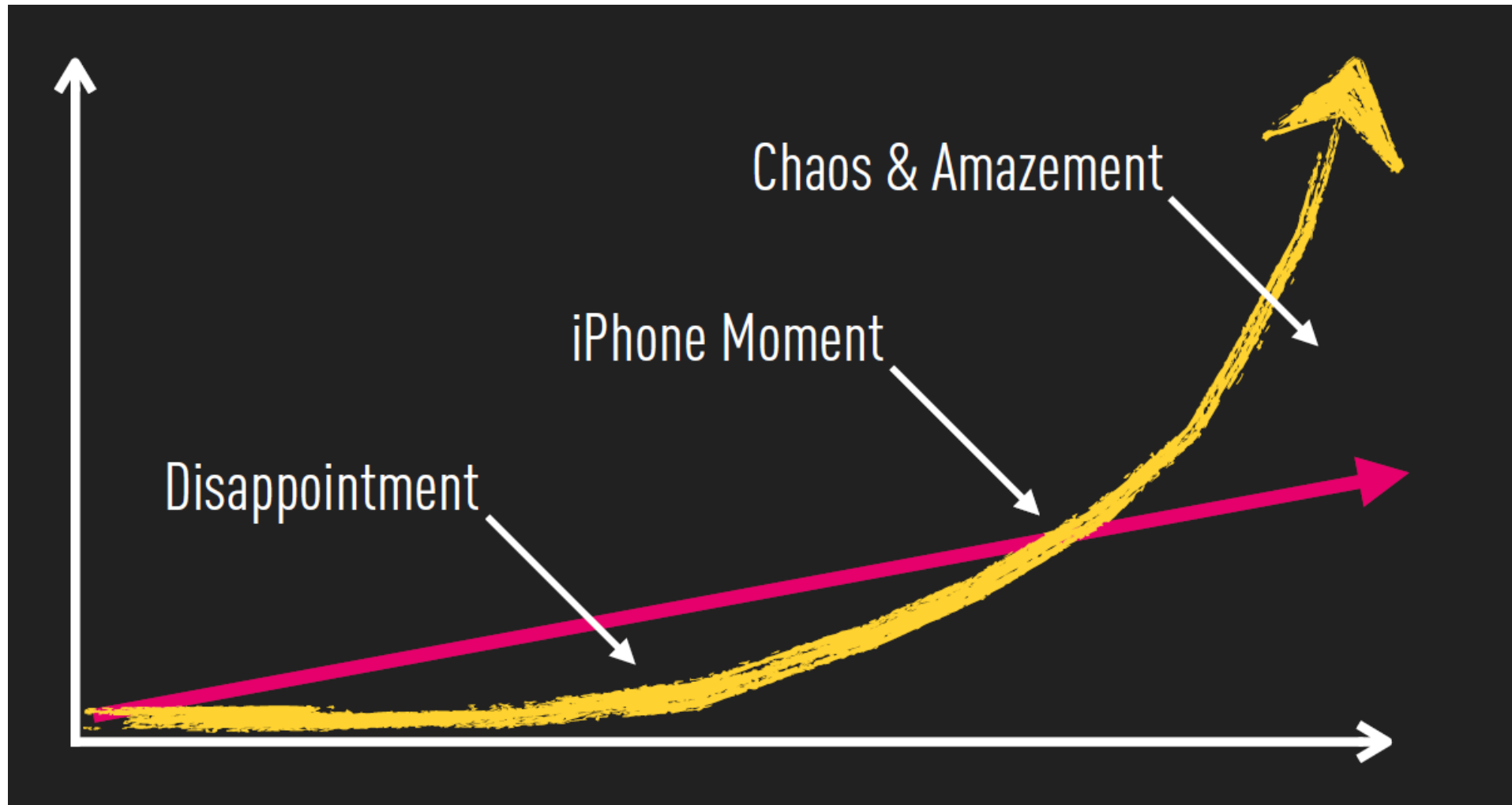

Technology Disruption

What is Disruption?



iPhone moment

- Jan 7, 2007: iPhone launched the touchscreen smartphone



- August 2007: <7 months later; Nokia the world leader launched

□ *“We didn’t do anything wrong, but somehow we lost...”*

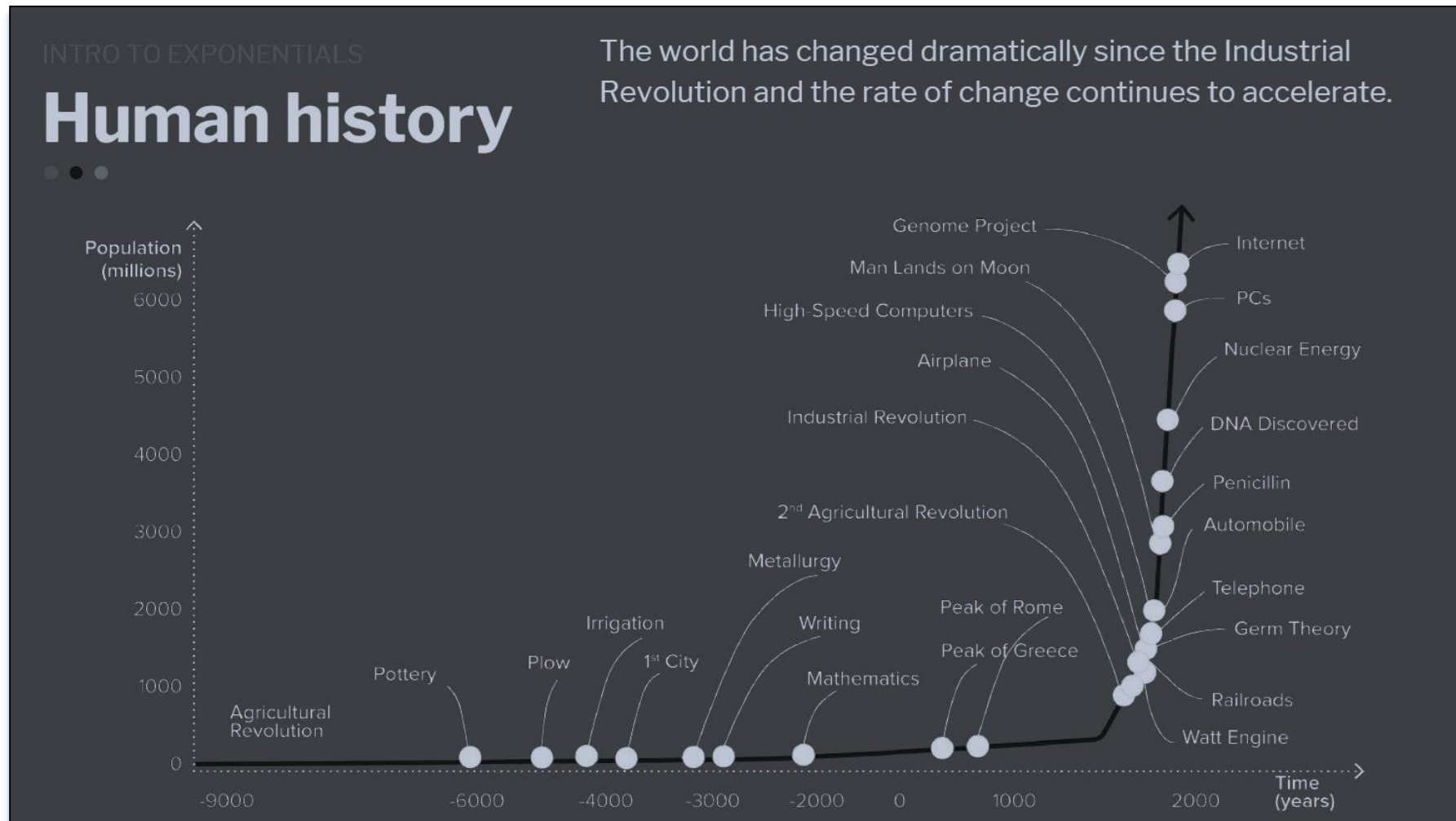
- CEO Stephen Elop

Technological change is exponential

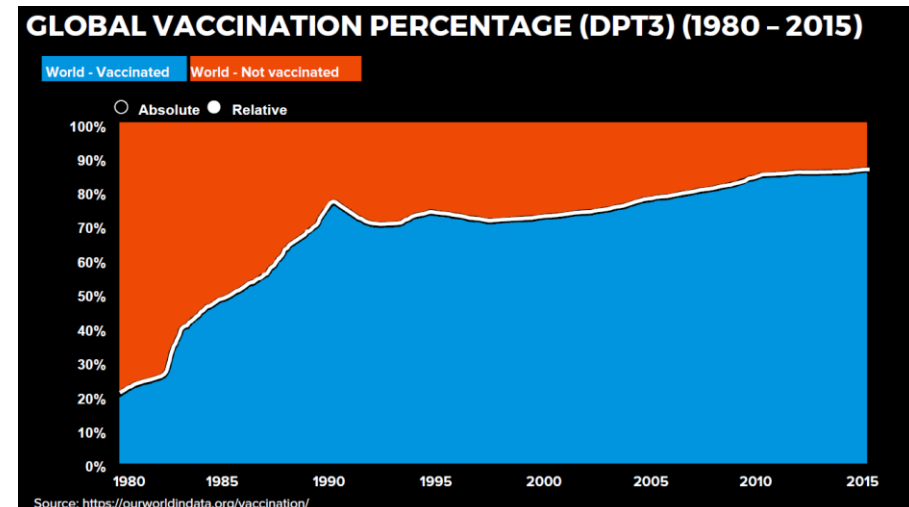
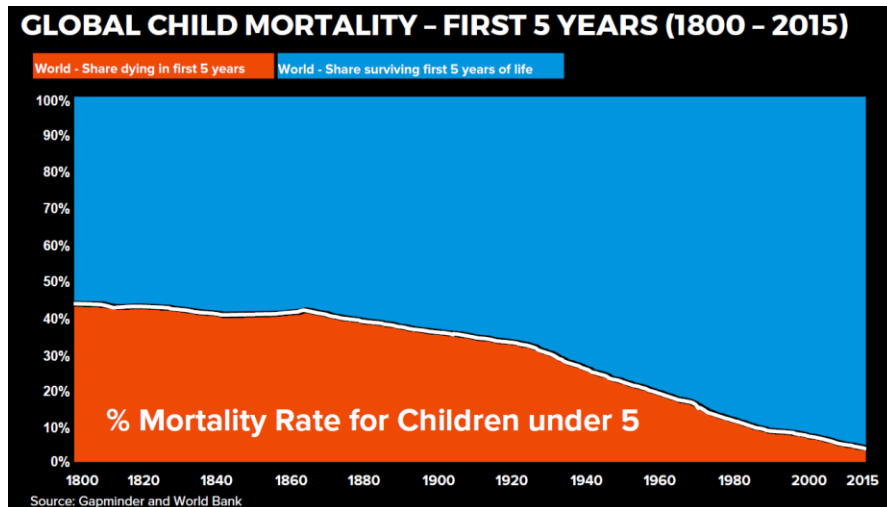
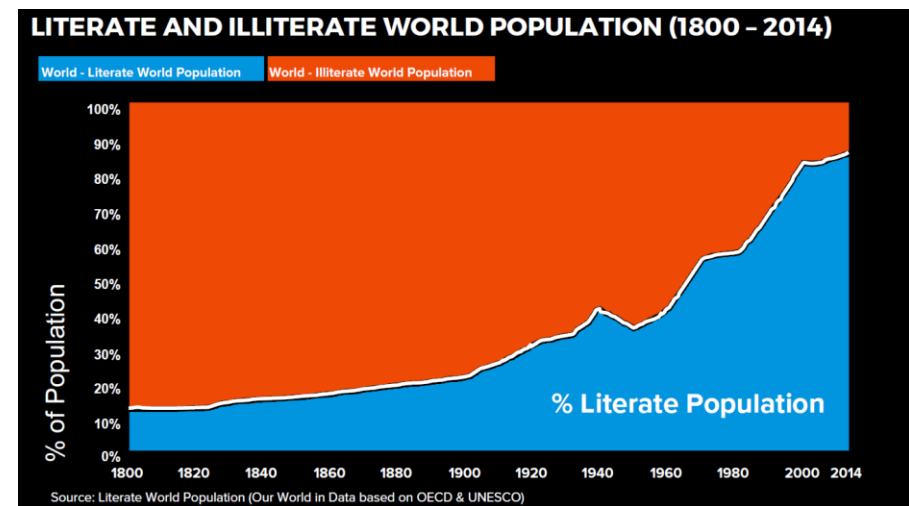
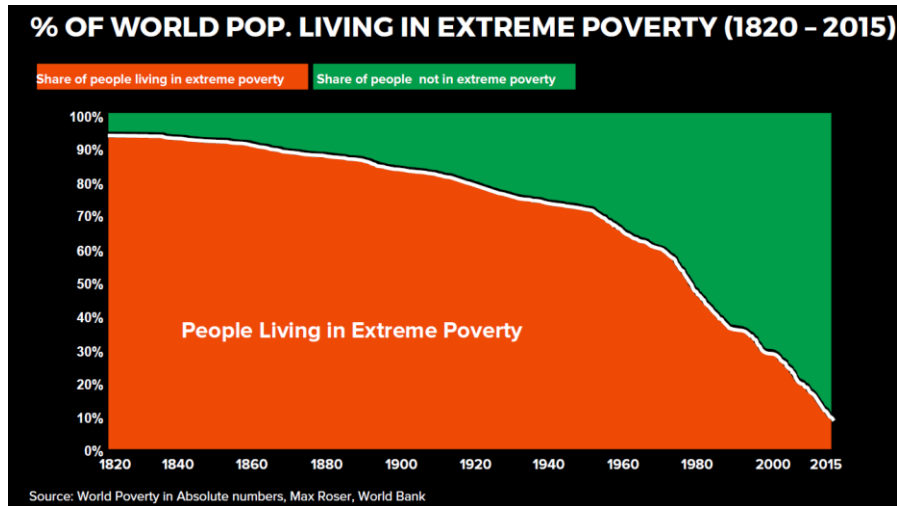


