Humankind 2.0: The Technologies of the Future

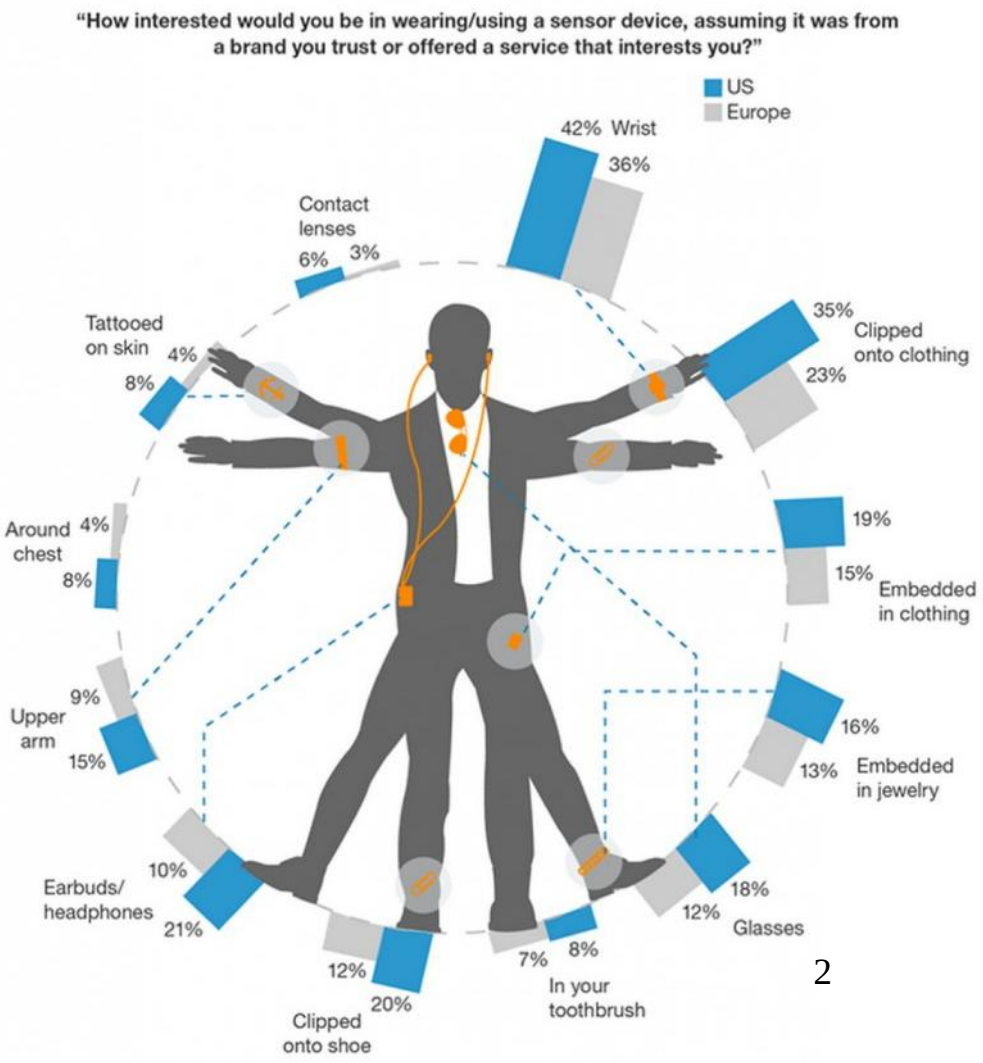
9. Wearables

Piero Scaruffi, 2016

See http://www.scaruffi.com/singular/human20.html for the full text of this discussion

