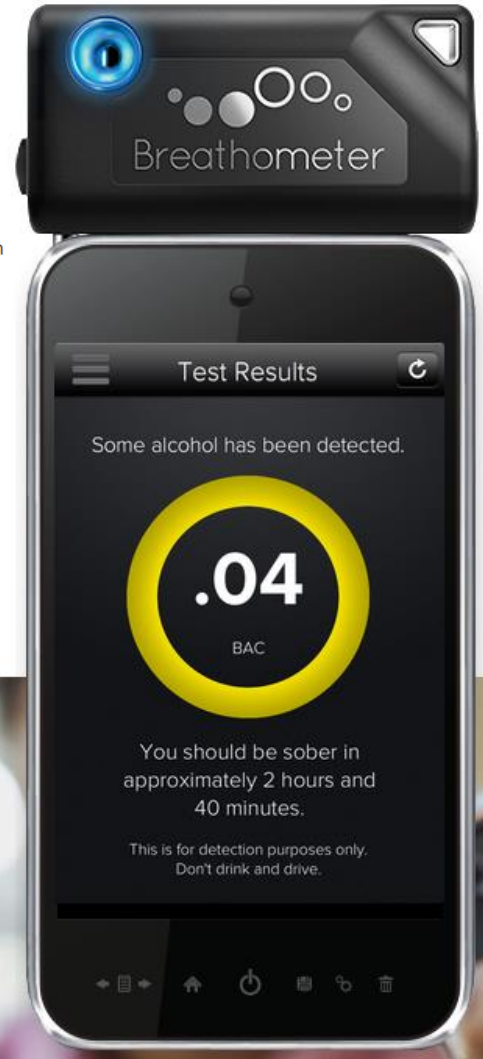
Back To Zero

Based on scientific research, Breathometer provides guidance on how long it will be before you are most likely "back to zero" blood alcohol level. This is an estimate, so please be sure to check again and always use your best judgement before driving!



Call a Cab

Push-button cab service for quick and easy access to a local cab service near you.



<https://www.breathometer.com/>

Getting Inside (the Body)



MEMS-NEMS Breast Cancer Killing Chip
Northwestern University



Catheter-tip balloons with flex and stretchable sensors monitoring balloon's performance in the body.
MC10

Trivia Question

How many sensor types my products showcase presented?

Answer:

I counted 81

Summary

- Future will be more amazing than shown products sampler.
 - Creating New Future will trigger multiple market Tornadoes, redefining global economies and providing room for many new companies.
 - The 2020 room is \$19T big...
- Rapid market evolution is expected to replace 40% of current Fortune 500 companies within 10 years...
 - By companies we didn't hear about yet.
- 50% of current employment will be eliminated by robots.
 - New jobs driven by IoX will require massive re-training.
- Byproducts of the 3rd Revolution:
 - Abundance, eliminating major global problems.
 - Medical diagnostic will become faster, cheaper, portable, wireless... personal.
 - We will start curing diseases rather than alleviate symptoms.
 - All of us will live longer and healthier, in less polluted and more energy efficient world.
 - We will have more fun than ever.
 - We will enjoy the biggest bull market in history?
- The first MEMS/NEMS/Bio Billionaires ~~may~~ have emerged (Nest)...
 - Are you to be the next one?

Thank you

www.TSensorsSummit.org
jbryzek@TSensorsSummit.org