We all know about the magic of compounding... apply this on a LOG SCALE

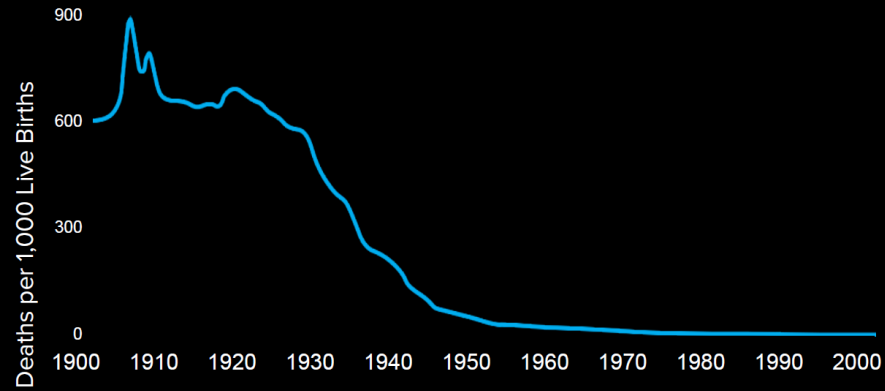
Disruption has gone exponential



We live in exponential times

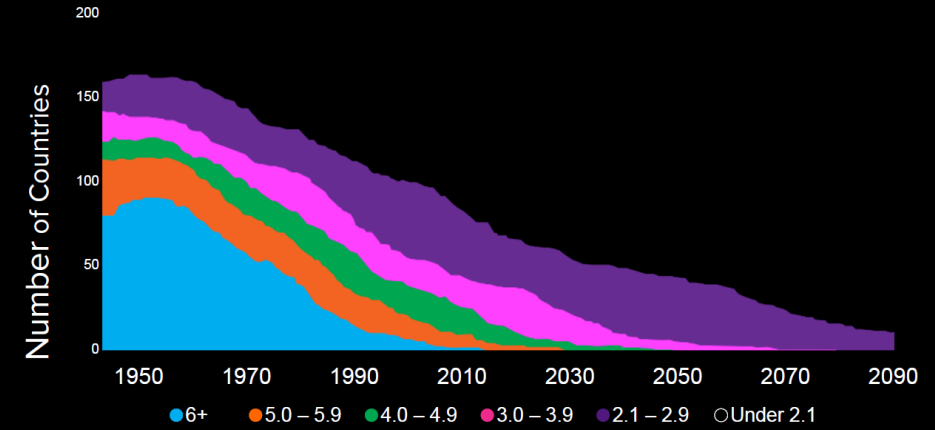


MATERNAL MORTALITY RATES



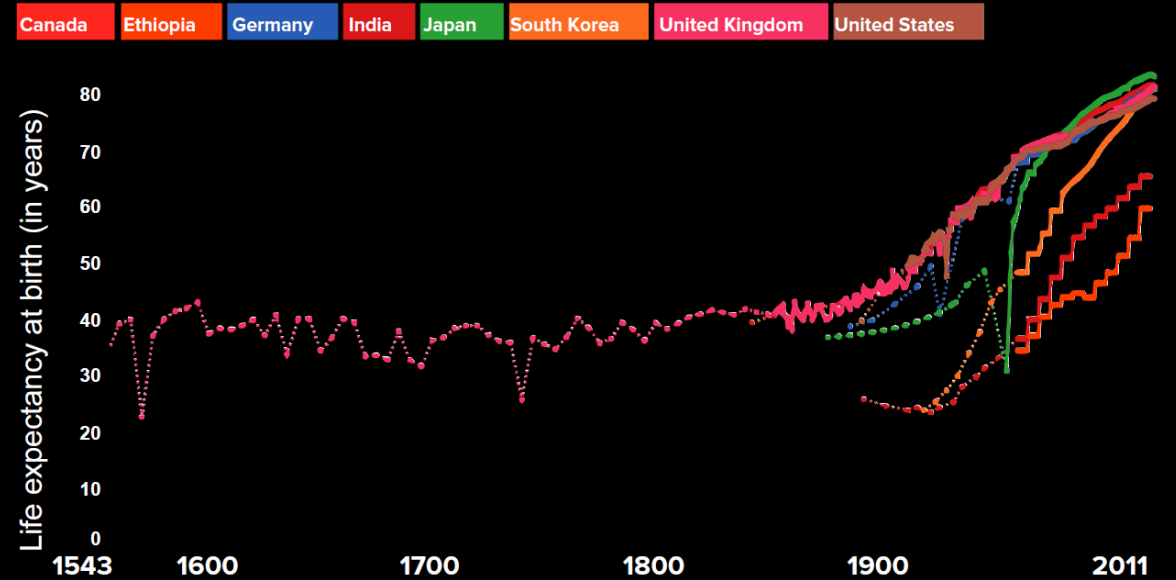
Source: Historical Statistics of the United States, Series B-148; and Health, United States, 1998, Table 45.

GLOBAL REDUCTION IN CHILDREN PER FAMILY



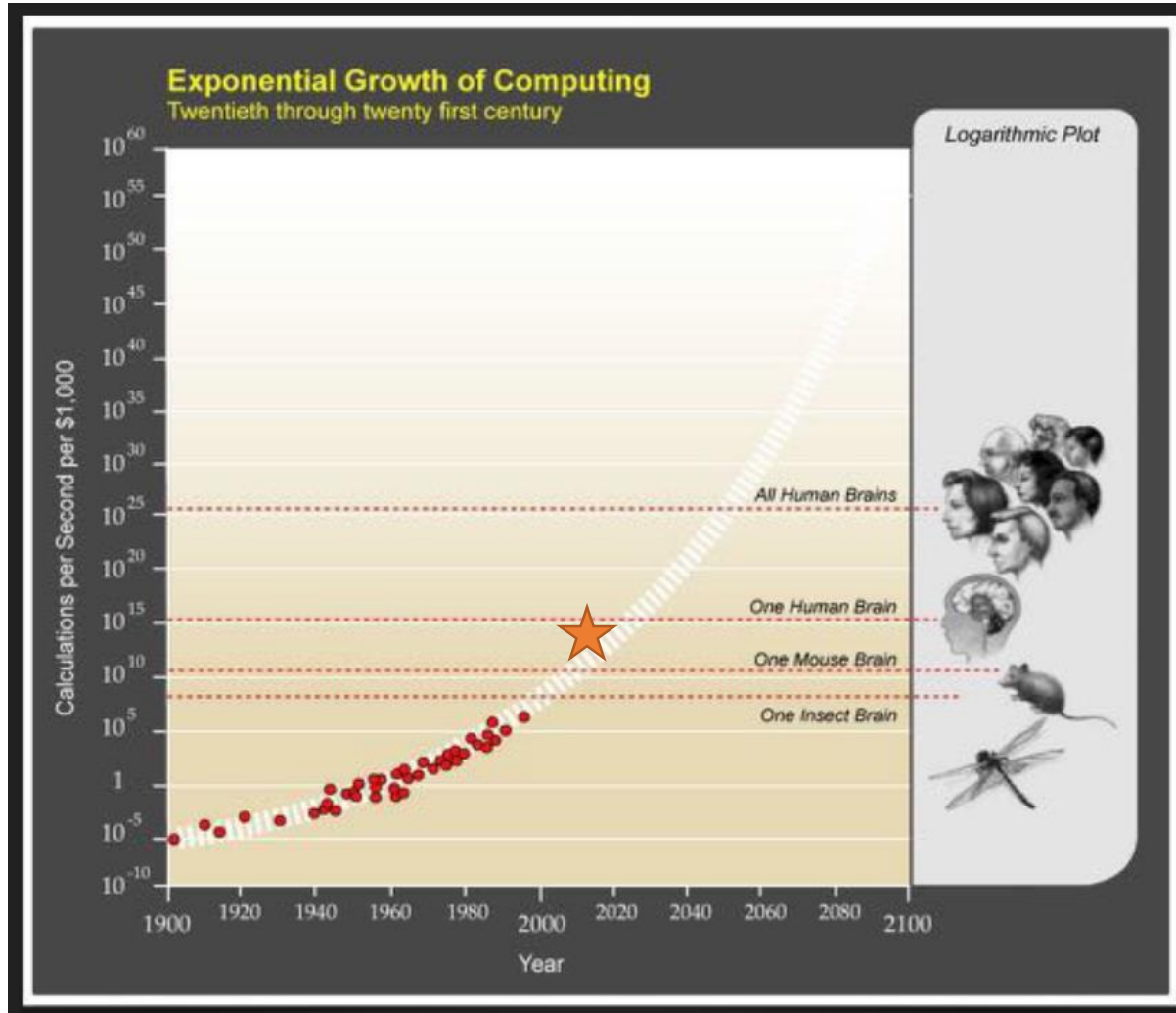
Source: http://esa.un.org/unpd/wpp/Analytical-Figures/htm/fig_9.htm

GLOBAL AVERAGE LIFE EXPECTANCY (1543 - 2011)



Source: <https://ourworldindata.org/life-expectancy/>

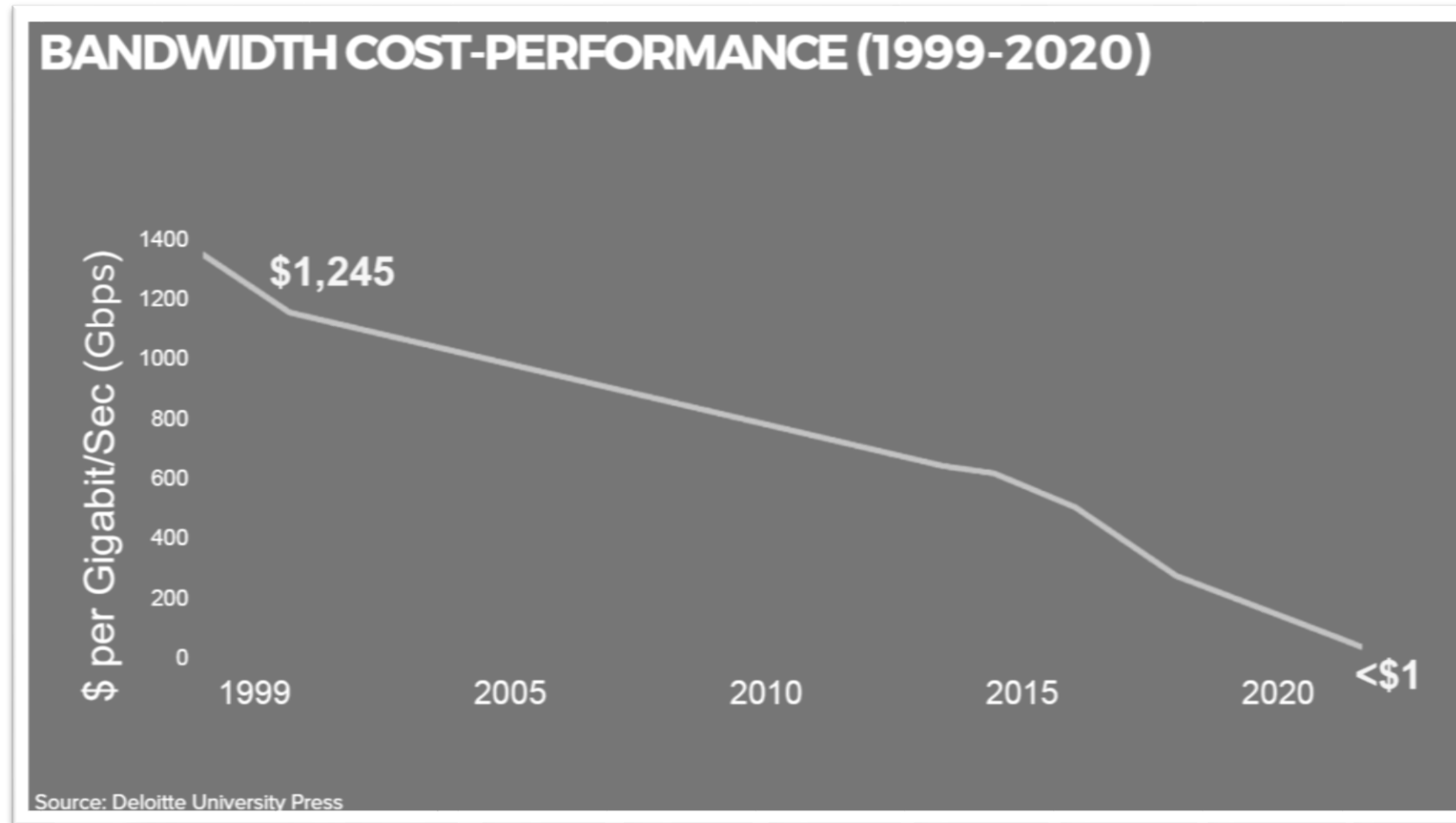
Computing power has gone exponential



Computers already
beating humans at
Chess, AlphaGo

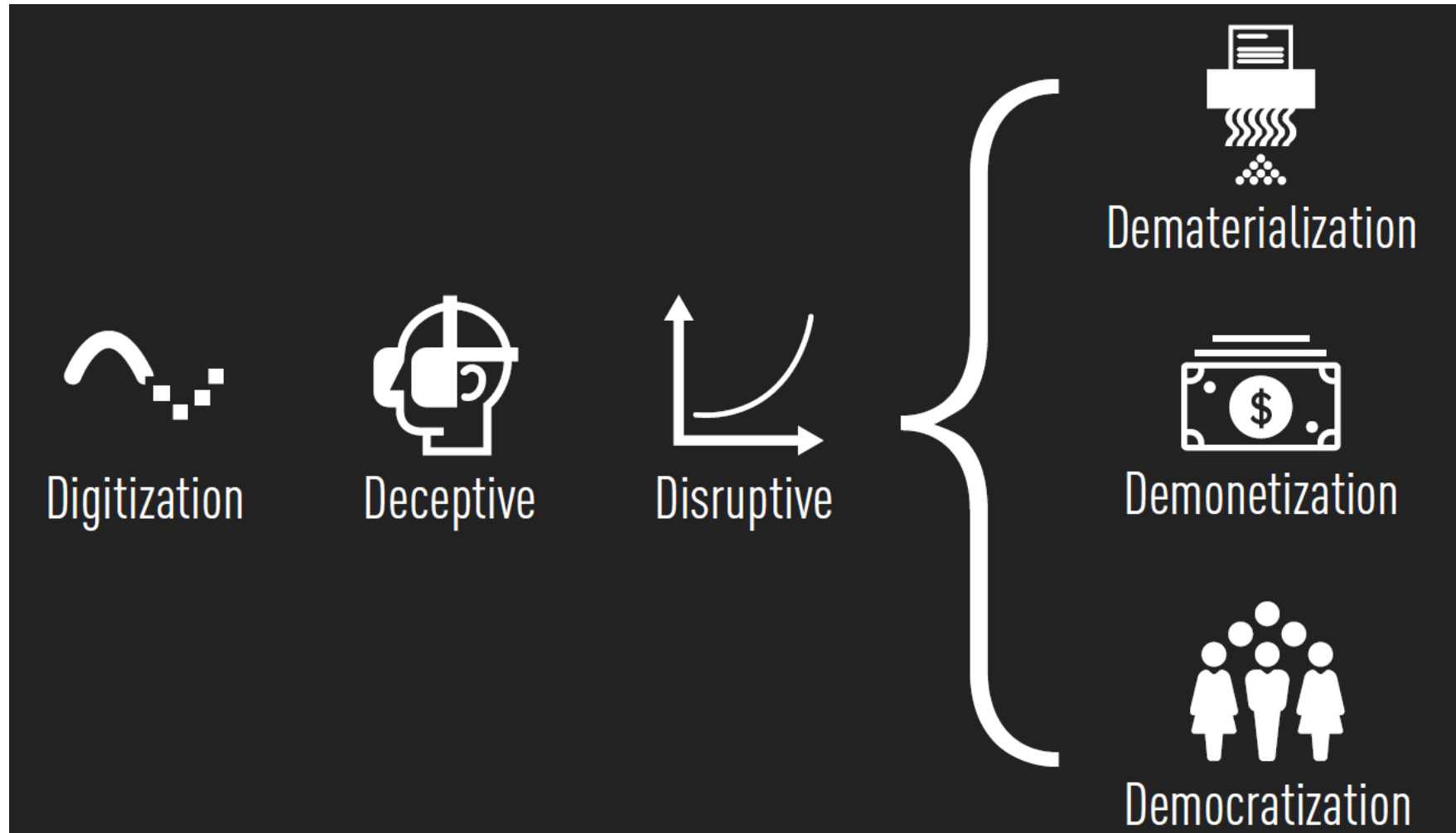
AI and Machine
Learning already
allowing algorithms,
digital assistants to
make human
intervention redundant.