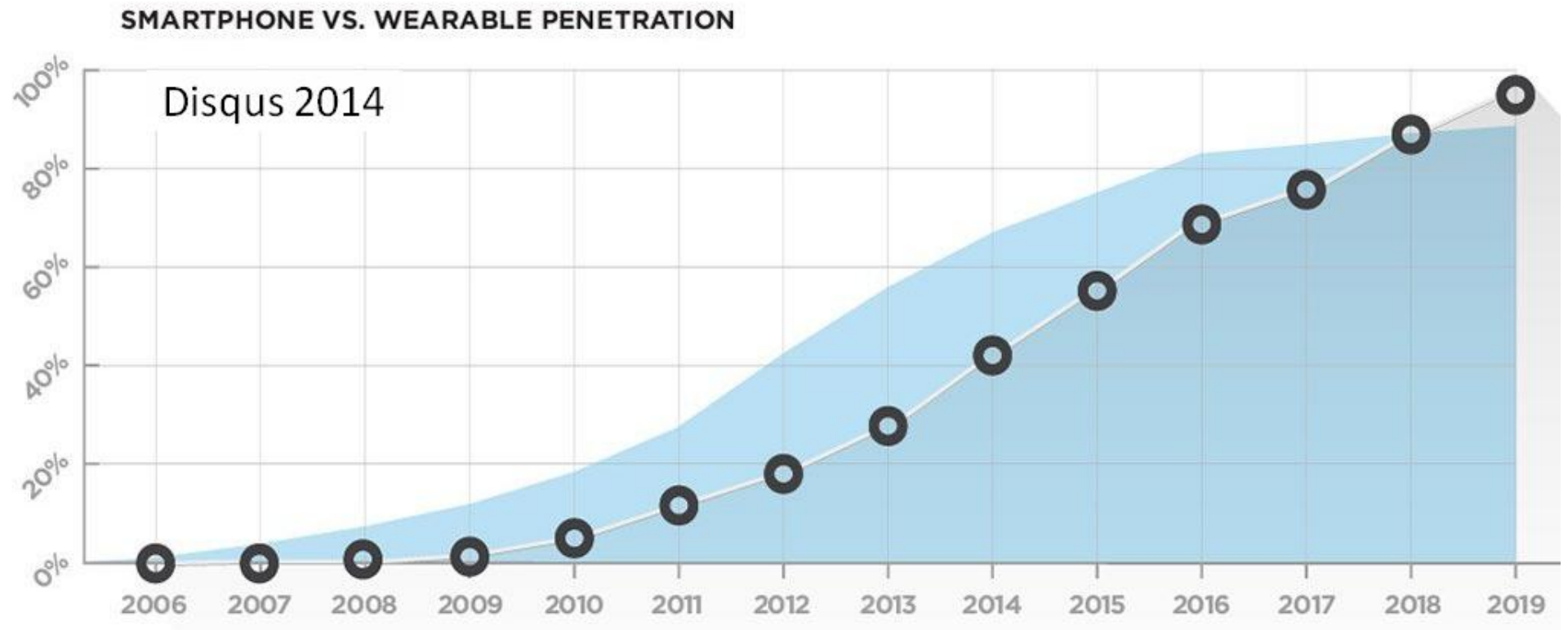
Wearables

- Your body is a business opportunity



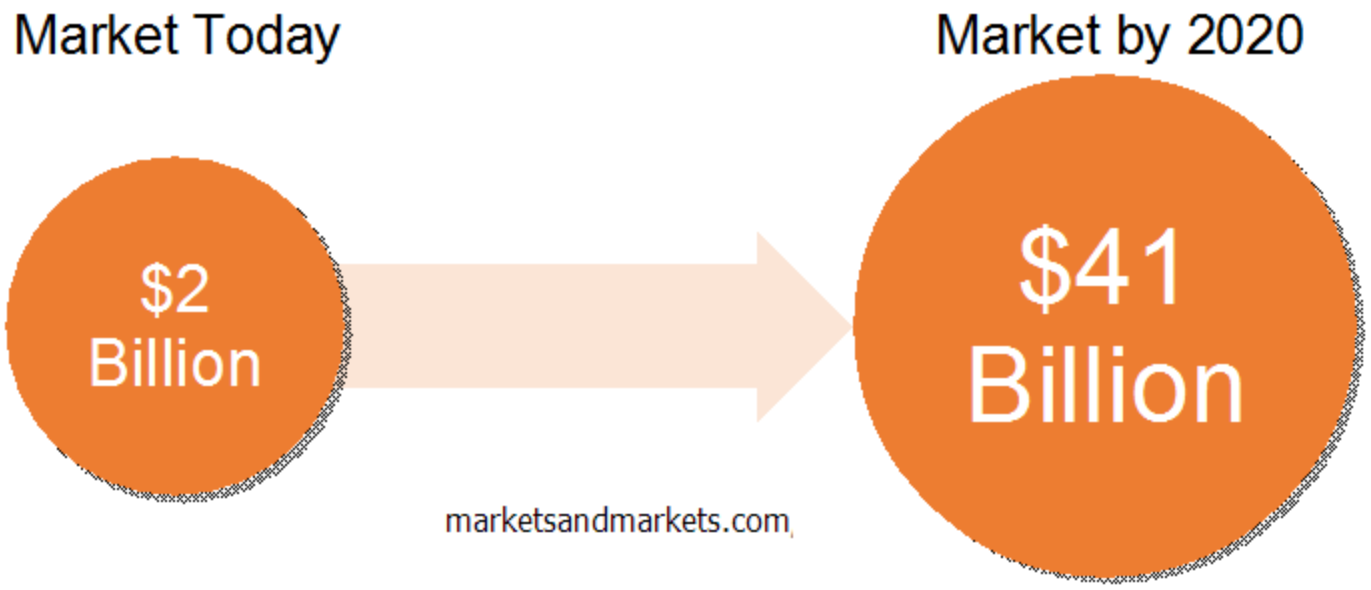
Wearables

- The market for wearables will grow faster than the market for smartphones



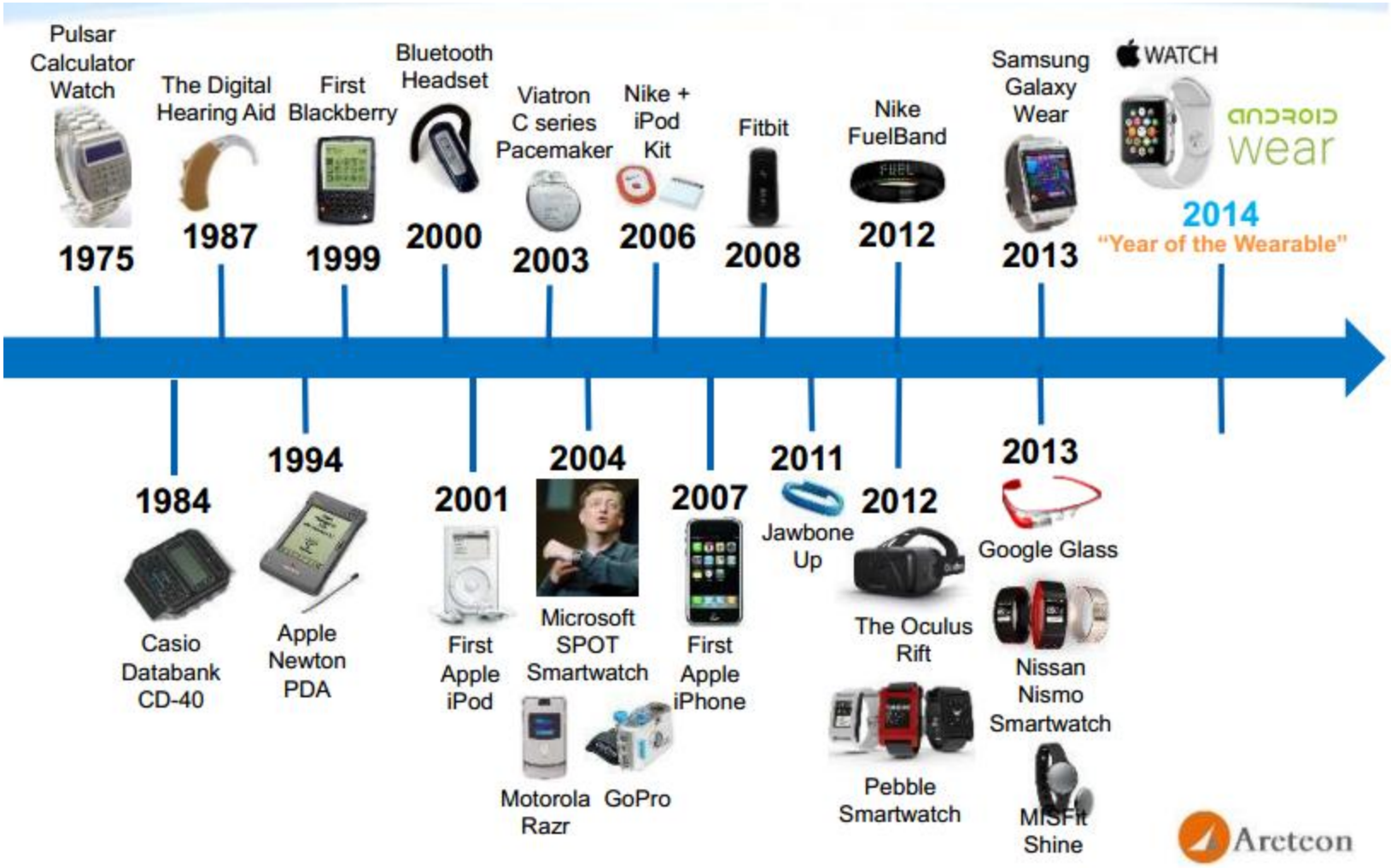
Wearables

- The market for wearables will grow to $41 billion by 2020



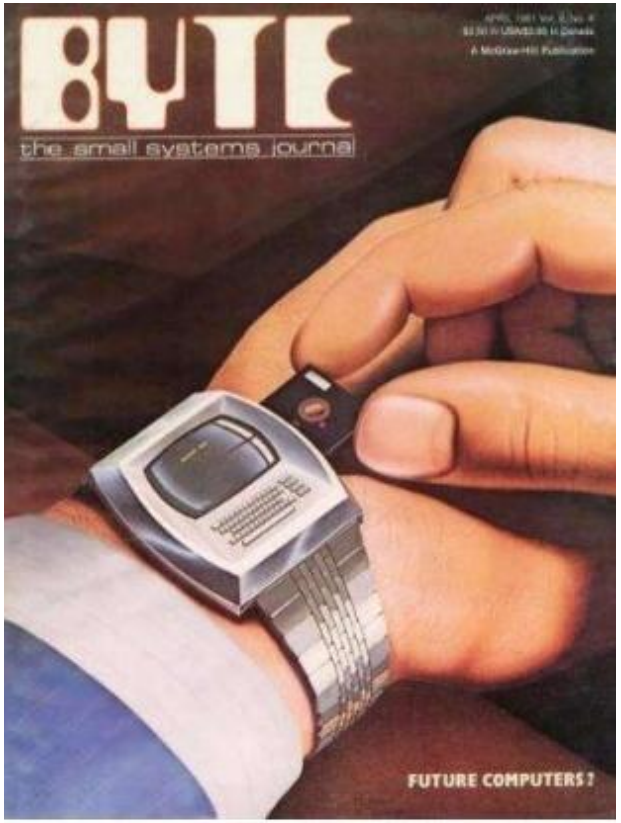
- Berg Insight: 64 million devices shipped in 2017
- ABI Research: 485 million devices in 2018
- Cisco pointed to a total of 177 million devices in the market by 2018
- Juniper Research: 130 million devices by 2018
- IMS research forecasted the market size under three scenarios (based on adoption rate) that vary from 40mn to 171 million devices shipped

A brief History of Wearables



A brief History of Wearables

- 1981: Byte magazine's issue on Future Computers
- 2014: Time magazine's "Never Offline" issue



Byte Magazine Volume 06 Number 04, 1981

A brief History of Wearables

- 1993: Thad Starner's self-made custom computer device (MIT)
- Daniel Siewiorek's wearables for the military (Carnegie Mellon)
- 1998: Steve Mann's smartwatch (MIT)
- 1994: DARPA's Land Warrior project (1994-2007)
- 1997: first IEEE International Symposium on Wearables Computers

A brief History of Wearables

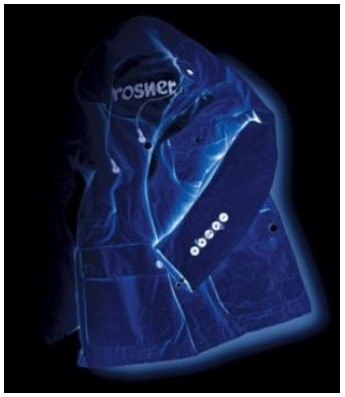
- Smart clothes
  - 1998: Sundaresan Jayaraman's wearable motherboard (Georgia Tech)
  - 1998: Mikko Malmivaara's heart-rate sensing shirt (Finland)
  - 2000: Reima's body belt for hands-free mobile phone communications (Finland)
  - 2000: SoftSwitch's embeddable keypad (England)
  - 2000: the ICD+ jacket, that incorporates a mobile phone and an MP3 music player (Philips + Levi)

CLOTHING+

Smart Clothing

- 2002: International Fashion Machines (Boston)
- 2003: the Amp Jacket, a snowboarding jacket incorporating an iPod (Burton)

Smart Clothing



- 2004-6: the age of self-adapting shoes, self-heating jackets, etc
- 2004: Rosner/Infineon smart jacket with a mobile phone and an MP3 player (Germany)
- 2004: Vivometrics "LifeShirt" (Los Angeles)
- 2004: Adidas' "self-adapting" shoes
- 2004: North Face's "self-heating" jacket
- 2006: Sensatex's smart shirt that monitors body functions (Maryland)

Smart Clothing

- Biometric garment:
  - Sensatex (Maryland): SmartShirt (2006)
  - Hexoskin (Canada, 2006)
  - AiQ Smart Clothing (Taiwan, 2009)

Smart Clothing

- …
- 2012: Diane von Furstenberg fashion show
- 2014: Tommy Hilfiger's clothes with solar chargers

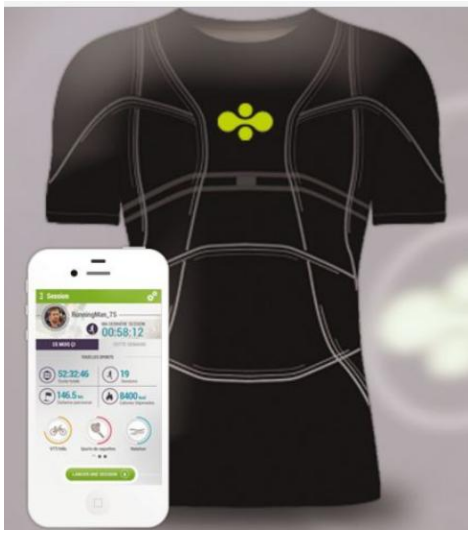
Tommy Hilfiger

Smart Clothing

- Lilypad Arduino consists of electronic kits (basically, sensors) that can be sewn into clothes to create "interactive garments".
- Climate Dress (2009) that detects carbon dioxide in the air (based on Lilypad)

Smart Clothing

- Gymi: smart shirt
- Cityzen Sciences (France): D-Shirt (inbuilt devices including a heart rate monitor, accelerometer, built-in GPS, and altimeter)
- Omsignal (Canada): T-shirt that is connected to the Internet