Bandwidth costs have collapsed



A child in Africa with a smart phone has access to as much information as the President of the USA had in 1998!

The 6 D's of Disruption

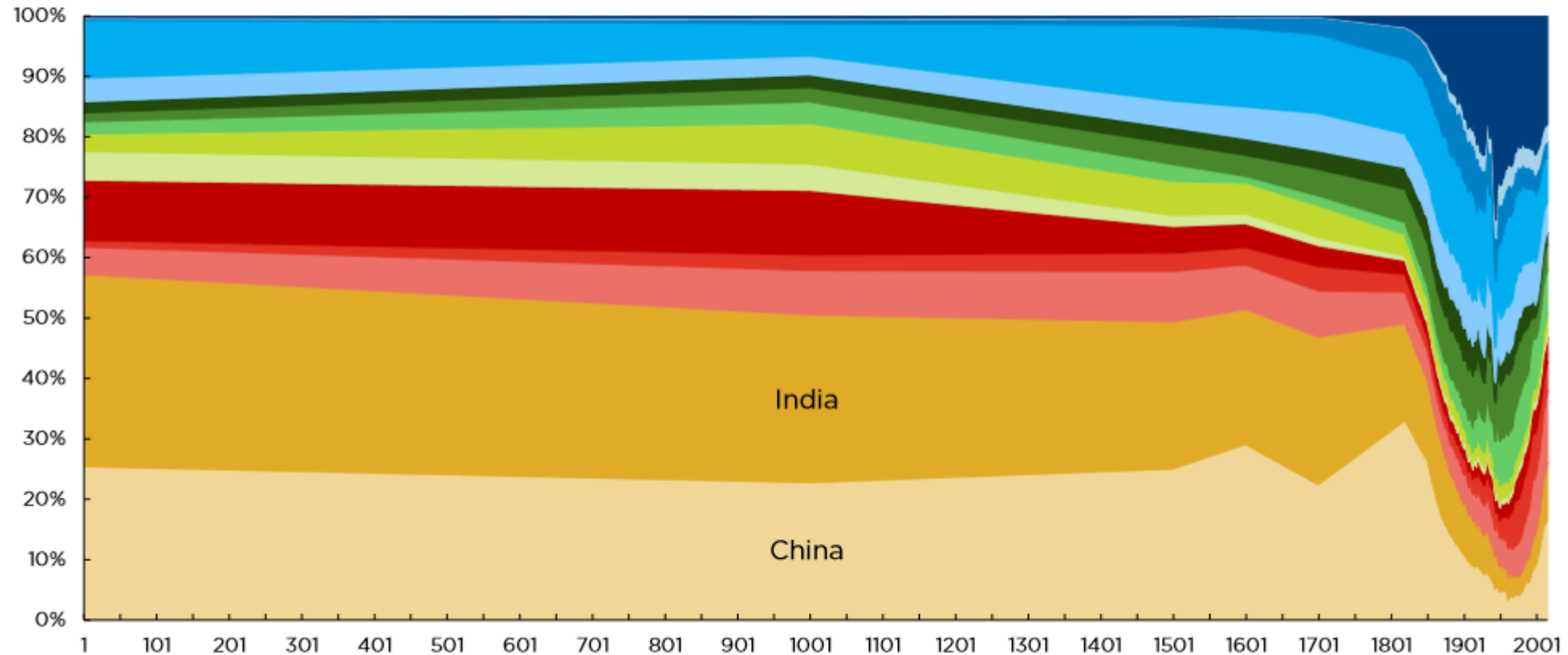


In 10 years, it's predicted that 40% of the Fortune 500 companies will no longer exist as things that were once scarce become abundant

A reminder: What missing a big trend can do...

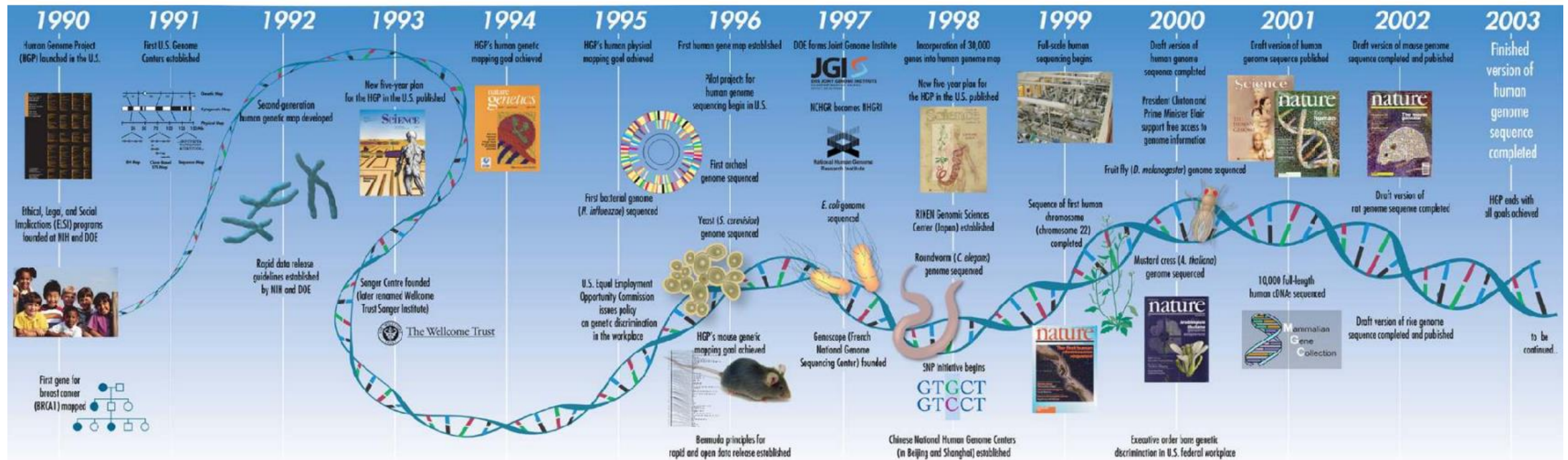
19th Century Industrial Revolution. India goes from ~25% to <2%

Share of World GDP (%), 1-2016 CE

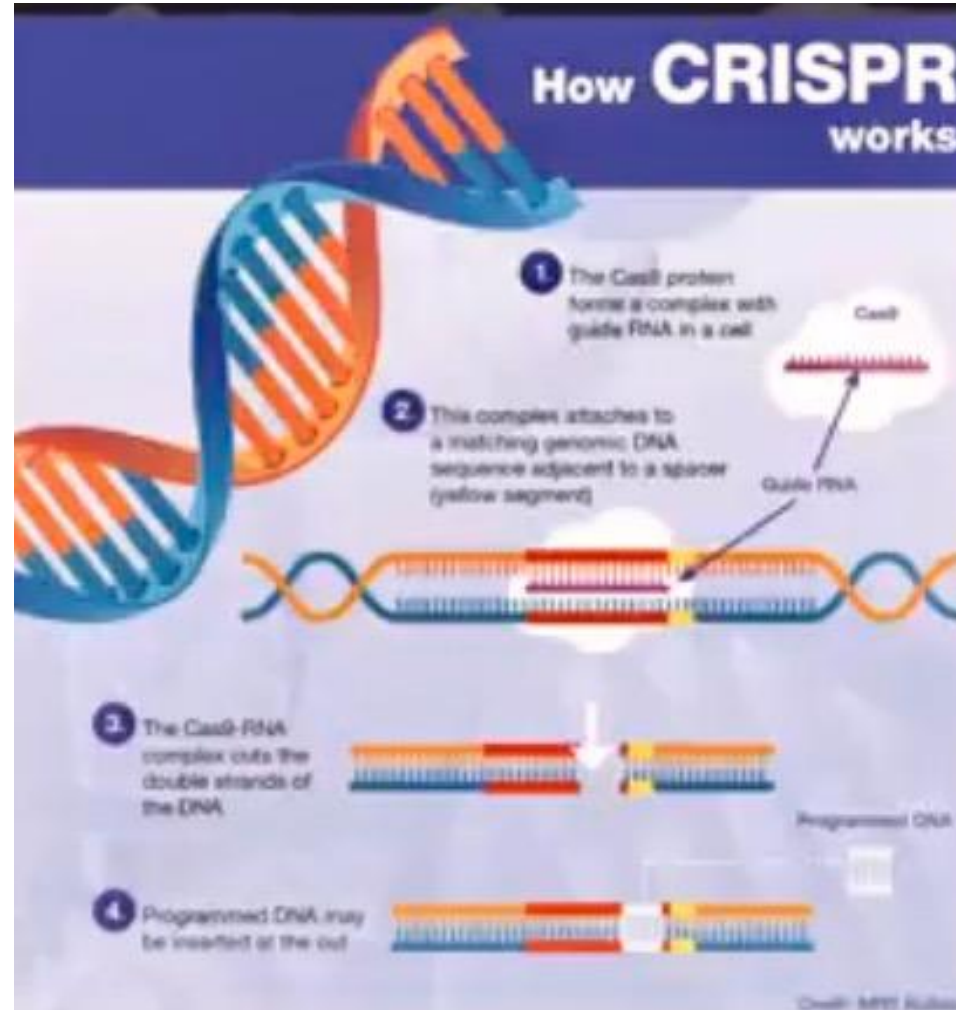
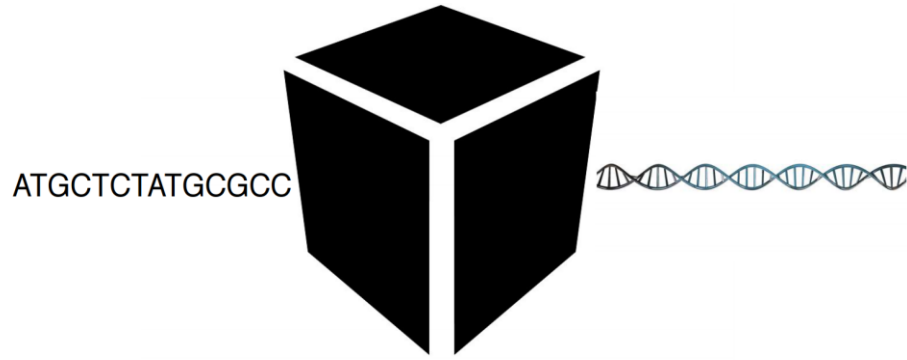


Disruption in life sciences

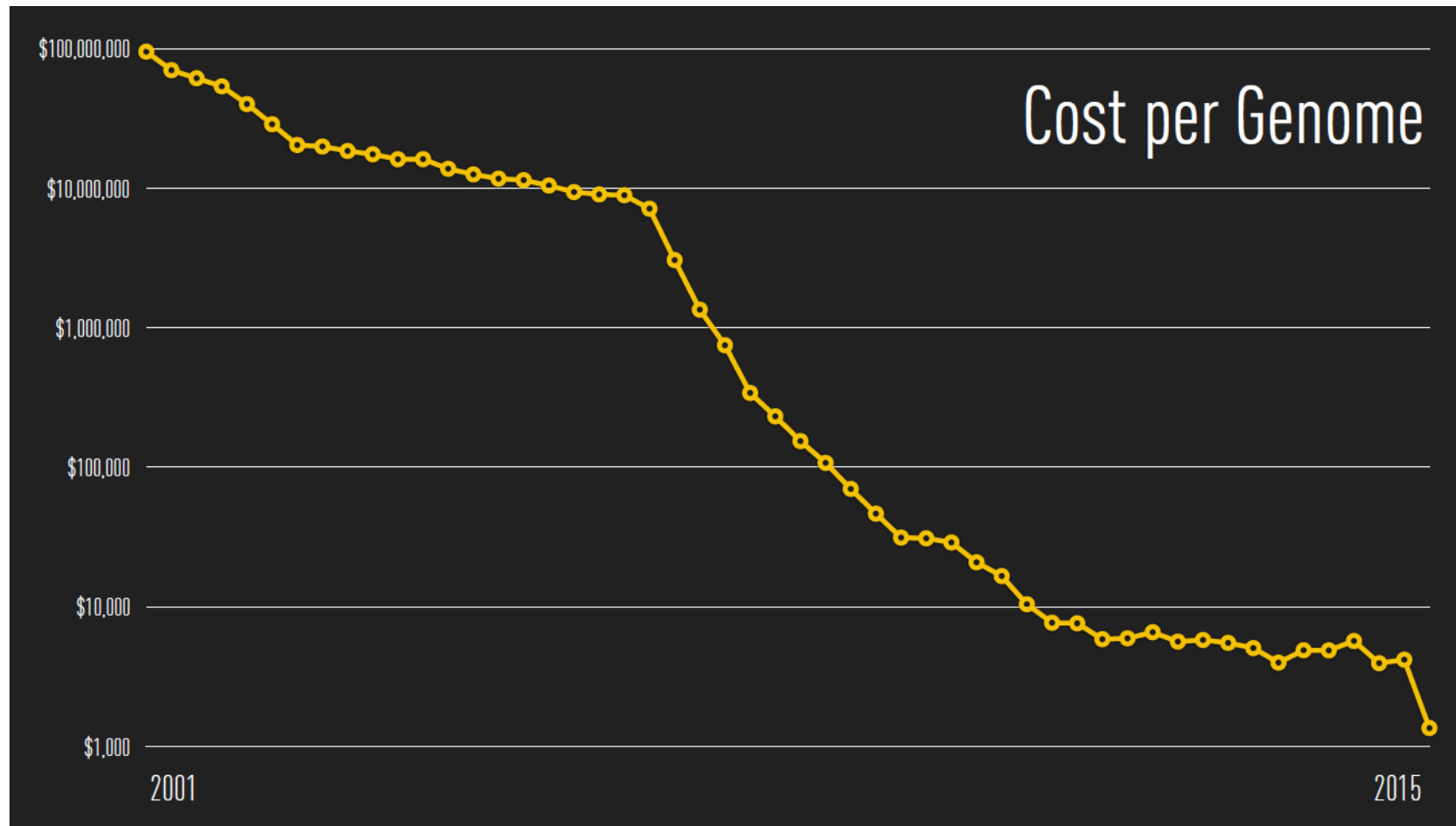
Digital Biology is going exponential



Digital Biology

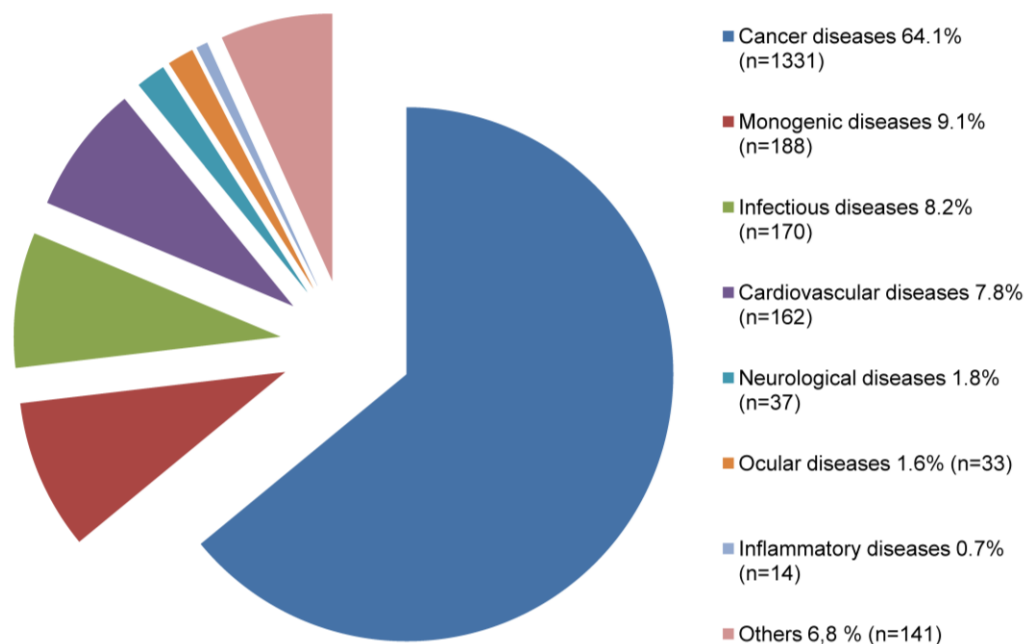


Cost of DNA Sequencing



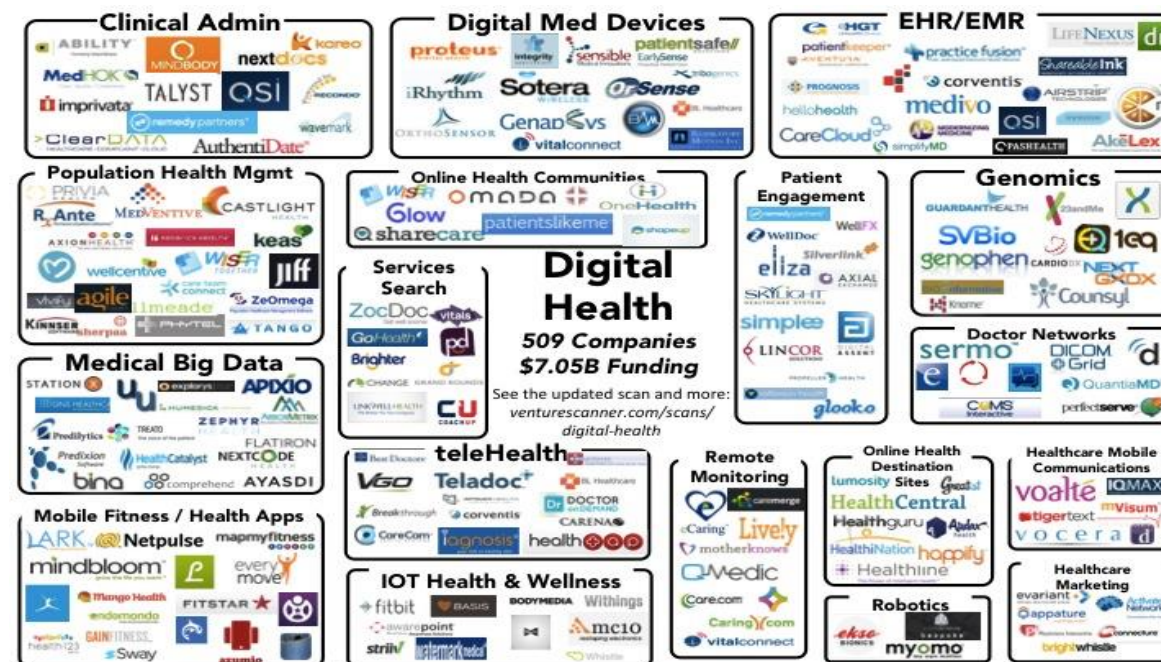
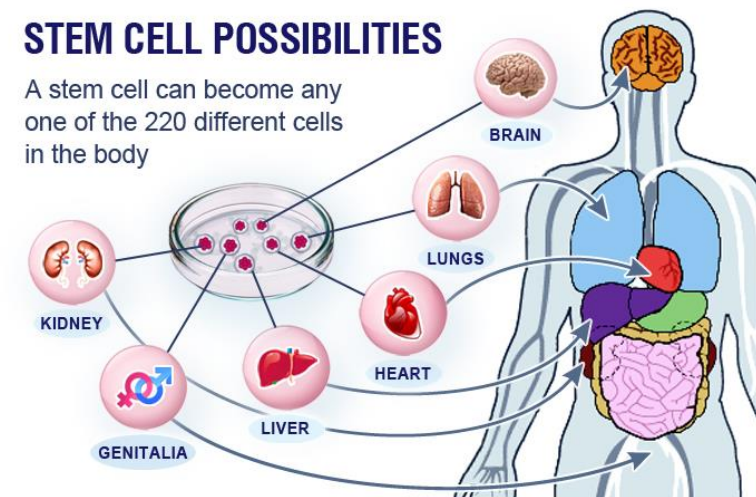
Healthcare being disrupted

Indications addressed by gene therapy clinical trials



STEM CELL POSSIBILITIES

A stem cell can become any one of the 220 different cells in the body



Venture Scanner

Synthetic Biology Funding



Healthcare being disrupted

- **Robotics**: Last month, a robot dentist in China successfully implanted 3D-printed teeth into a female patient's mouth with "high precision." The only human medical staff involvement was to conduct light setup and a pre-test. Imagine when such robots are in every healthcare facility on the planet, delivering service for the cost of electricity.
- **Virtual Reality**: VR is also entering the operating room. In July 2017, University of Minnesota doctors used VR to prepare for a challenging non-routine surgery -- separating a pair of twins conjoined at the heart. Not only was the life-saving surgery a success, the VR prep gave doctors unforeseen insights that prompted them to accelerate the surgery by several months. It won't be long until we refuse to have surgery completed by any human who hasn't prepared in virtual reality using a personalized 3D model.
- **CRISPR/Gene Editing**: Finally, in August 2017, the Food and Drug Administration (FDA) approved the first-ever treatment that uses gene editing to transform a patient's own cells into a "living drug." Kymriah, a one-time treatment made by Novartis, was approved to treat B-cell acute lymphoblastic leukemia -- an aggressive form of leukemia that the FDA calls "devastating and deadly." The FDA is currently considering over 550 additional experimental gene therapies. What happens to our healthy human lifespan as these life-saving treatments demonetize and become universally accessible?

Pioneering cancer drug, just approved, to cost \$475,000 — and analysts say it's a bargain

—

The Food and Drug Administration on August 30, 2017 approved a futuristic new approach to treating cancer, clearing a Novartis therapy that has produced unprecedented results in patients with a rare and deadly cancer. The price tag: \$475,000 for a course of treatment.

The therapy, called a CAR-T, is made by harvesting patients' white blood cells and rewiring them to home in on tumors. Novartis's product is the first CAR-T therapy to come before the FDA, leading a pack of novel treatments that promise to change the standard of care for certain aggressive blood cancers.

Novartis's therapy is approved to treat children and young adults with relapsed acute lymphoblastic leukemia. It will be marketed as Kymriah.

In a clinical trial, a single dose of Kymriah left 83 percent of participants cancer-free after three months, [results oncologists have hailed as a major advance](#) for patients with few other options.

Each dose is custom-tailored for an individual patient, requiring a complex process in which human cells must be safely ferried across the country, reliably re-engineered, and soundly returned.

To get Kymriah, patients will have to travel to one of just 32 sites around the country. From there, doctors harvest patients' white blood cells and ship them off to a Novartis facility in New Jersey where they can be edited and mailed back. The entire process takes about 22 days, the company said.