Smart Clothing

- Electricfoxy: the Ping Dress that responds to programmable gestures
- Synapse smart dress: an interactive 3D-printed dress fitted with biosensors to take bodily and environmental measurements
- Studio Roosegarde (Holland): the Intimacy Dress made of fabric that changes color and visibility
- Pauline van Dongen: wearable solar clothes that act as solar panels to recharge batteries

Smart Clothing

- Largest and fastest growing category of wearables: smart garments (Gartner Group, 2014)
- Progress in sensors, batteries and fabrics
- Seamless integration of garments with monitoring and electronic devices
- A vast new world of data-driven revenue opportunities
- 2016: Advanced Functional Fabrics of America (AFFOA)

Futurewear Fair: Enabling the Fabric Revolution
Yoel Fink (Massachusetts Institute of Technology)

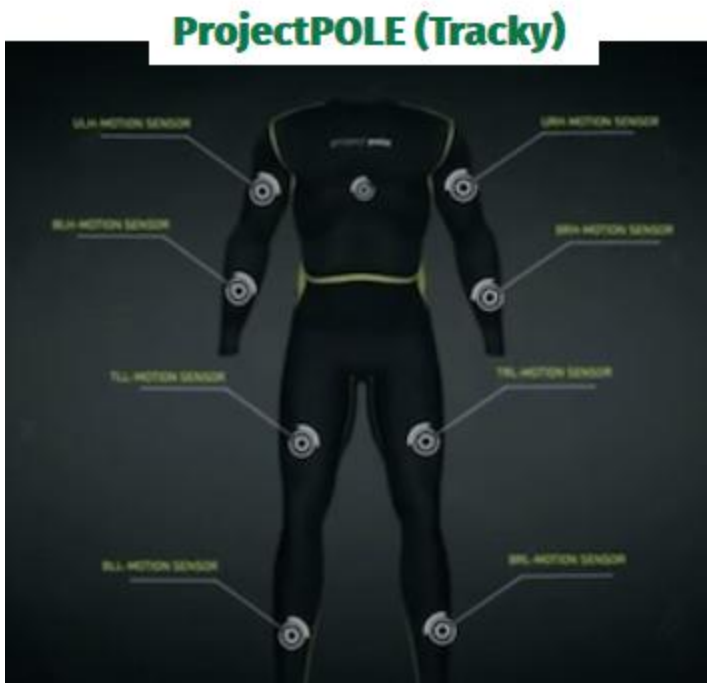
Smart Textiles: Fashion That Responds
Juan Hinestroza (Cornell University)

A brief History of Wearables

- Smart fitness
  - 2011: Fitbit's Ultra (San Francisco)
  - 2011: Jawbone
  - 2012: Nike's FuelBand
  - 2014: Xiaomi Mi Band

Smart Fitness

- Smart products for fitness apparel: Adidas, Under Armour, Ralph Lauren, Victoria's Secret
- ProjectPOLE: Tracky line of smart clothes (T-shirts, sweaters, and coveralls) fitted with fitness sensors
- E-textile solutions for health monitoring: HealthWare, McLaren Applied Technologies



Smart Fitness

- Monitoring babies:
  - Mimo: baby monitor
  - Sensible Baby: baby monitor

Smart Fitness

- Monitoring the elderly:
  - CarePredict: learns your routines and makes sure you don't forget them

A brief History of Wearables

- Smart watches
  - 2004: Microsoft's smartwatch
- 2011: WIMM's smartwatch (Silicon Valley)
- 2012-13: mass-market smartwatches
- 2014: Google Android Wear platform
- 2015: Apple Watch

Microsoft SPOT

Sony SmartWatch 2

VS

Qualcomm Toq

VS

Samsung Galaxy Gear

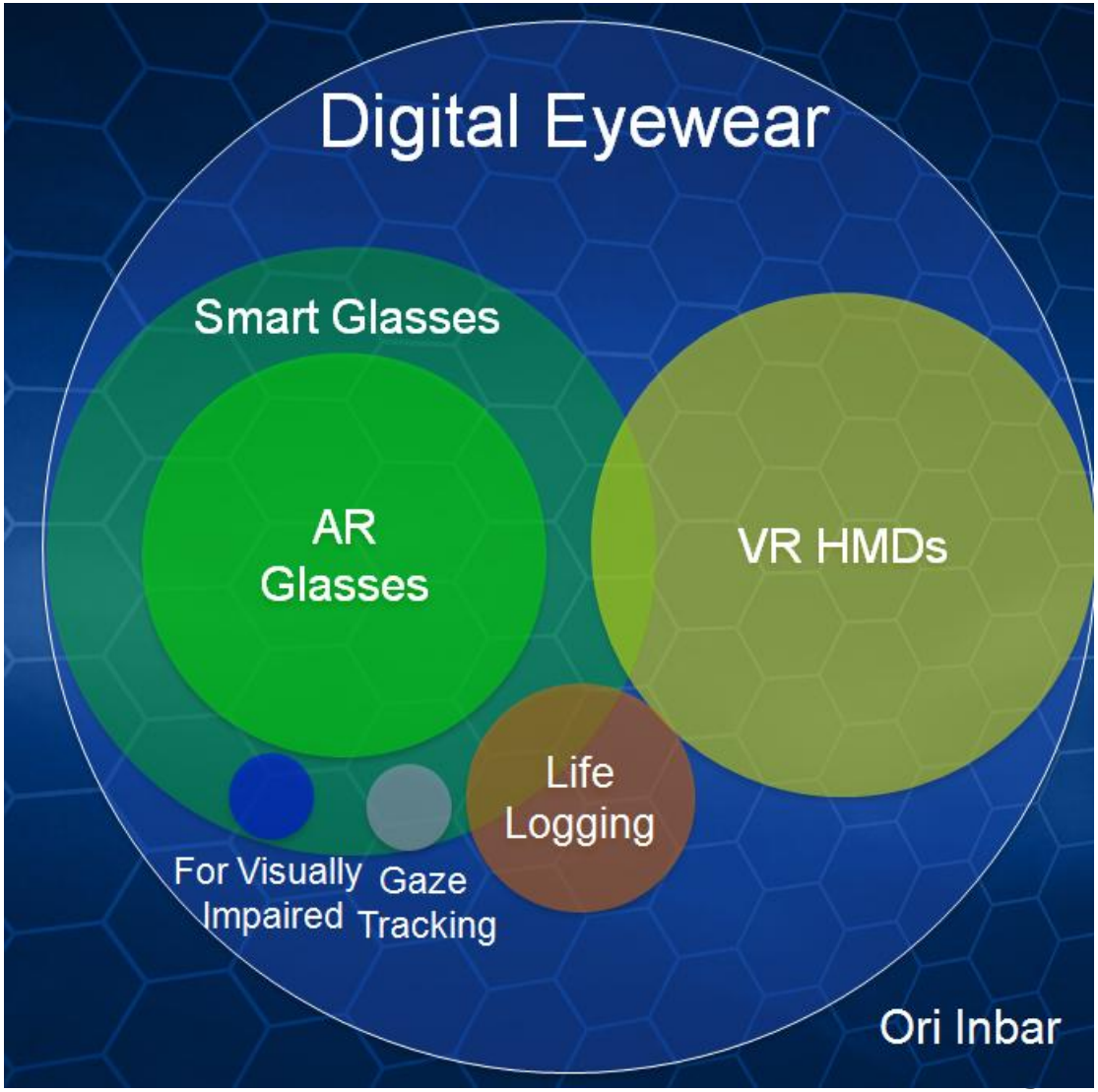
A brief History of Wearables

- Smart eyeware
  - 2013: Google Glass
  - The social stigma

In the September 2014 issue, Vogue dedicated all those 12 pages featuring models wearing Google Glass of various colors.

Smart Glasses

- Digital eyewear

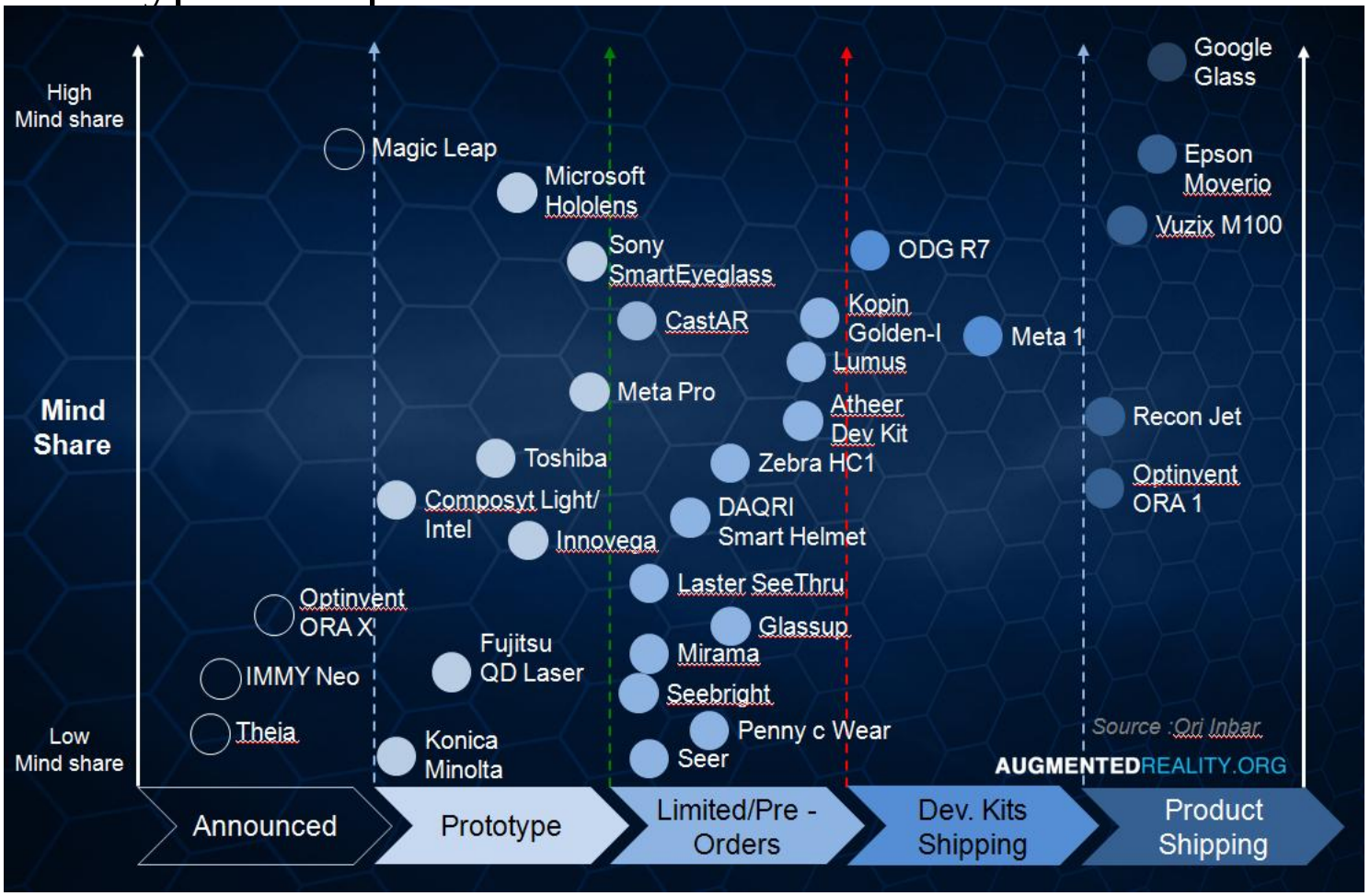


Smart Glasses

- Pioneering startups
  - Vuzix,
  - Lumus,
  - Opinvent,
  - Laster,
  - Recon,
  - Kopin,
  - Innovega,
  - ODG,
  - Penny

Smart Glasses

- Prototypes and products of 2015



Smart Glasses

Google Glass

Epson BT200

Vuzix m100

Optinvent ORA-X

Recon Jet

Laster SeeThru

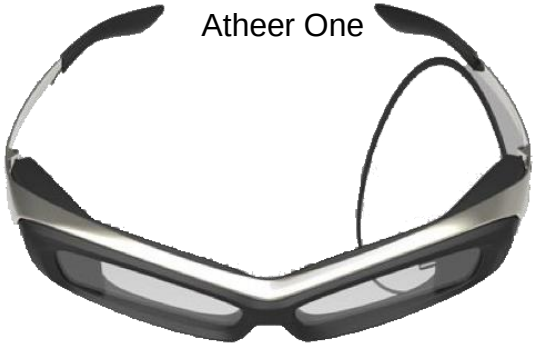
Smart Glasses

Meta Pro

Atheer One

Lumus DK40

ODG Consumer

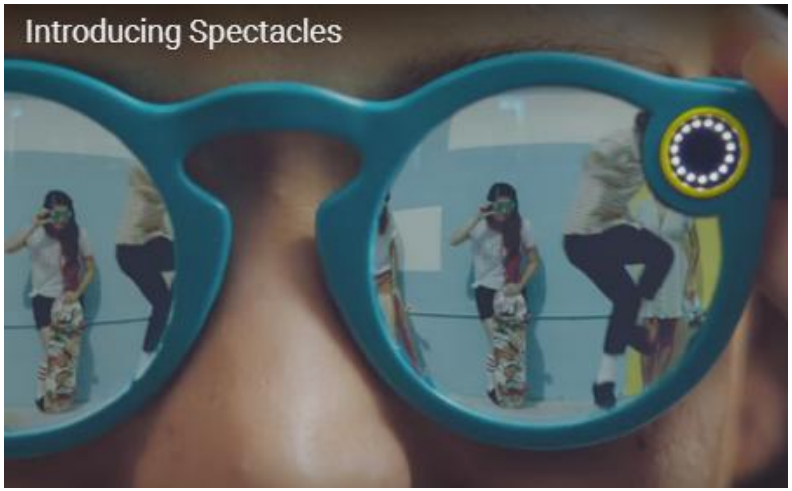


Sony SmartEyeGlasses

Microsoft Hololens

Smart Glasses

- Snapchat Spectacles: the 10-second video



Smart Glasses

- Vue (2018)

A brief History of Wearables

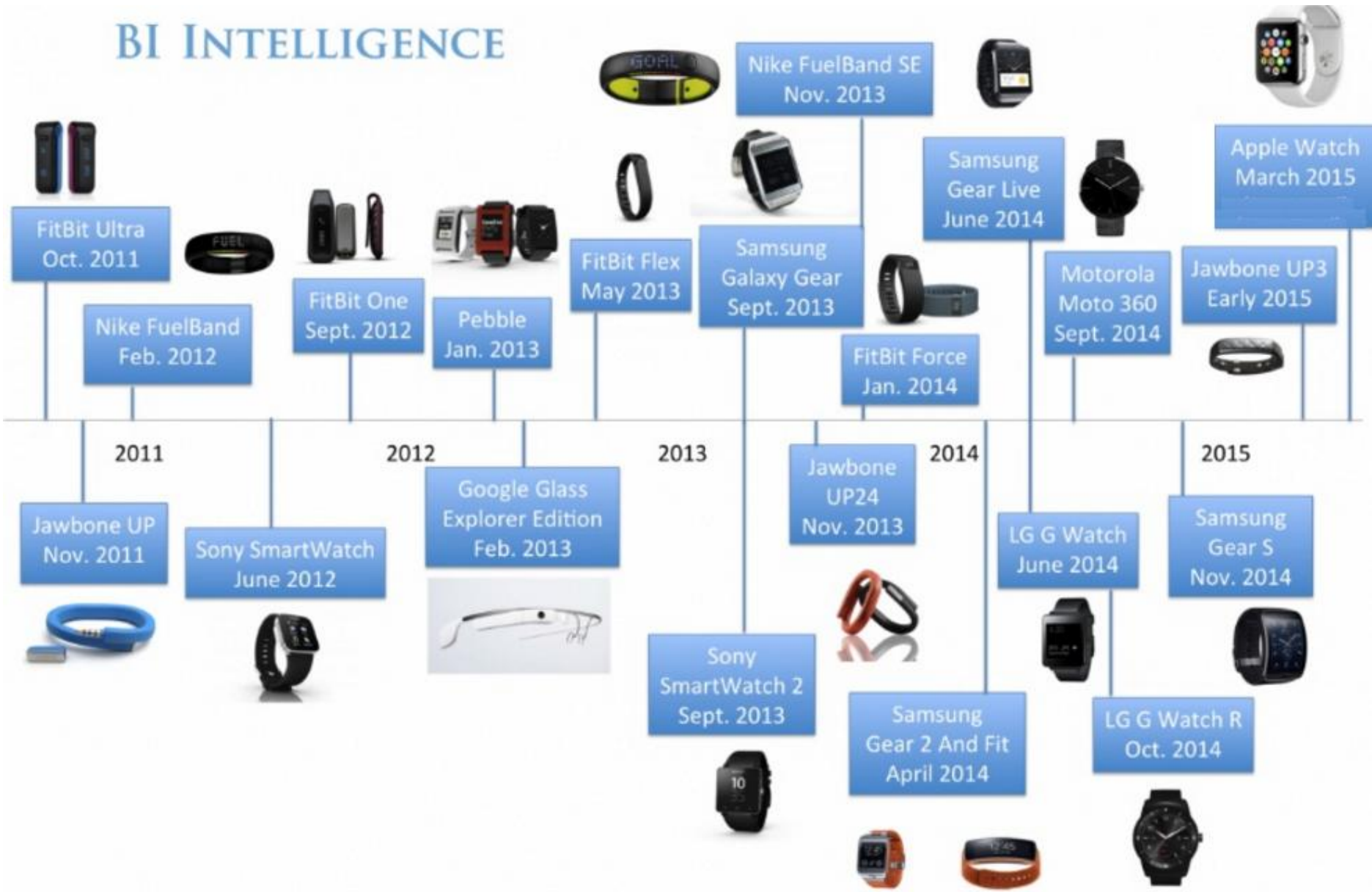
- Wearable multi-function
  - Logbar (San Francisco, 2014): control of mobile devices and home appliances, electronic payments (based on Bluetooth)