Bioprinting is already a reality



**Kamen to lead \$294M effort in Manchester
Millyard to grow human organs on industrial
scale**

Energy

Energy

1 Day of Humanity's Energy Use =

Energy

10 Seconds of Sunlight

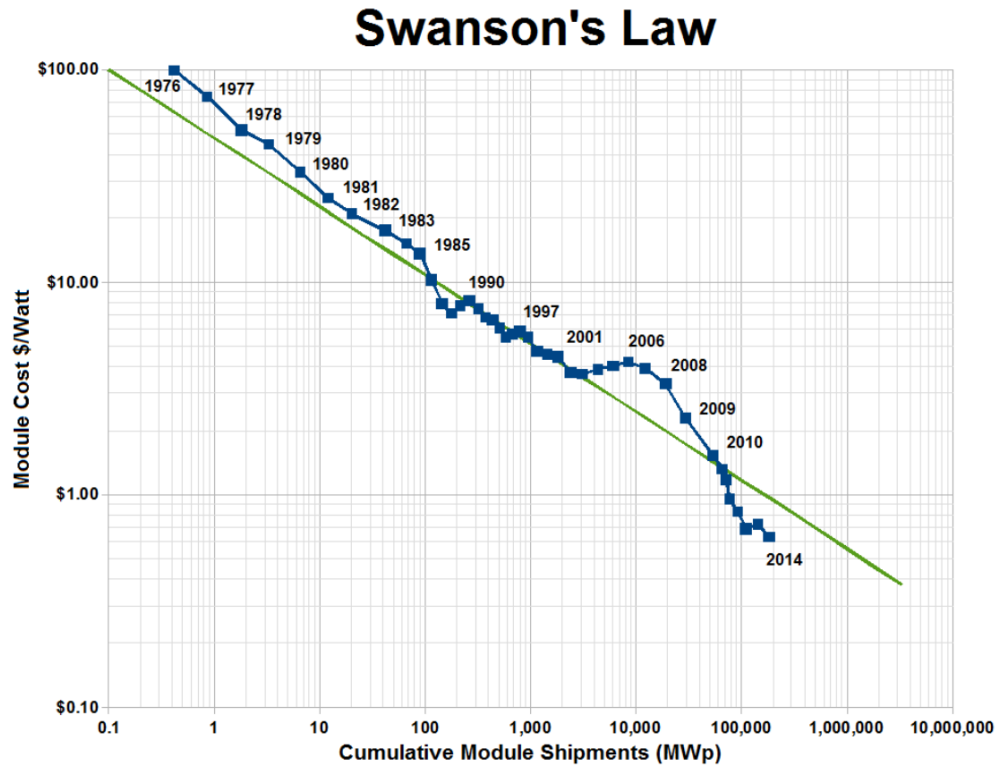
Energy

1 Year of Humanity's Energy Use =

Energy

1 Hour of Sunlight

Solar Energy



Photovoltaic Cell

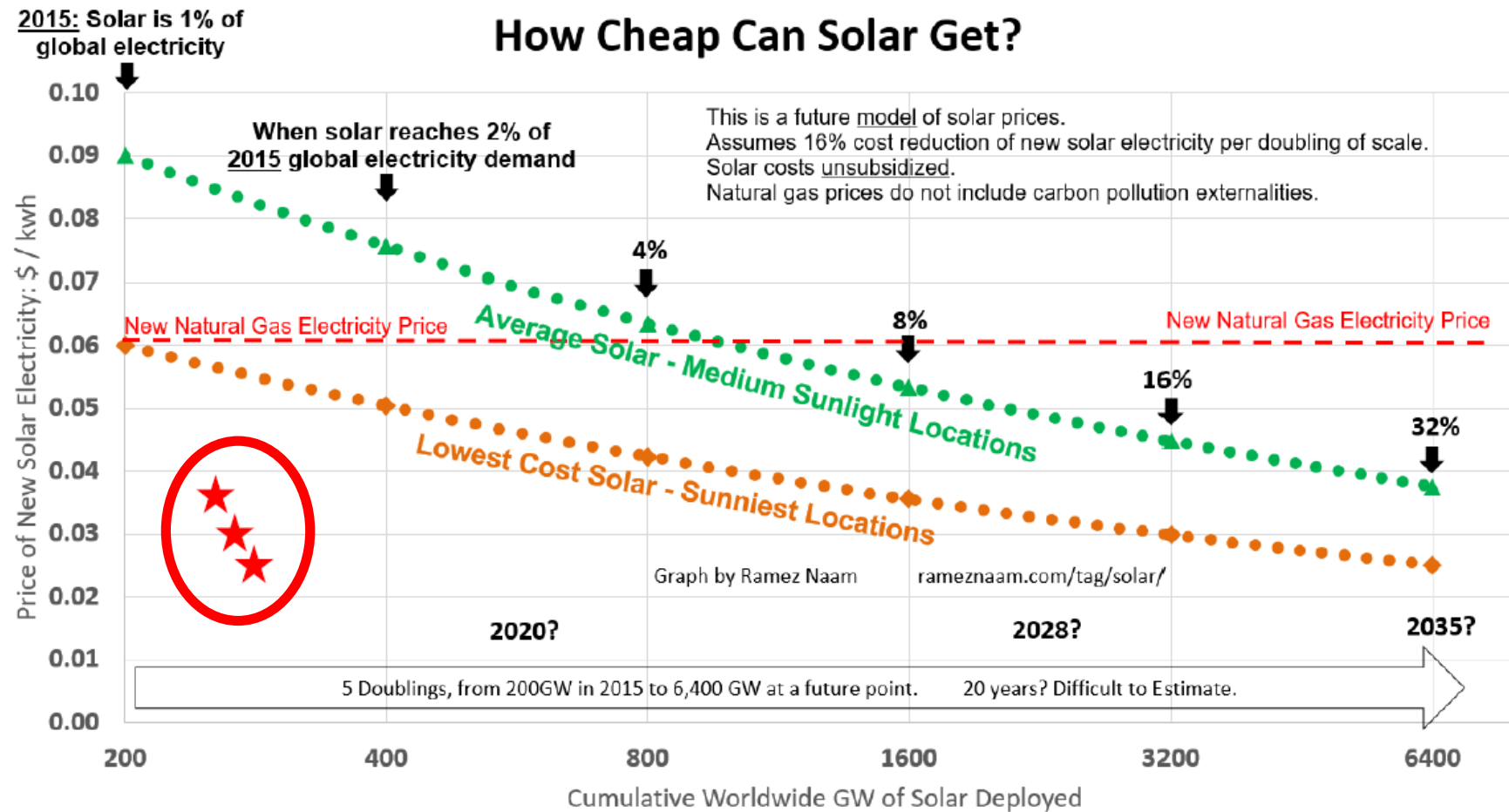
1977: **\$76.67**

1987: **\$10**

2015: **\$0.30**

2016: **\$0.03**

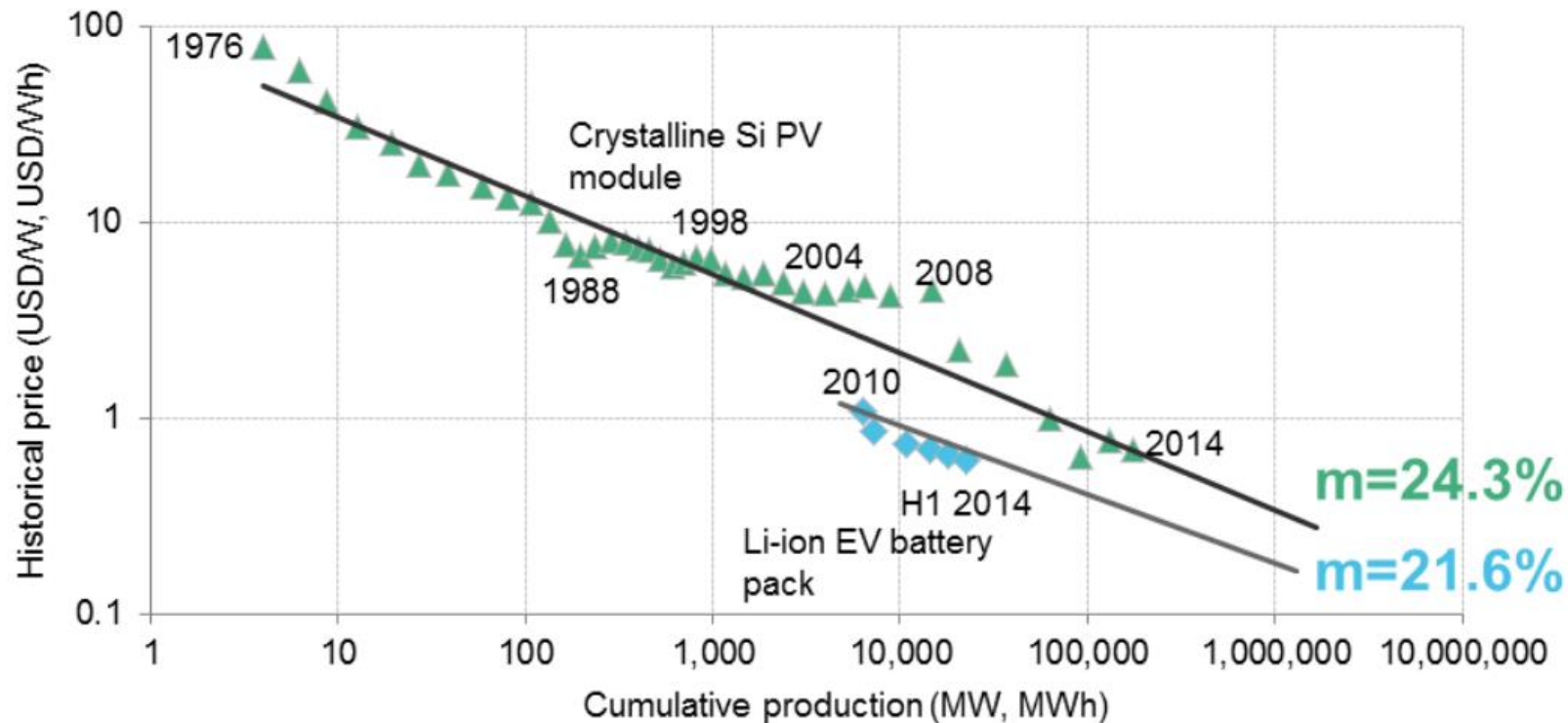
Solar Energy



Batteries to follow Solar's Cost Curve

LITHIUM-ION EV BATTERY EXPERIENCE CURVE COMPARED WITH SOLAR PV EXPERIENCE CURVE

Bloomberg
NEW ENERGY FINANCE



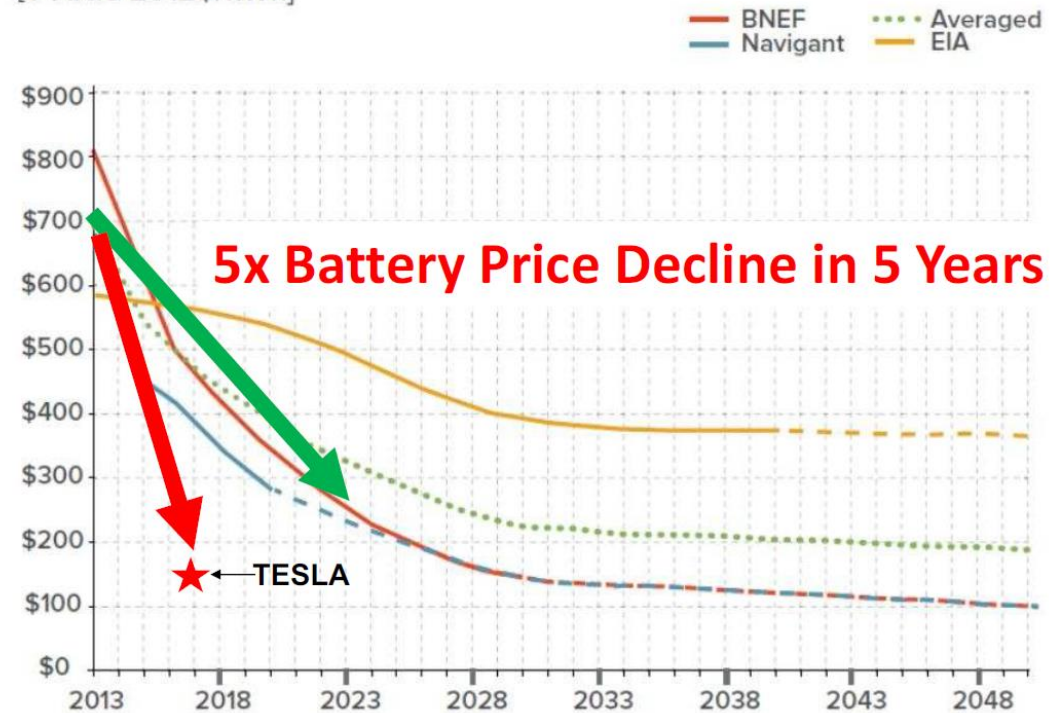
Note: Prices are in real (2014) USD.

Source: Bloomberg New Energy Finance, Maycock, Battery University, MIT

Energy

BATTERY PRICE PROJECTIONS

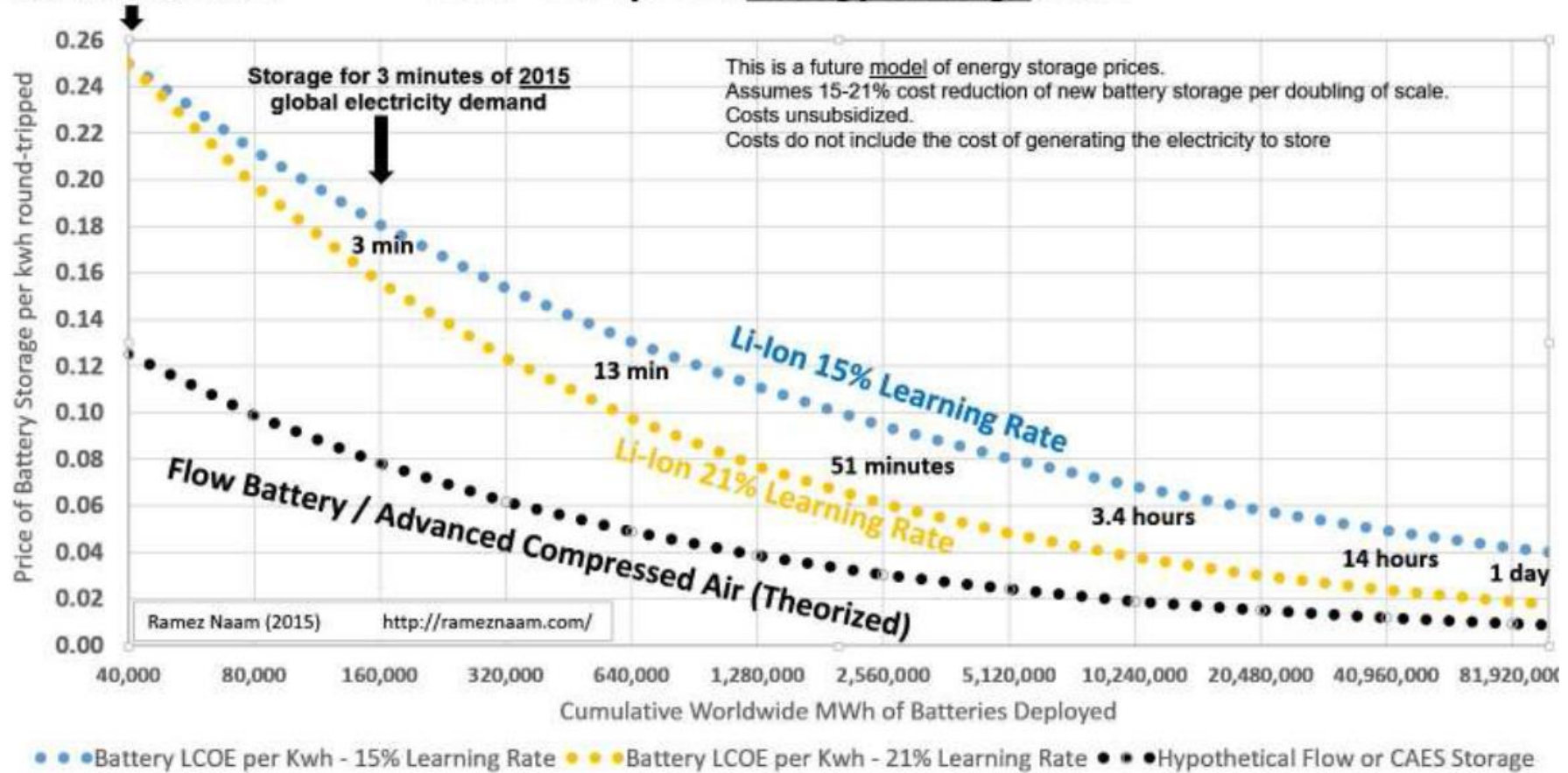
[Y-AXIS 2012\$/kWh]



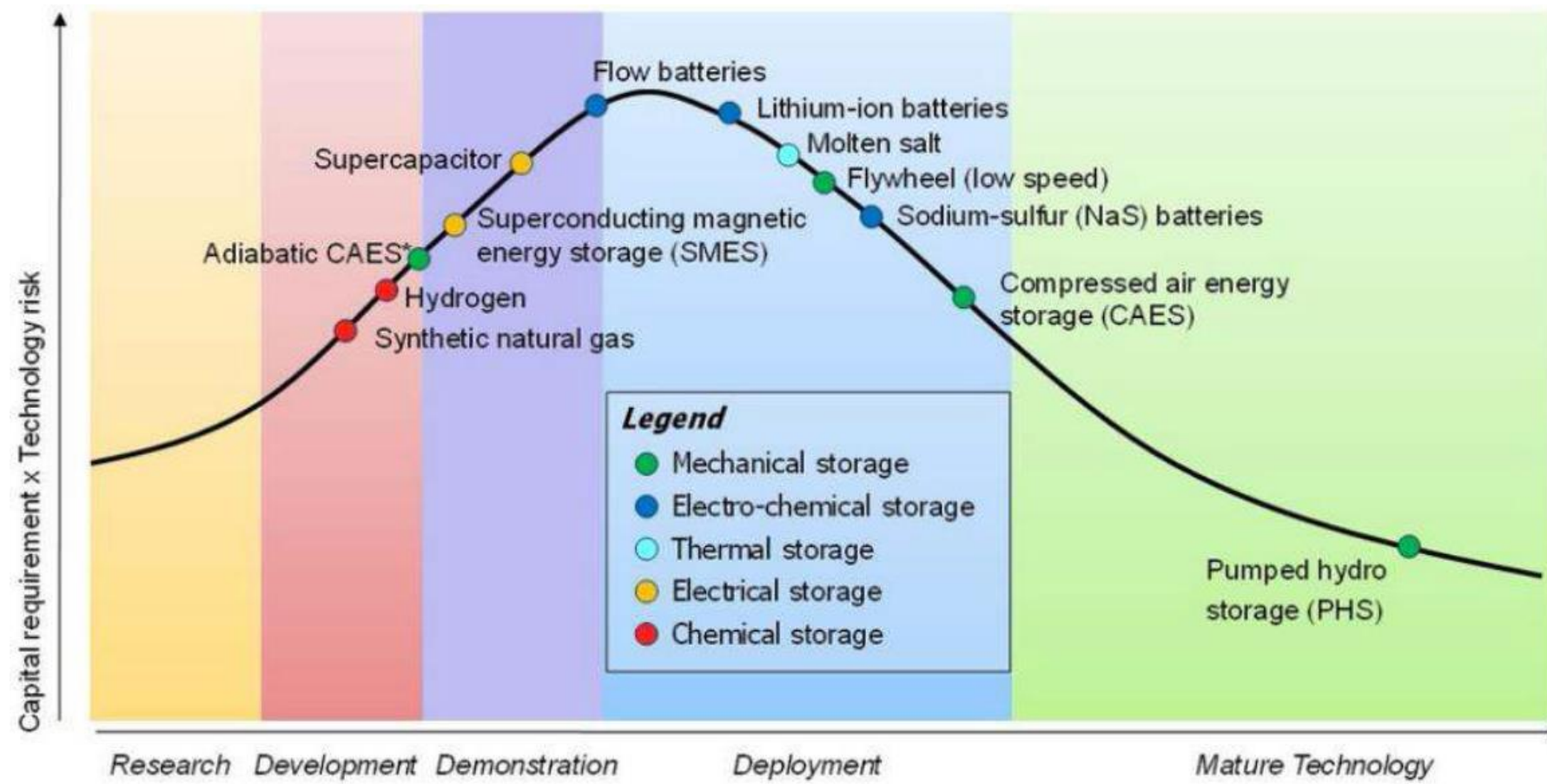
Energy

2015: Store <1 Minute of World Electricity Demand

How Cheap Can Energy Storage Get?



Many other Storage Technologies are coming



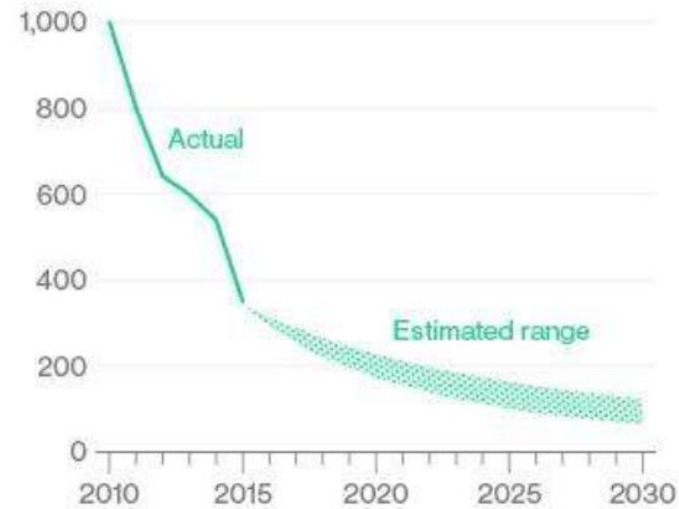
Electric & Self Driving Vehicles

Energy disruption = EVs

Batteries make up a third of the cost of an electric vehicle.
As battery costs continue to fall, demand for EVs will rise.

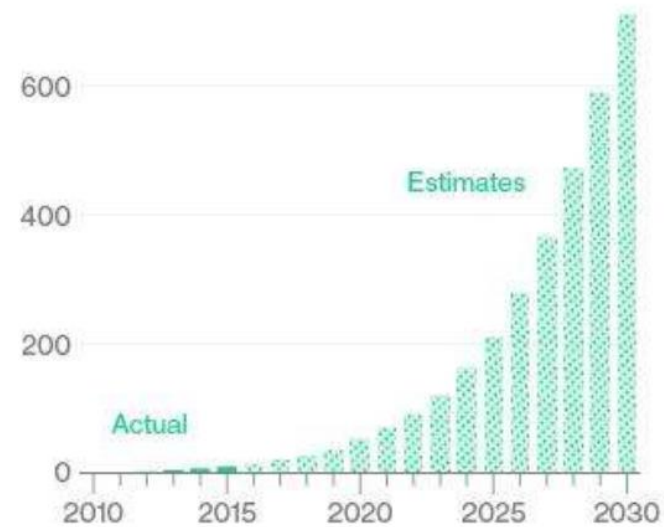
Cost for lithium-ion battery packs

\$1,200 per kilowatt hour



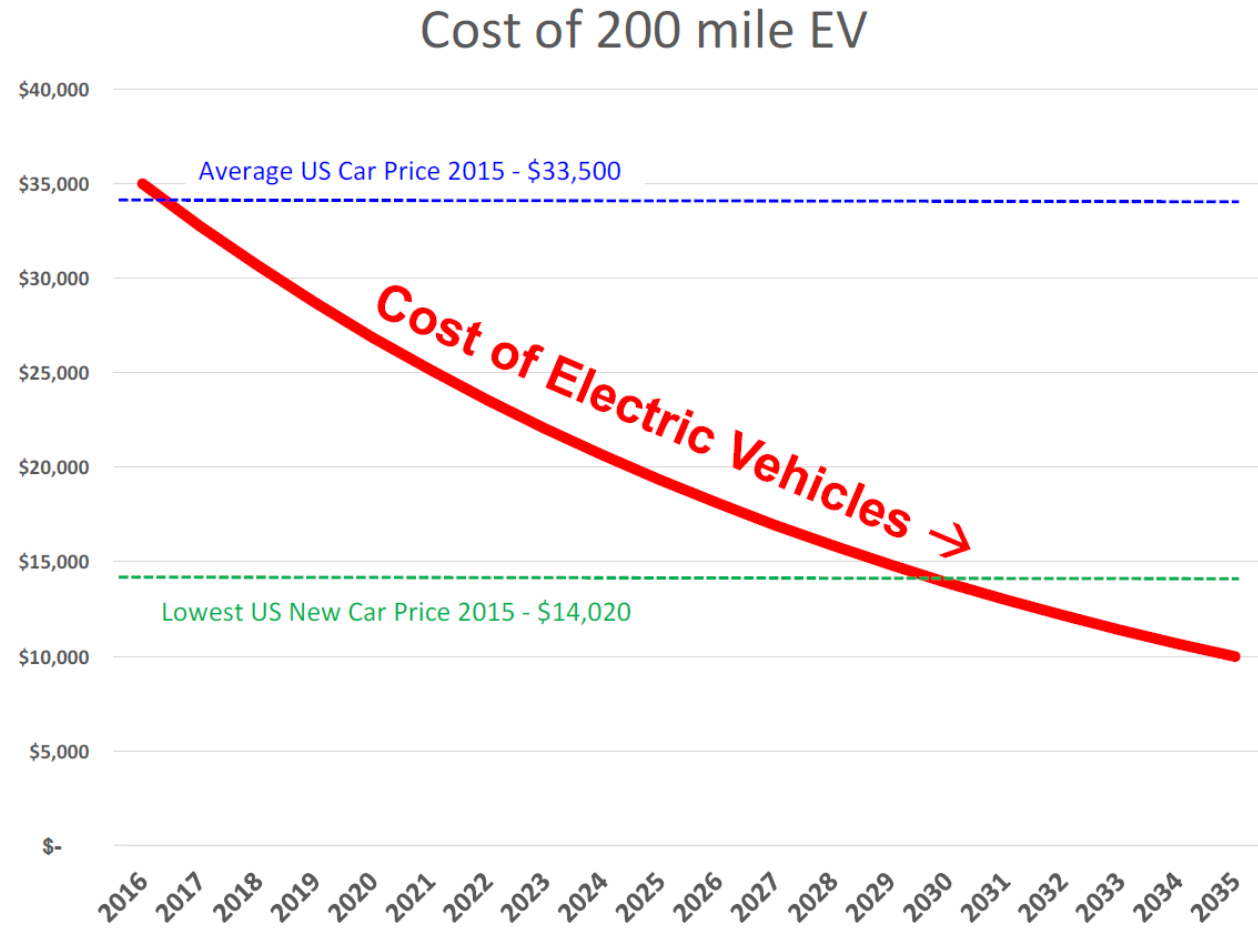
Yearly demand for EV battery power

800 gigawatt hours



Source: Data compiled by Bloomberg New Energy Finance

EV's disruption: faster than you think



Autonomous Driving

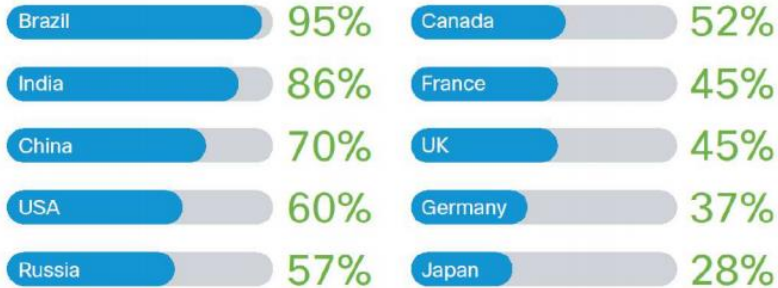
Consumers Desire More Automated Automobiles

Consumers Trust Driverless Cars



57%

of consumers, globally, trust driverless cars—even more so in emerging markets

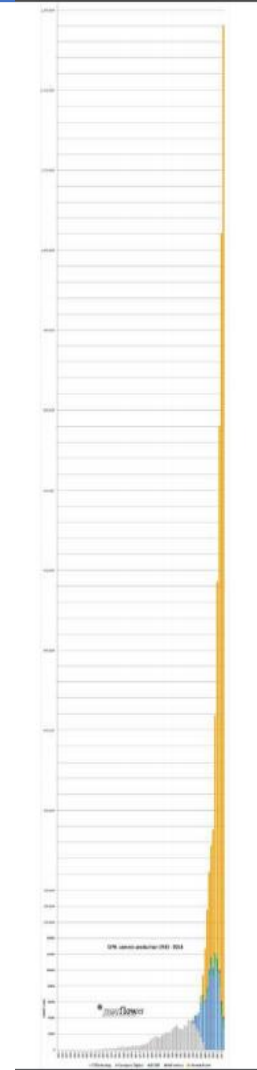
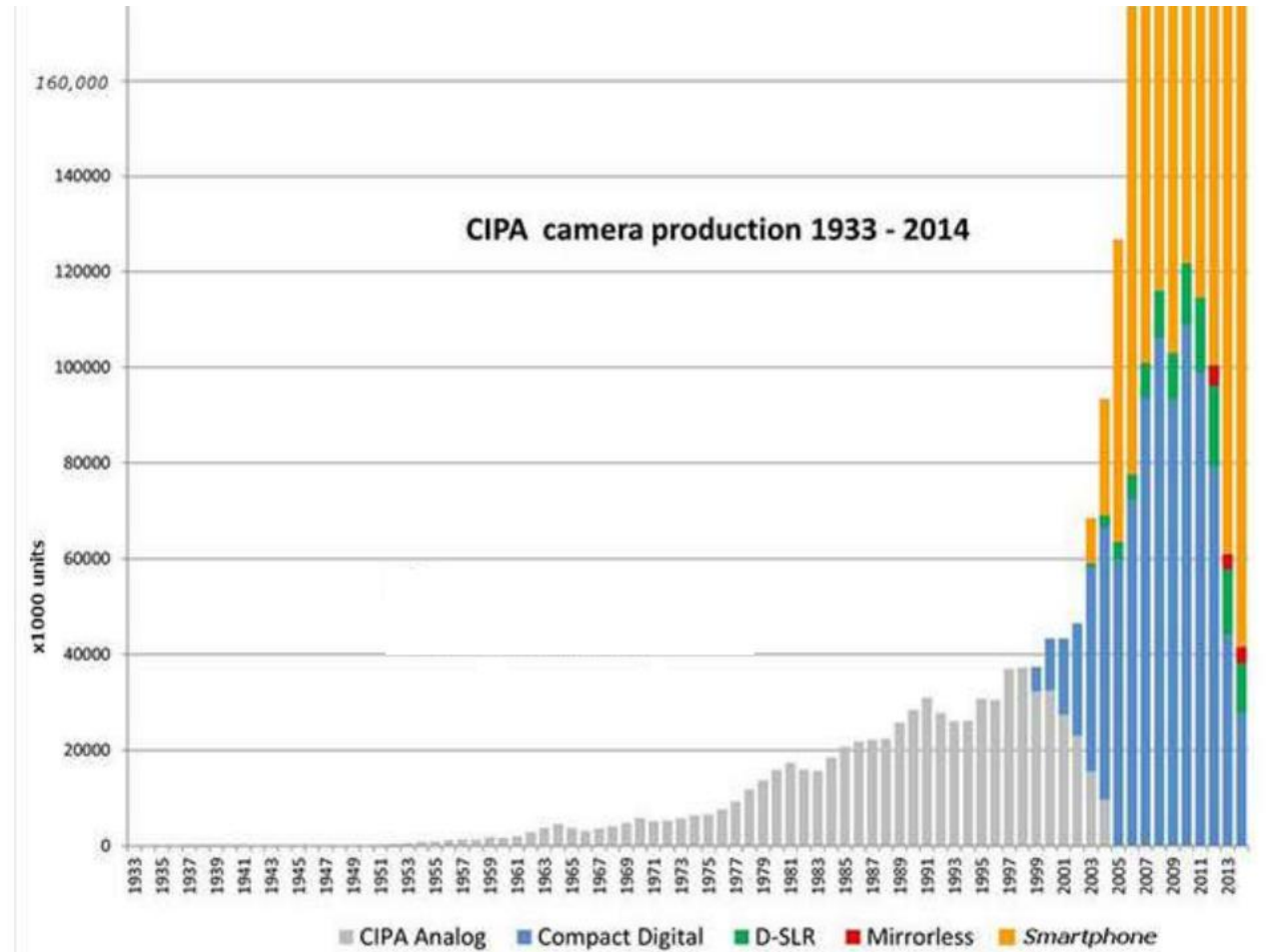


Source: Cisco Customer Experience Report for Automobile Industry, May 2013 survey of 1,511 consumers in 10 countries.