A brief History of Wearables

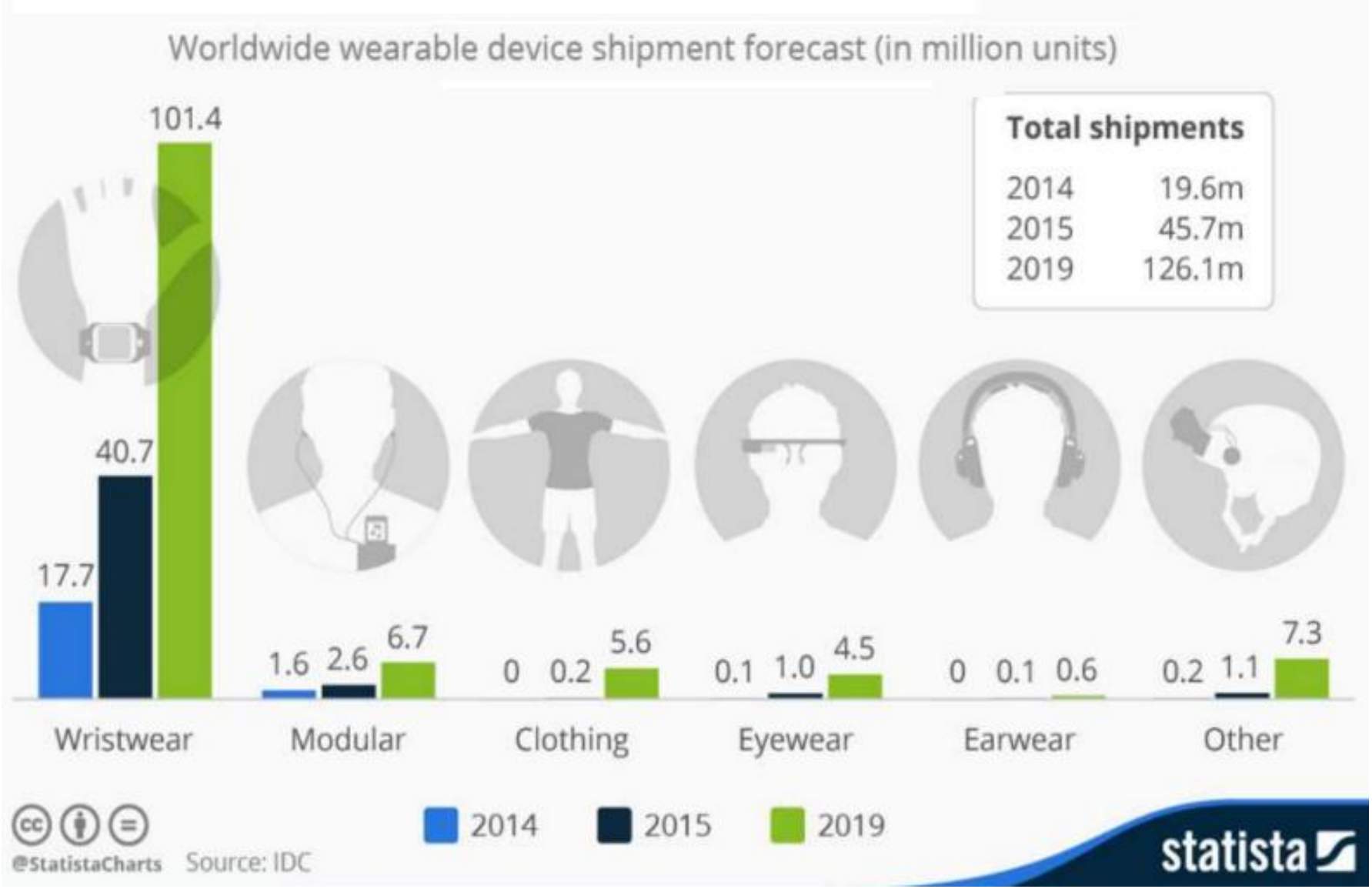
- Virtual Reality
  - 2015: Samsung VR Gear
  - 2016: Facebook Oculus

(See V.R. presentation)

A brief History of Wearables



Wearables


Worldwide wearable device shipment forecast (in million units)
Total shipments
2014 19.6m
2015 45.7m
2019 126.1m
101.4
40.7
17.7
1.6 2.6 6.7
0 0.2 5.6
0.1 1.0 4.5
0 0.1 0.6
0.2 1.1 7.3
Wristwear
Modular
Clothing
Eyewear
Earwear
Other
2014
2015
2019
@StatistaCharts
Source: IDC
statista

Wearables

- The appeal of wearables
  - Quantify ourselves (mostly for fitness purposes)
  - Document our lives
  - Augment ourselves (exoskeletons, smart shoes)
  - Express ourselves (smart clothes, smart jewelry)

Wearables

- Wearables of 2015

Microsoft Band

Google Glass

Apple Smartwatch

Jawbone Up

Pebble Watch

Fitbit Products

Wearables

- Wearables of 2015

FITBIT
SURGE – $250

Pros: Built in GPS, heart rate monitor, classic watch clasp, works with most phone

Cons: Dated '80s-like design, not completely accurate, weaker battery life

FITBIT

GARMIN
VIVOACTIVE – $250

Pros: Built in GPS, lightweight design (1.34 oz), water-proof, relatively long-lasting battery (up to 2 wks),"Move Bar" (inactivity alerts), text/call/social media notifications

Cons: More sporty and basic looking – not as fashionable/sleek as competitors

GARMIN

JAWBONE
UP3 – $180

Pros: Elegant design, comfortable to wear, advanced sleep and movement tracking

Cons: No built in display, new features are not useful, overpriced

JAWBONE

XIAOMI
MI BAND – $15

Pros: Cheap, long-lasting battery (30 days), lightweight and comfortable, waterproof

Cons: No built in display, supports few activities, data does not sync in real-time, can overestimate activity, limited app, temperamental LEDs

XIAOMI

HUAWEI
TALKBAND B2 – $200

The TalkBand 2 consists of a Bluetooth headset with a displayed attached to a wristband.

Pros: Clear call quality, sleek design, comfortable, dust-proof and waterproof

Cons: Faint, reflective display, positioning in ear can be finicky

HUAWEI

SAMSUNG
GEAR LIVE – $200

Pros: Bright and colorful high-resolution display, works with Google Now and most phone notifications, microphone is sensitive and accurate, comfortable

Cons: Issues syncing apps to Gear Live, Short battery life (1 day), navigation still temperamental

SAMSUNG

SOURCE: TECHRADAR, PCMAG, WAREABLE

Wearables

- Wearables of 2015

Nike+ SportWatch GPS

$149

Bolt Smart Bulb $50

- Wirelessly connected
- Over a million colors controlled by mobile app (iOS and Android)
- Alarm sunrise simulation
- LED technology

Flash Fitness + Sleep monitor

$49

FLASH

- Waterproof
- No charging, 6-month battery
- Watch Function
- Measures & tracks steps, calories, distance, sleep
- Smartphone compatibility

Shine Fitness + Sleep monitor

Misfit

$99

SHINE

$169

- Waterproof
- No charging, 6-month battery
- Watch Function
- Measures & tracks steps, calories, distance, sleep
- Smartphone compatibility
- Since March available as Swarovski Shine Set

Beddit Sleep monitor

$150

- Tracks sleep time, cycles, light sleep duration
- Heart rate
- Ambient sound, snoring
- Sleep graphs & stats
- Alarm, soothening sounds
- Placed between mattress & sheets

Pebble Time

$249

Pebble Smart Watch

$99

Pebble Steel

pebble

$199

Wearables

- Wearables of 2015

vivoactive GARMIN

$330

vivo Series

$140 – $190

Forerunner Series

$130 – $450

Gear smartwatch series

Gear S – $299 (no carrier contract)

- Calls, emails & directions
- Curved 2-inch Super AMOLED display
- Internet radio service
- Exercise tracking, heart rate, barometer
- Various apps available

Gear 2 – $299

- Calls, emails & directions
- 1.63-inch Super AMOLED display
- Voice control and response
- Stand-alone music player
- 2MP built-incamera

Gear VR

Samsung GALAXY Gear

$199

- Used with several Samsung smartphone models
- Super AMOLED display and Oculus-driven software
- 360 degrees view
- Still an 'Innovator' Edition

Gear Circle Headset

$99

- Calls, text messages, music
- Splash resistant
- Gear manager mobile app to control notifications, settings, SoundAlive equalizer
- 9 hours music play time / 11 talk time
- Compatibility with all Bluetooth enabled devices

Wearables

- Wearables of 2015

SONY

SmartBand Talk SWR30

SmartWatch 3 SWR50

SmartBand SWR10

fitbit

Flex™ Wireless Activity + Sleep Wristband $95

- Tracks steps, distance, calories burned and active minutes.
- LED lights show progress against goal.
- Water and dust proof
- Directly Sync with mobile device, PC and MAC
- Monitors your sleep and wakes you with a silent alarm.

Charge/Charge HR™ Wireless Activity + Sleep Wristband $130

- Tracks steps, distance, calories burned and active minutes.
- OLED display with daily stats and watch
- Call notifications and Wireless Sync with compatible devices
- Battery life of 7-10 days
- Monitors your sleep and wakes you with a silent alarm.
- HR – heart rate tracking

Surge™ Fitness Super Watch $250

- GPS tracking
- PurePulse™ heart rate
- Multi-sport activity tracking
- Call and text notifications and music controls

One™ Wireless Activity + Sleep Tracker $100

- Tracks steps, distance, calories burned and stairs climbed.
- Monitors your sleep and wakes you with a silent alarm.
- Sweat, rain, and splash proof
- Wirelessly syncs to computers and select smartphones
- Attaches easily to clothes, belts, sacks etc.

Zip™ Wireless Activity Tracker $60

- Tracks steps, distance and calories burned.
- Sweat, rain, and splash proof
- Wirelessly syncs to computers and select smartphones
- Replaceable battery, lasts 4-6-months.

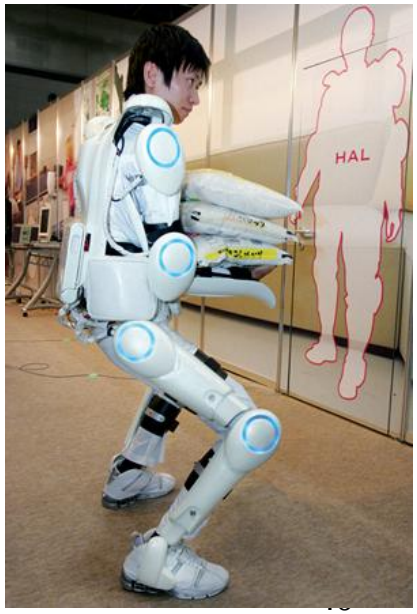
Fitbit Aria Wi-Fi Smart Scale $130

- Scale measures weight, BMI and % body fat.
- Uses Wi-Fi to upload stats automatically to Fitbit.com.
- Set weight goals and chart your progress with free online graphs and tools.

Exoskeletons

BLEEX

- 2003: Homayoon Kazerooni's BLEEXes (UC Berkeley)
- 2003: Hugh Herr's computer-controlled knee (MIT)
- Monty Reed's Lifesuit (Seattle)
- 2008: Steve Jacobsen's XOS (Utah)
- 2009: Cyberdyne's HAL5 (Japan)



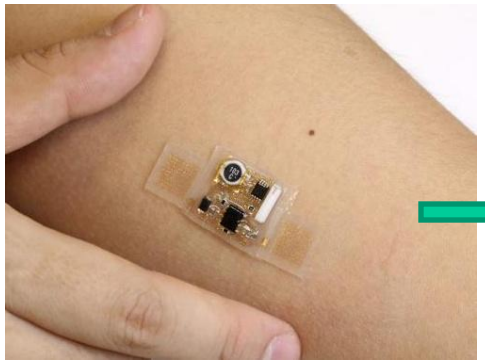
Exoskeletons

- 2010: Berkeley Bionics' computer-controlled suit
- 2012: Claire Lomas completes the London Marathon using the exoskeleton ReWalk (Israel)
- ReWalk (Israel) built by quadriplegic inventor Amit Goffer
- 2014: Lockheed's Fortis
- 2014: The World Cup of soccer is kickstarted by a paraplegic wearing Miguel Nicolelis’ mind-controlled exoskeleton
- 2016: SRI's spinoff Superflex

Amit Goffer

Future Wearables

- Health monitoring
- Integration with medical records and social media



Future Wearables

- Health monitoring
  - Proteus & Otsuka: the “digital drug” Abilify MyCite (2017)

Future Wearables

- Wearable communication devices

(Source: Hashem AL-Ghaili
https://www.youtube.com/watch?v=ceN3grs0fWw)

Future Wearables

- Wearable wallet

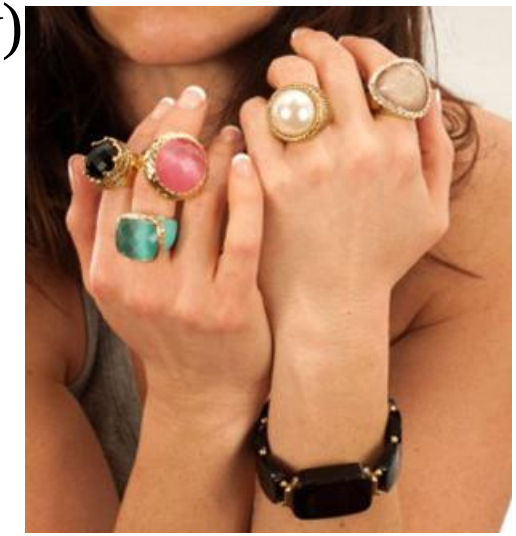
(Source: Hashem AL-Ghaili
https://www.youtube.com/watch?v=ceN3grs0fWw)

Future Wearables

- Bendable and rollable (2016)
  - Polyera Wove bendable smartwatch
  - LG OLED rollable display

Future Wearables

- Smart jewelry (New York-based Ringly)



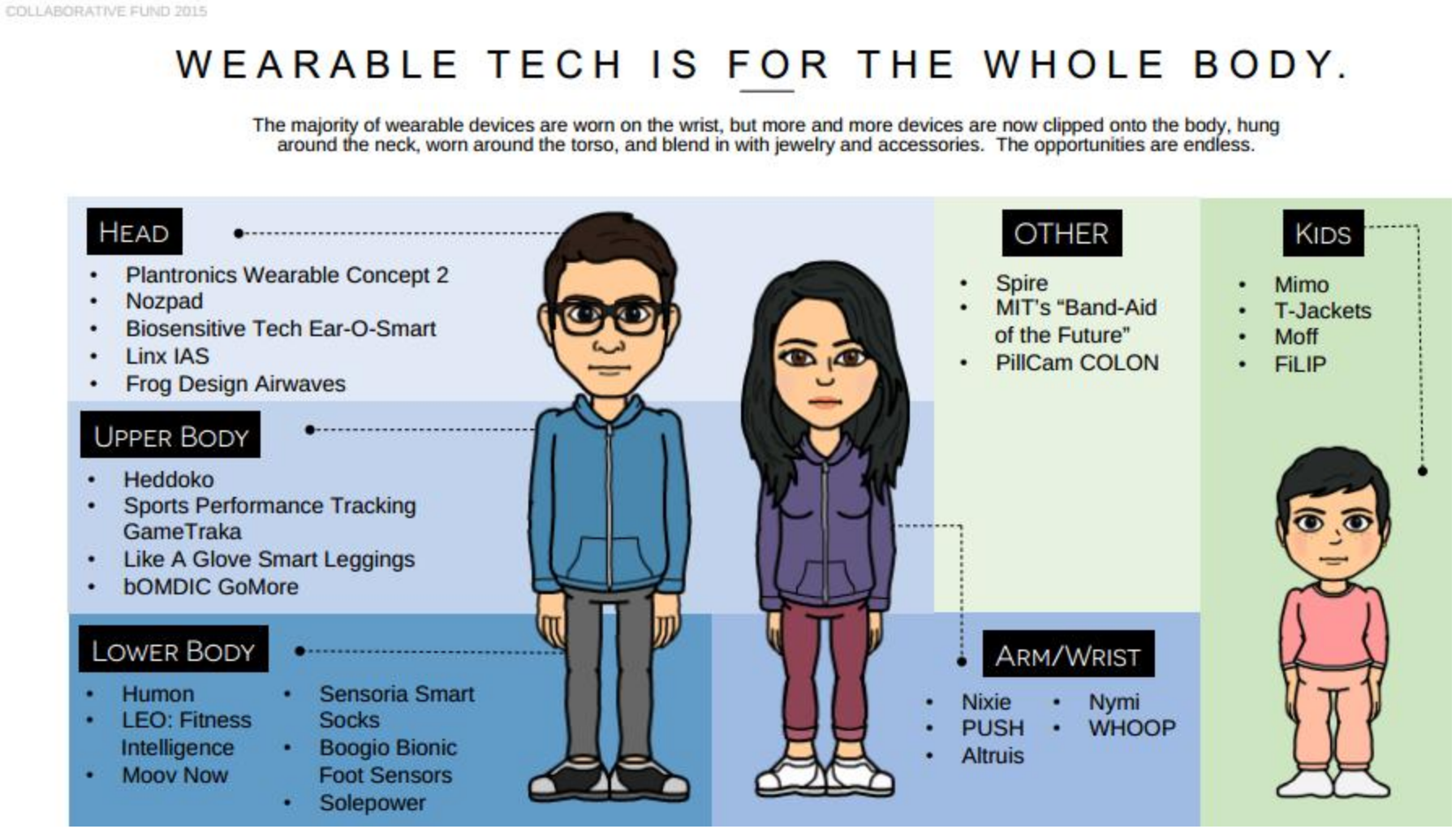
Future Wearables

- Chem-Phys patch (UC San Diego, 2016): wearable device capable of monitoring both biochemical and electric signals in the human body.

Future Wearables

- Future trends for smart eyewear
  - Dual-contact lens: Innovega
  - Direct retinal projector: Brother, Fujitsu DQLaser, EyeWay, Composyt Light
  - Transparent OLED: LusoVu
  - Pinlight display: Nvidia, UNC
  - Dynamic lightfield: Magic Leap
  - Laser combiner: Fukui

Future Wearables



Future Wearables

COLLABORATIVE FUND 2015

WEARABLE TECH IS FOR THE WHOLE BODY.

HEAD

Plantronics Wearable Concept 2 (Prototype)

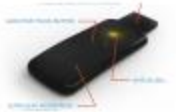
Plantronics WC2 features hands-free voice commands and motion tracking capabilities to enable comprehensive capture of device orientation in 3D.

Nozpad (Beta Testing)

Nozpad tracks status and makes prediction of health diagnosis based on nostril air pressure, breathing rate variation, and BMI to breath ratio.

Biosensitive Technologies Inc. Ear-O-Smart

Ear-O-Smart is the world's first smart earring (patent pending) which can monitor user's heart rate, calories, and activity.



Linx IAS

Linx IAS offers real-time alerts and impact data, when a head collision occurs. The app can be used to administer post-impact sidelines tests.

Frog Design Airwaves (Product Concept)

Airwave's air quality data is merged with the readings of thousands of other masks, creating a crowdsourced global data network. The mask also creates a microenvironment for the wearer.

UPPER BODY

Heddoko

Heddoko is the first smart compression suit that tracks full-body movement in 3D.

SPT GameTraka

GameTraka is a GPS tracking device (fitted in a vest) that samples the user's location five times a second, provides key performance analytics, can compare performances for all team members.

Like a Glove Smart Leggings

Like A Glove Smart Leggings measures the wearer's legs via sensors and sends the stats to the app. The app then matches the measurements against exact measurements of thousands of jeans and finds brands, models, sizes that fit the user the best.

bOMDIC GoMore

GoMore helps users understand how much stamina is required to complete a routine and when their body is running low on stamina.