~~Not Ready~~



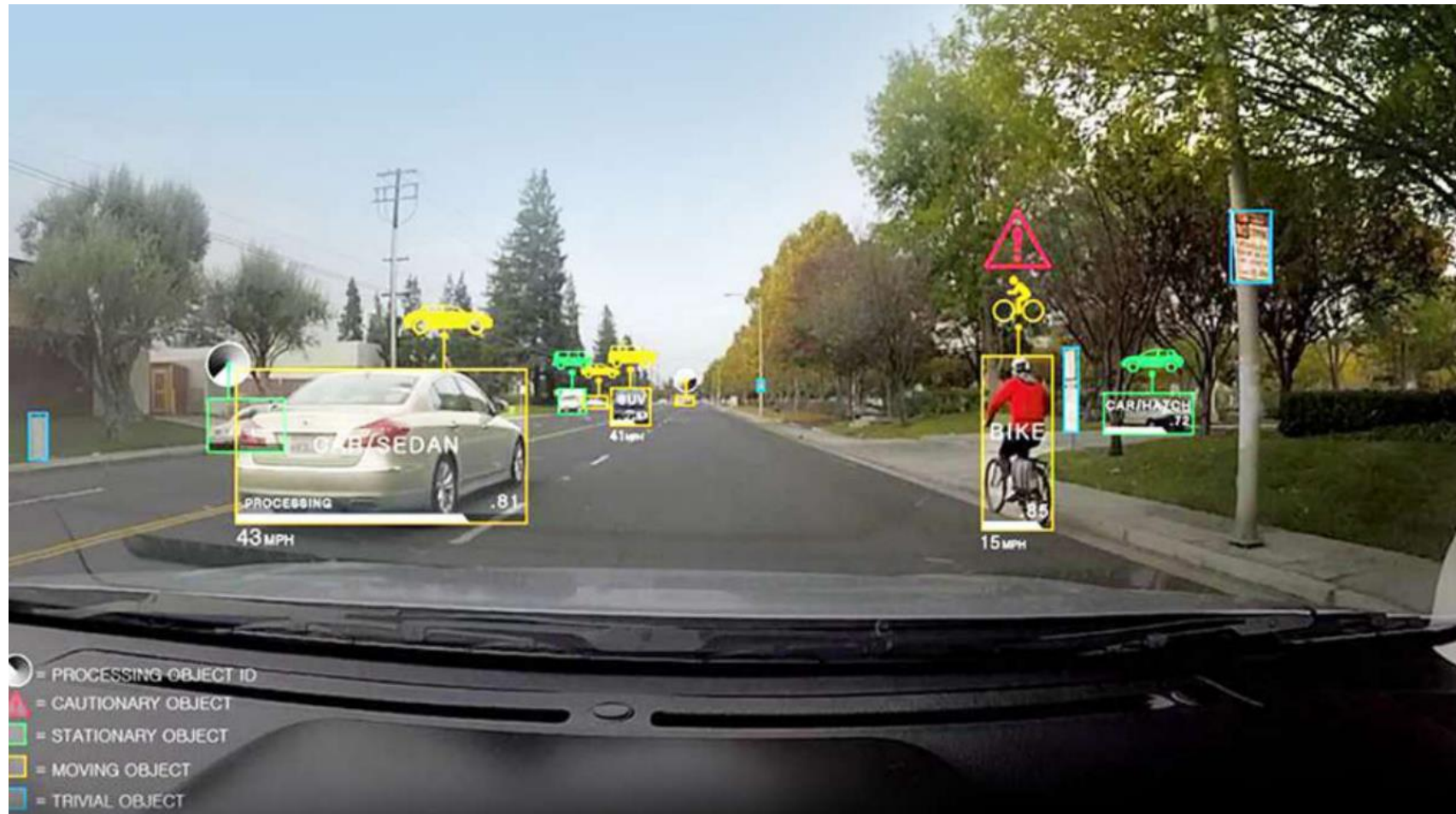
Digital Cameras = Smart Phones = Mobility



AI Image Recognition is now mainstream



AI Image Recognition



Autonomous Driving: Cameras + AI + Sensors



Internet of Things & Sensors

IOT – What is it?



- Relatively small
- Battery/Solar powered
- Sensor-based
- Remotely administered
- No User interface
- Limited network comms

IOT – Why now?

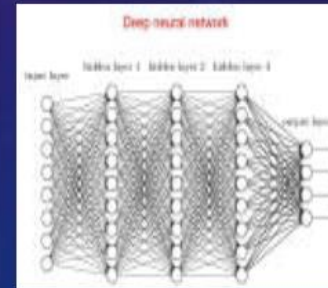
- The Perfect Storm of factors:
 - Dense chips + cloud compute + ML algo + New Devices



+



+



+



IOT – Weather reports were remote sensing



Local weather



THE WEATHER.								
METEOROLOGICAL REPORTS.								
Wednesday, July 31, 5 to 6 a.m.	R.	F.	M.	D.	F.	C.	I.	S.
Nairn	22 54	57	60	W.S.W.	6	9	a.	3
Aberdeen ..	22 60	59	54	S.S.W.	5	1	b.	2
Leith	22 70	61	55	W.	3	5	c.	2
Burwick ..	22 69	59	55	W.S.W.	4	4	c.	3
Anderson ..	22 73	57	55	W.	5	4	c.	5
Portrush ..	22 72	57	54	S.W.	2	2	b.	2
Stirling ..	22 30	56	54	W.S.W.	4	5	c.	3
Galway ..	22 33	55	52	W.	5	4	c.	4
Scarborough ..	22 35	59	55	W.	3	6	c.	2
Liverpool ..	22 38	61	56	S.W.	2	8	c.	2
Valencia ..	22 37	62	63	S.W.	3	5	c.	3
Quezon ..	22 55	61	59	W.	3	5	c.	3
Yarmouth ..	22 05	61	59	W.	3	2	c.	5
London ..	22 02	62	56	S.W.	3	2	b.	—
Dorset ..	22 01	70	61	S.W.	3	7	c.	2
Portsmouth ..	22 01	61	59	W.	3	6	c.	2
Portland ..	22 03	63	59	S.W.	3	2	c.	3
Plymouth ..	22 00	62	59	W.	5	1	b.	4
Pennance ..	22 04	61	60	S.W.	2	4	c.	5

Regional weather

Distributed
Information



IOT – Third Wave Effects



First Wave:
Scarce resource.
Usage rationed.



Second Wave:
One-to-one usage.



Third Wave:
Everywhere.
Virtually free.

...are those that Disappear!



Sensor Explosion

- The list of available sensors is enormous...and growing

- Acceleration / Motion
- Gasses / VOCs
- Cameras / Traffic / Road speed
- Particulates / Smog
- Humidity / Temperature / pH
- Tilt / Rotation
- Touch / Voice / Presence
- Arrival / departure
- Location / Proximity
- Seating / Engine coolant / TPMS
- Torque / Wheel speed / Hall effect



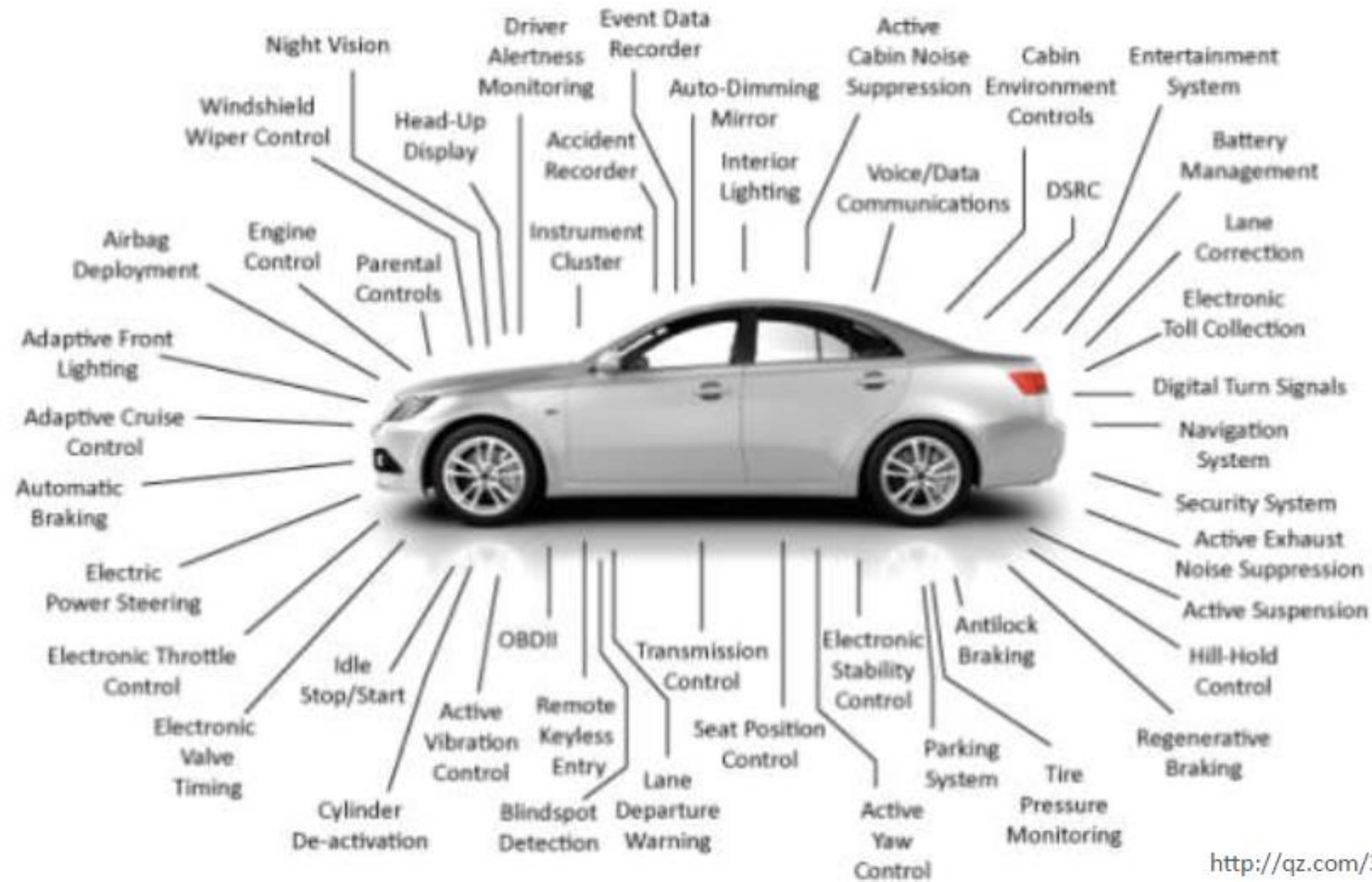
Your Phones are already sensing more than you!



apple.com

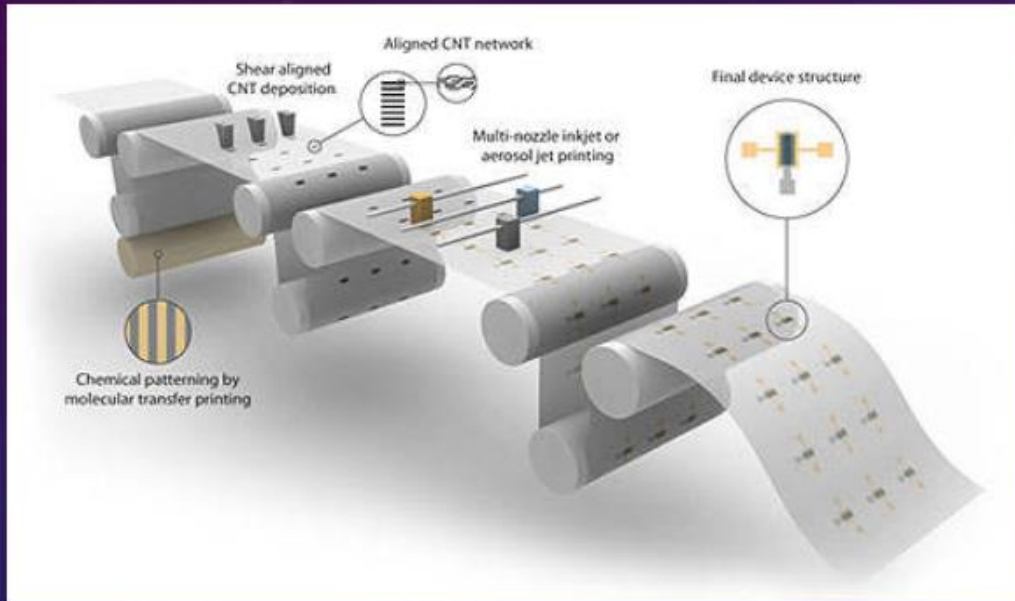
- 25 sensors
 - Accelerometer, Magnetometer, Gyro, Barometer, Humidity, GPS, WiFi, Bluetooth, LTE, NFC, Touch screen, buttons, fingerprint sensor, ALS, Optical Proximity, Camera front, Camera back, Temperature, Microphone x 3, Ultrasonic Gesture, Colorimeter, Heart Rate PPG, Magnetic cover switch