Future Wearables

COLLABORATIVE FUND 2015

WEARABLE TECH IS FOR THE WHOLE BODY.

ARM/WRIST

Nixie (In Development)

Nixie is the first wearable camera (worn on wrist) that can fly. With a gesture, Nixie takes off, captures a photo or video, and flies back to the user.

PUSH Band

PUSH is an armband that counts weight lifting sets, reps, power, and velocity automatically. The device suggests changes to weights and reps based on performance.

Altruis

Altruis is a smart stone that vibrates when the user gets priority notifications. The stone can be popped out and swapped amongst various accessories – ring to bracelet to pendant.

Nymi (Developer's Kit)

Nymi unlocks devices, remembers passwords, and can do payments, using the user's unique heart signature.

WHOOP

WHOOP is a wrist-worn strap designed to collect more than 150MB of physiological data per day. The data streams to the system's analytics platform to keep track of overtraining and quality of recovery.

LOWER BODY/FEET

Humon (Alpha Testing)

Humon is a real-time lactic acid threshold monitor designed for endurance athletes.

LEO: Fitness Intelligence

LEO translates bio-data into straightforward and actionable recommendations and notifies the user in real-time.

Moov Now

Moov Now has a number of workouts and training plans and uses a voice coach to guide and affect user's performance in real-time.

Sensoria Smart Socks

Sensoria Smart Socks can help improve the user's running form, speed, pace, cadence, and foot landing.

Boogio Bionic Foot Sensors

Boogio is a set of sensory stickers and tiny computers that activates any shoe to play in mobile and reality games, tracks movement and activity, and takes hands-free control of technology.

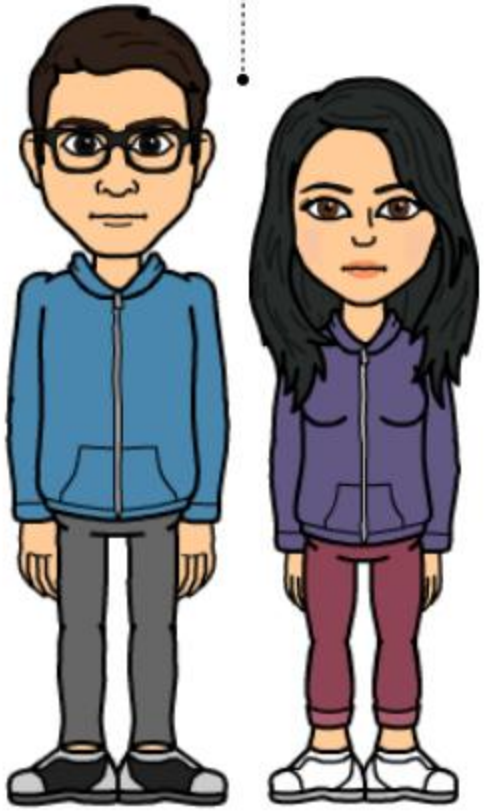
Solepower

Solepower is a power-generating shoe insole for charging portable electronics.

Future Wearables

COLLABORATIVE FUND 2015

WEARABLE TECH IS FOR THE WHOLE BODY.



OTHER

Spire

Spire (clip) tracks the wearer's motion and breathing patterns, notifying the user to relax when they are anxious or stressed.

MIT's "Band-Aid of the Future"

"Band-Aid of the Future" is a sticky, stretchy hydrogel that includes temperature sensors, LED lights, and drug delivery channels. The dressing can release medicine and give alerts when the medication is running low.

Given Imaging PillCam COLON

PillCam COLON is a battery-powered camera pill that takes high speed photos of the intestinal tract, serving as an alternative to invasive colonoscopy procedures. The photos are transmitted to a data recorder worn around the user's belt.

KIDS

Mimo

Mimo is a sensor that tracks the baby's breathing, body position, sleeping temperature, and activity level. Mimo can work with select Nest products.

Moff Band

Moff Band (slap bracelet) is a wearable smart toy that connects to apps wirelessly, senses the user's movement, and analyzes and responds by matching sounds to these movements.

T-Jacket

T-Jacket is a wearable technology vest that provides personalized deep pressure hugs that calm people. A built-in sensor monitors stress/arousal levels.

FiLip

FiLIP can make and receive phone calls, has a smart locator, and is worn on the child's wrist.

Future Wearables

- Philosophy
  - The human body will become one of many participants in a vast P2P network.
  - The world will become a P2P network of bodies, objects, apps, clouds, etc.
  - The primacy of the human experience over object "experience“ will slowly dissipate

Skin-inspired Materials

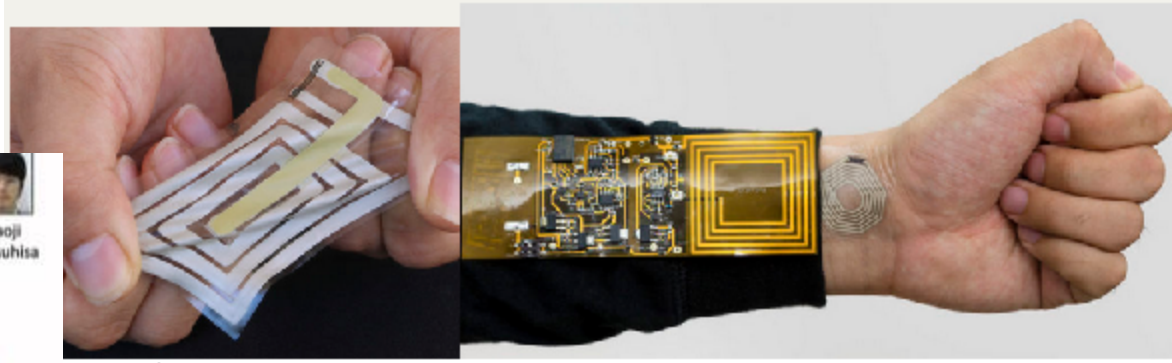
- Goal: a full-body skin-sensor array to collect physiological data

Chen, Tee, Chortos, Bao et al. **Nature Comm.**, 2014
isa, Ada Poon, William Burnette, Zhenan Bao et al. **Nature Electronics**, 2019

AUGUST 16, 2019

Stanford engineers have developed wireless sensors that stick to the skin to track our health

BodyNet.



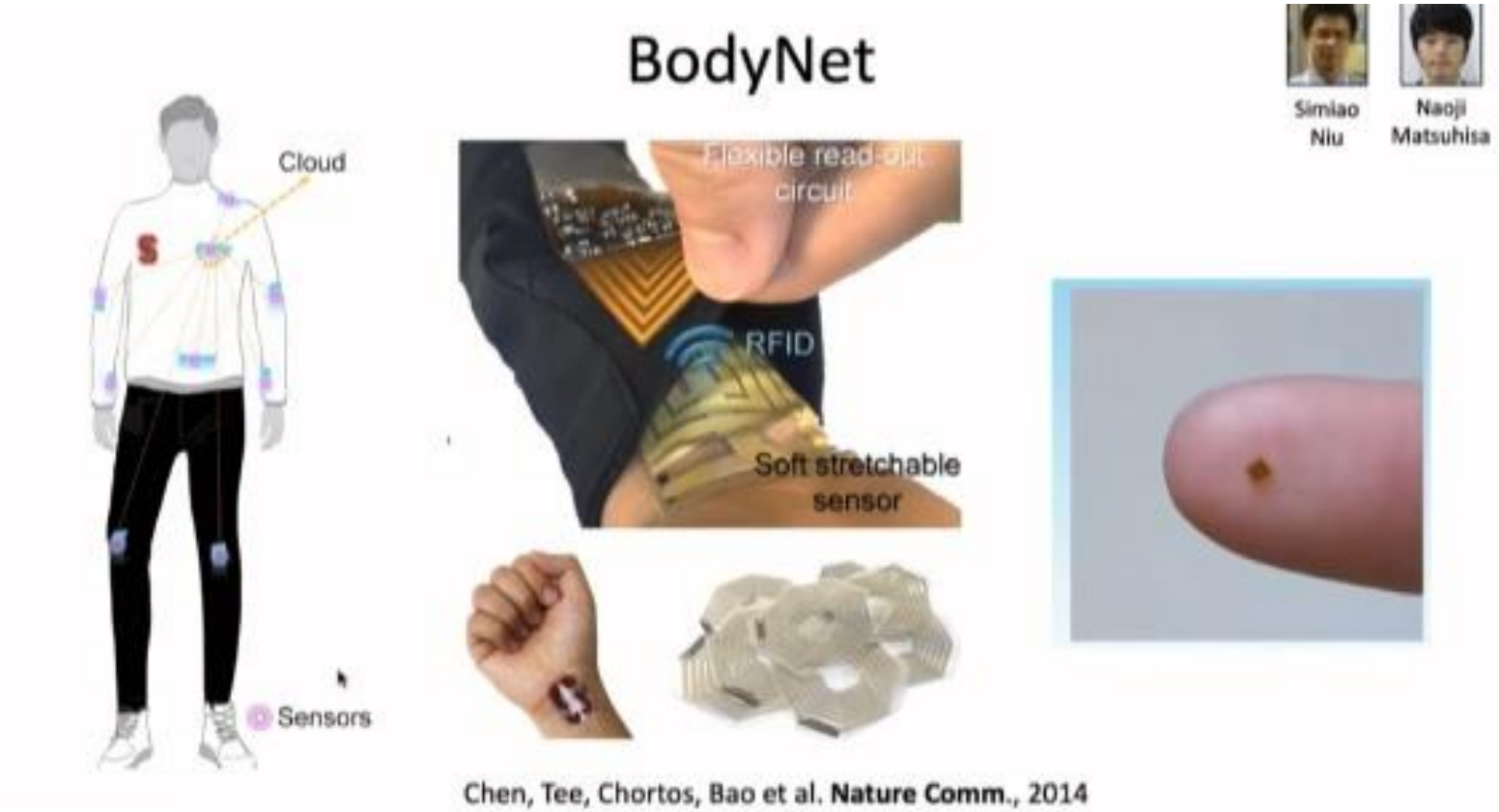
ticle | Published: 15 August 2019

wireless body area sensor network ased on stretchable passive tags

miao Niu, Naoji Matsuhisa, Levent Beker, Jinxing Li, Sihong ang, Jiechen Wang, Yuanwen Jiang, Xuzhou Yan, Youngjun Yun, William Burnett, Ada S. Y. Poon, Jeffery B.-H. Tok, Xiaodong Chen & Zhenan Bao

Skin-inspired Materials

- BodyNet at Stanford (2014-…)

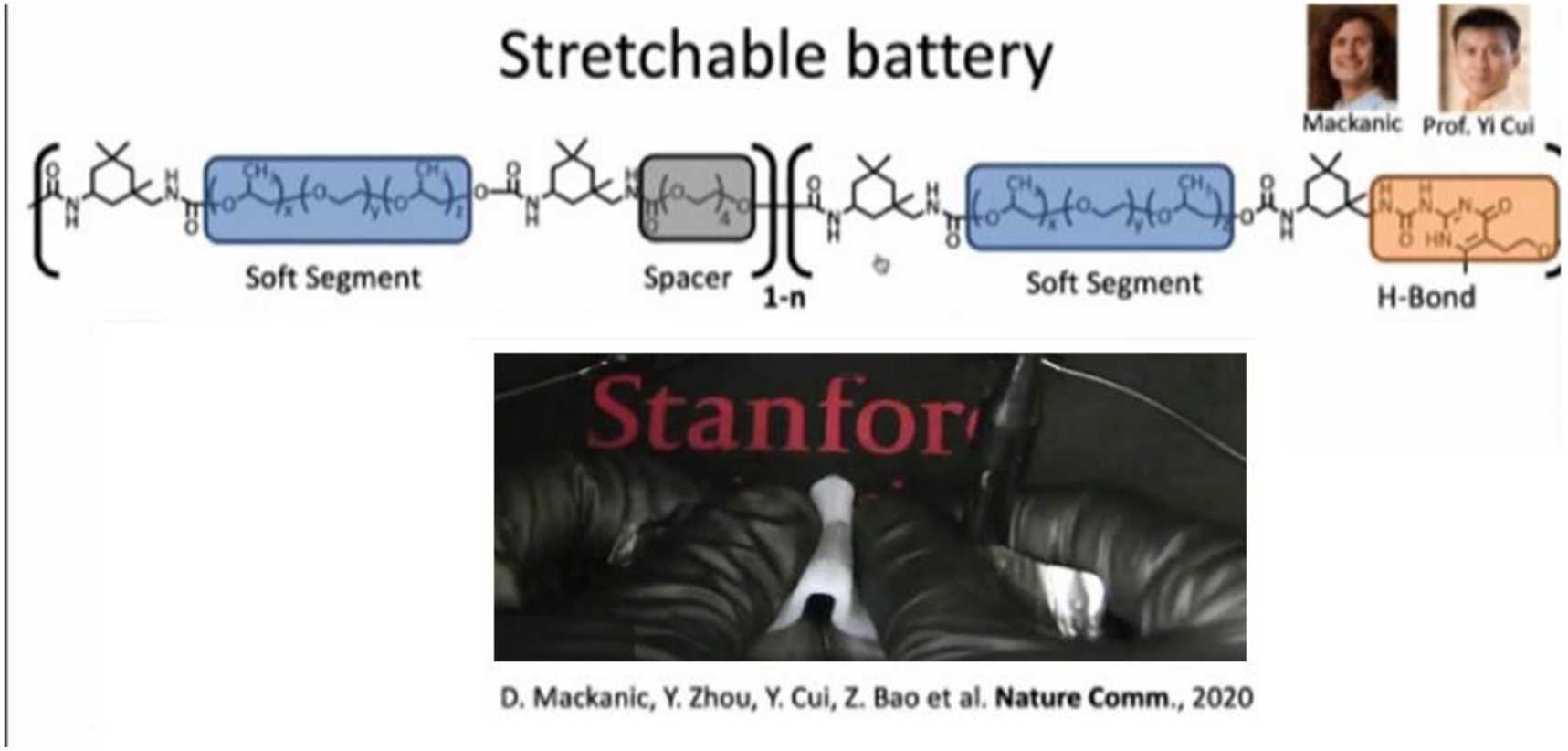


Chen, Tee, Chortos, Bao et al. **Nature Comm.**, 2014

o Niu, Naoji Matsuhisa, Ada Poon, William Burnette, Zhenan Bao et al. **Nature Electronics**, 2019

Skin-inspired Materials

- Stretchable battery (Yi Cui at Stanford)



Skin-inspired Materials

- Wearables for Precision Mental Health

Art

mit media lab

A Wearable Book Feeds You Its Characters' Emotions As You Read

January 25, 2014

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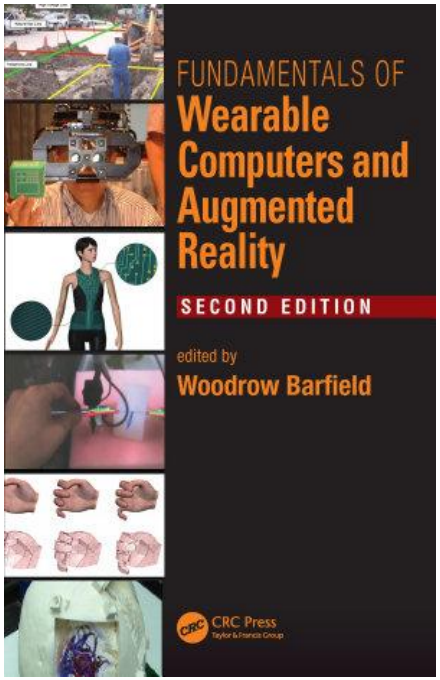
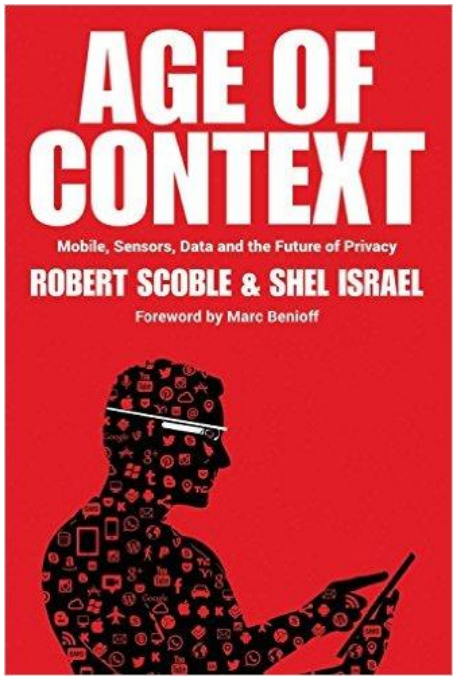
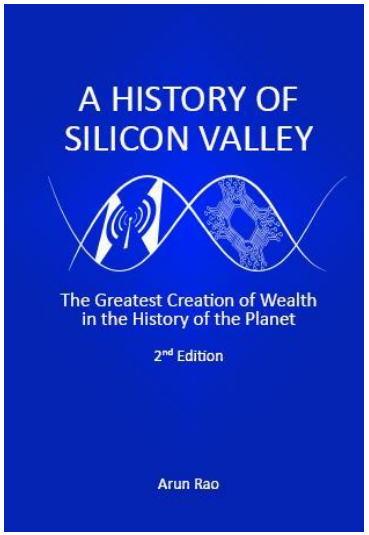
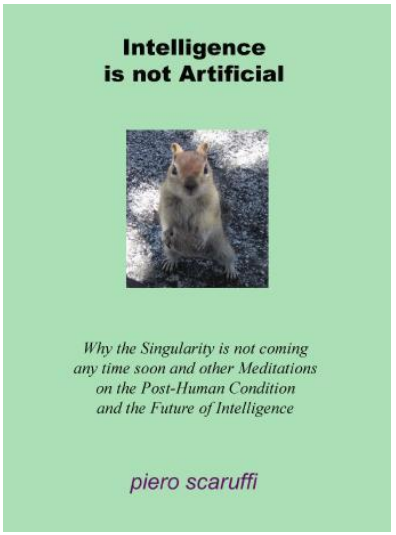


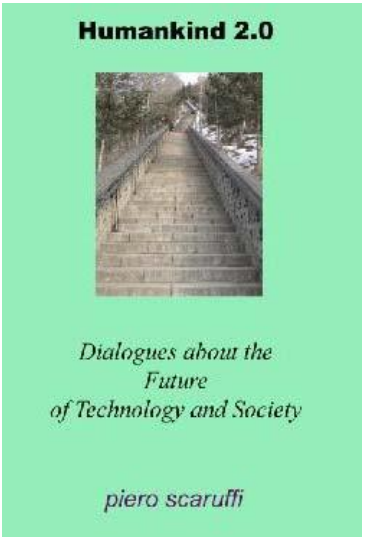


Contact

- www.scaruffi.com







See http://www.scaruffi.com/singular/human20.html for the full text of this discussion