Sensing a Revolution: Cars

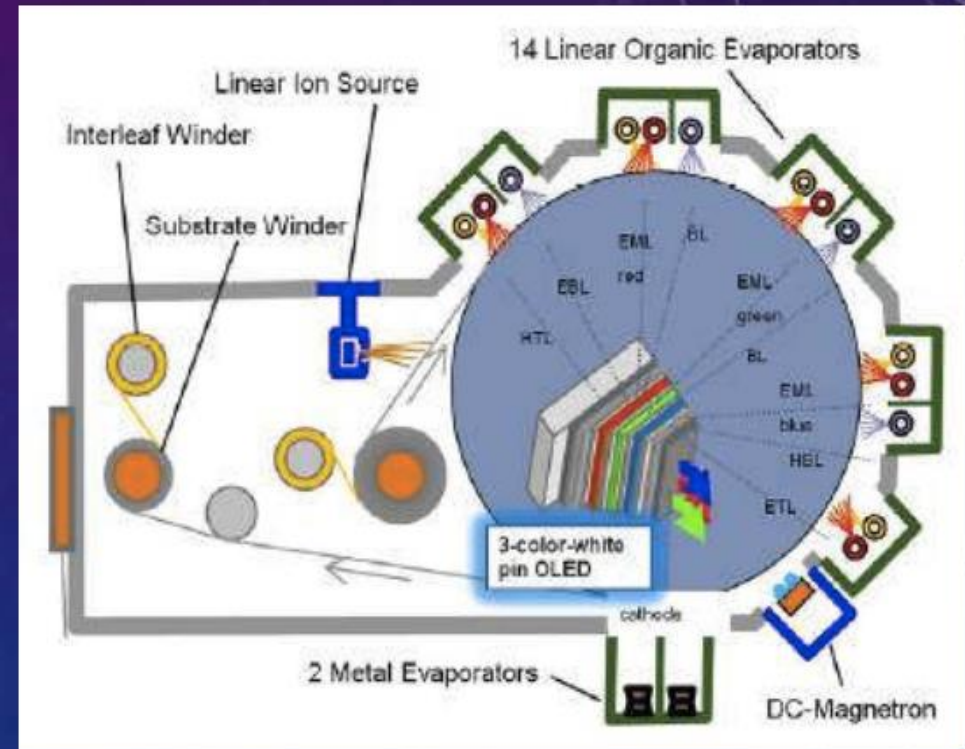


<http://qz.com/327326>

Sensing a Revolution: Manufacturing



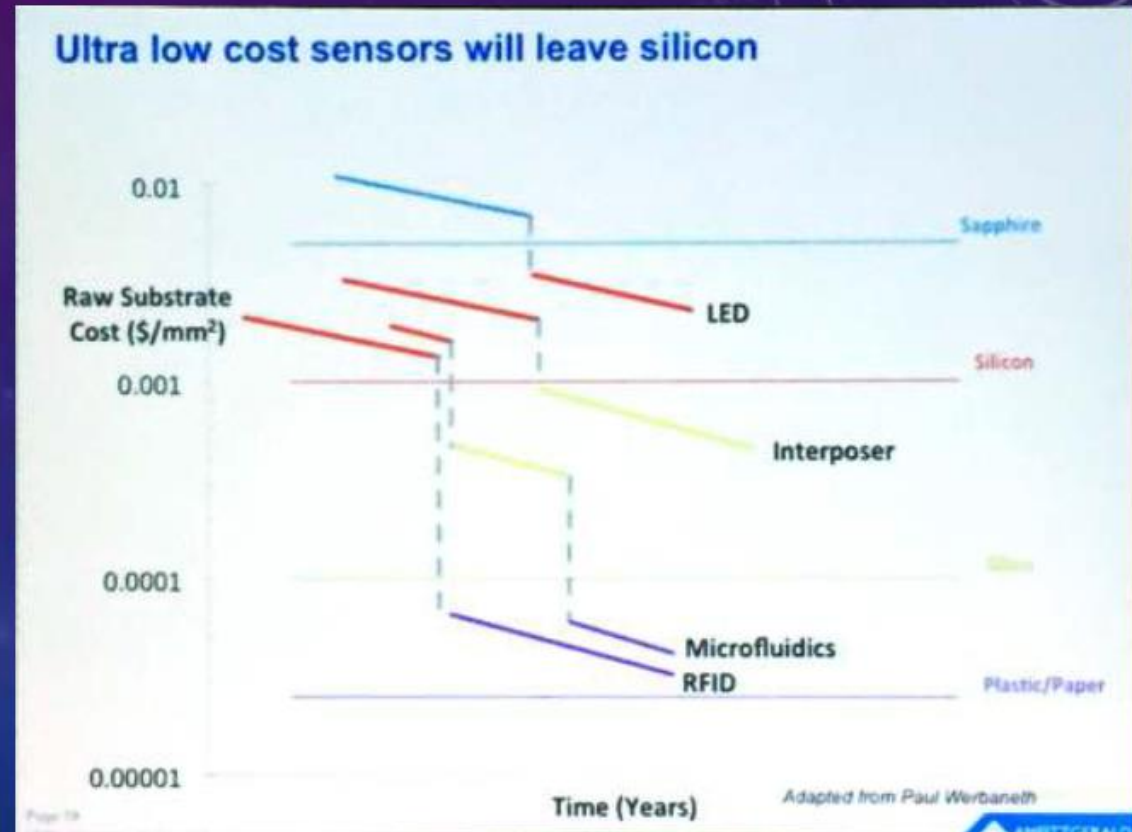
Ink Jet printed electronics



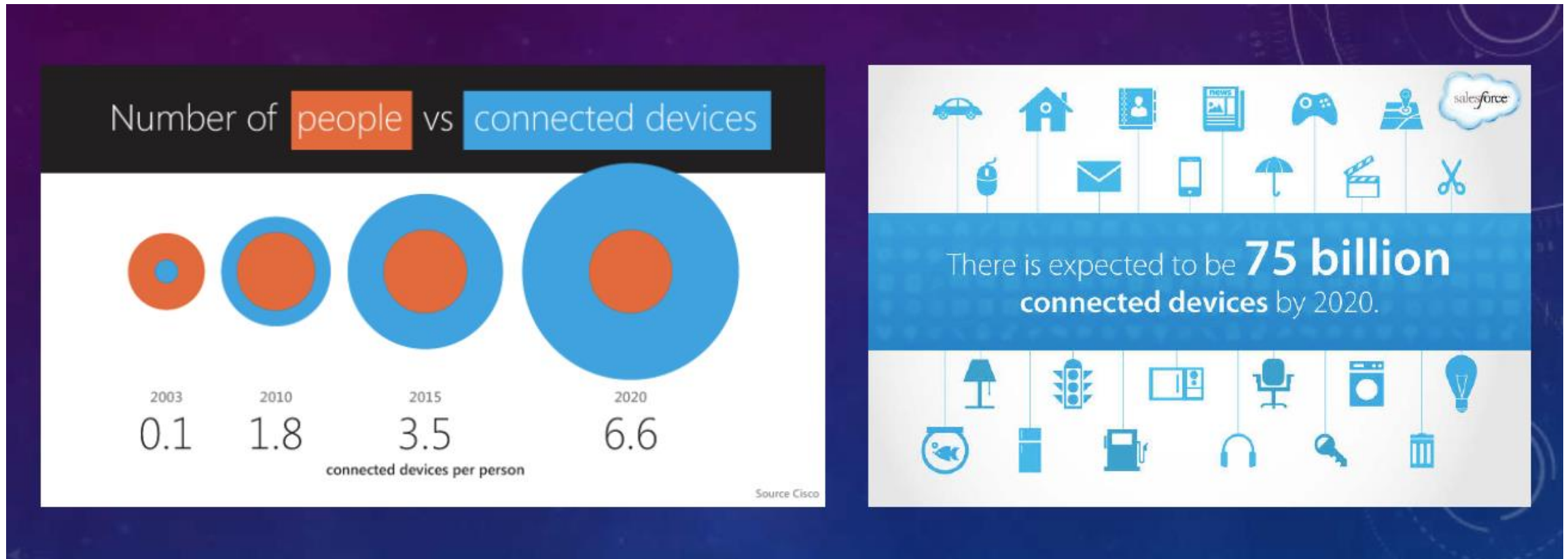
OLED evaporators

Sensors going exponential

- Silicon is dominant for performance, but not cost
- Major efforts for Paper/Plastic substrates
- Requires new manufacturing infrastructure



Connected Devices = Exponential Growth

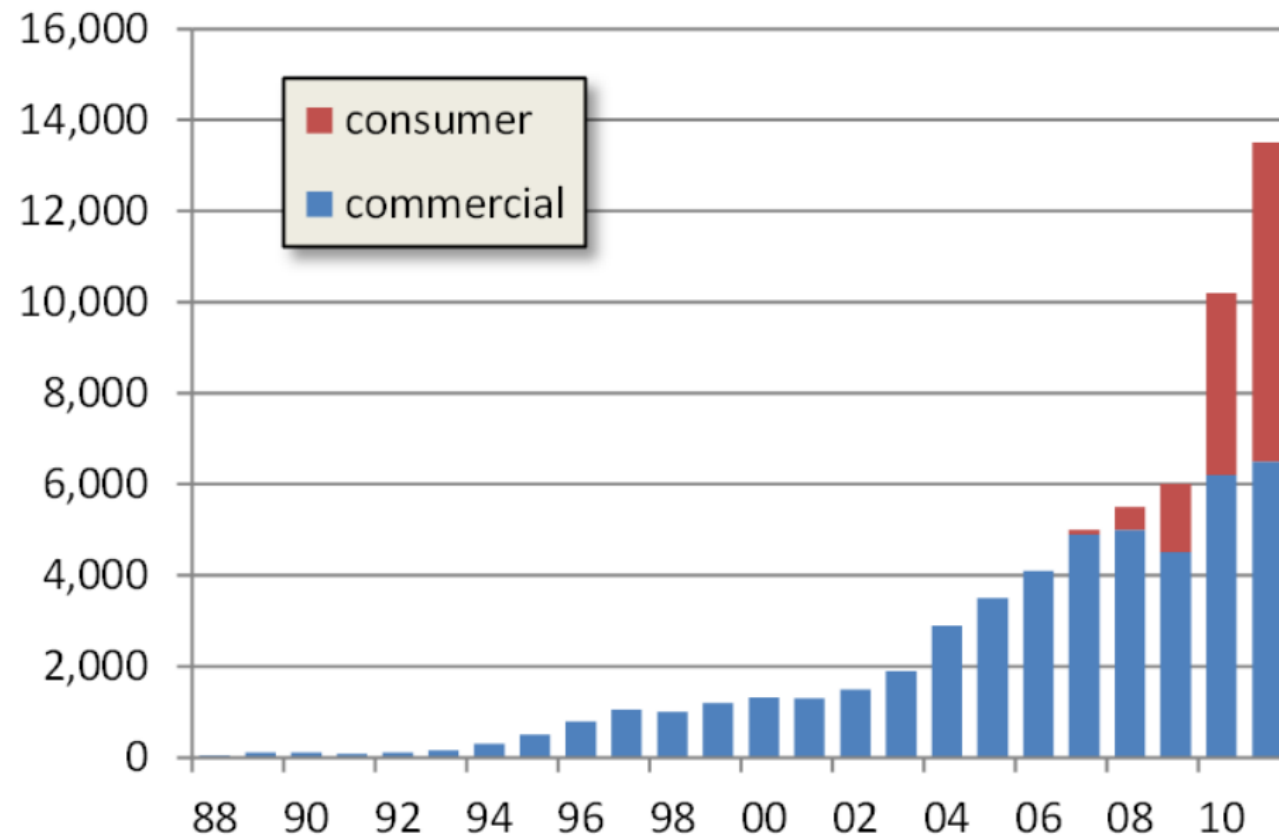


Digital Manufacturing/ 3D Printing

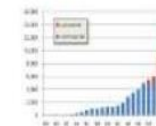
3D printers following the computer industry



Digital Manufacturing



Data: Wohlers report

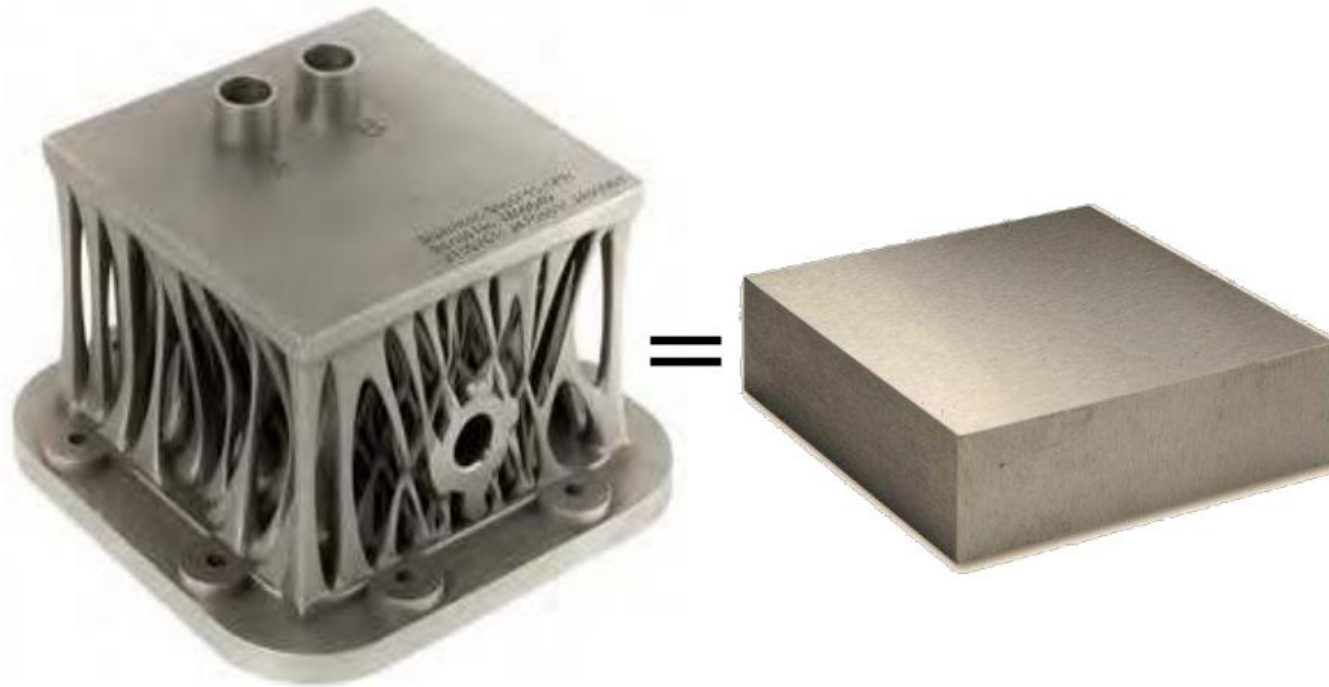


2014



2015

Disruption 1: Complexity is free



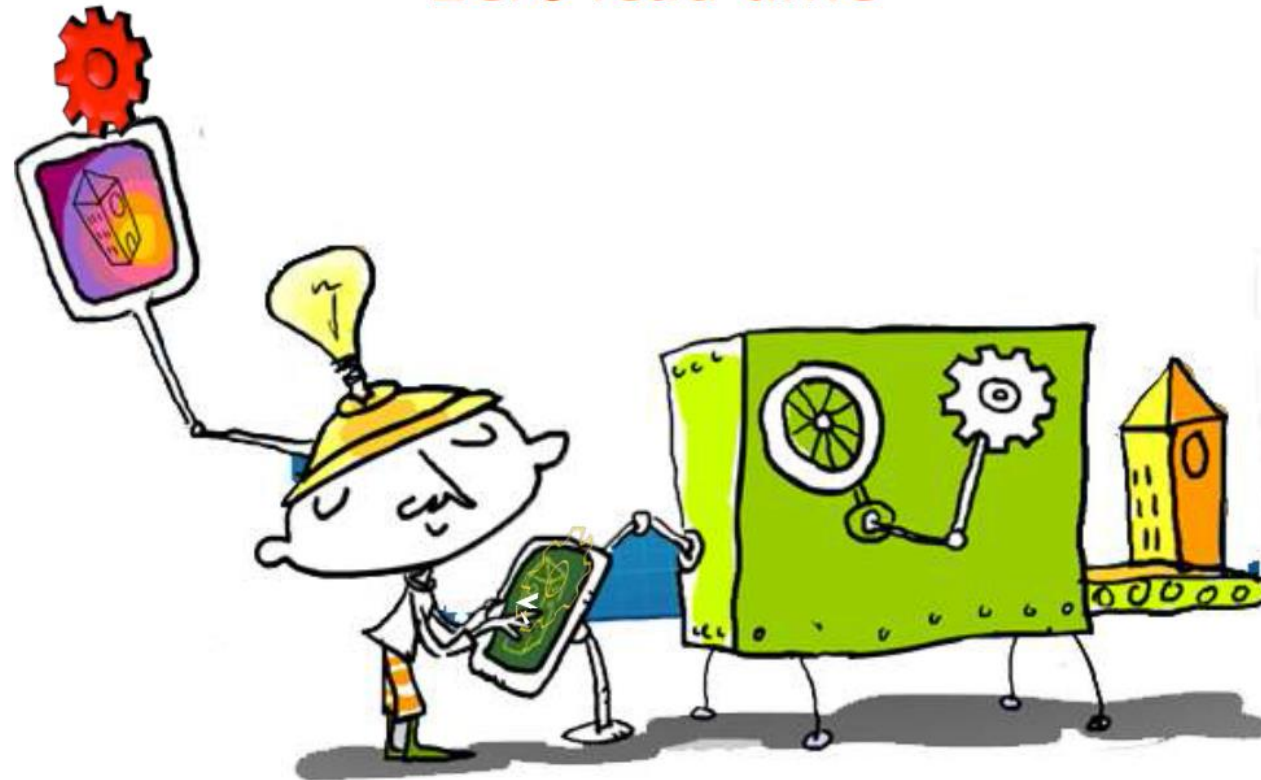


Disruption
No assembly required



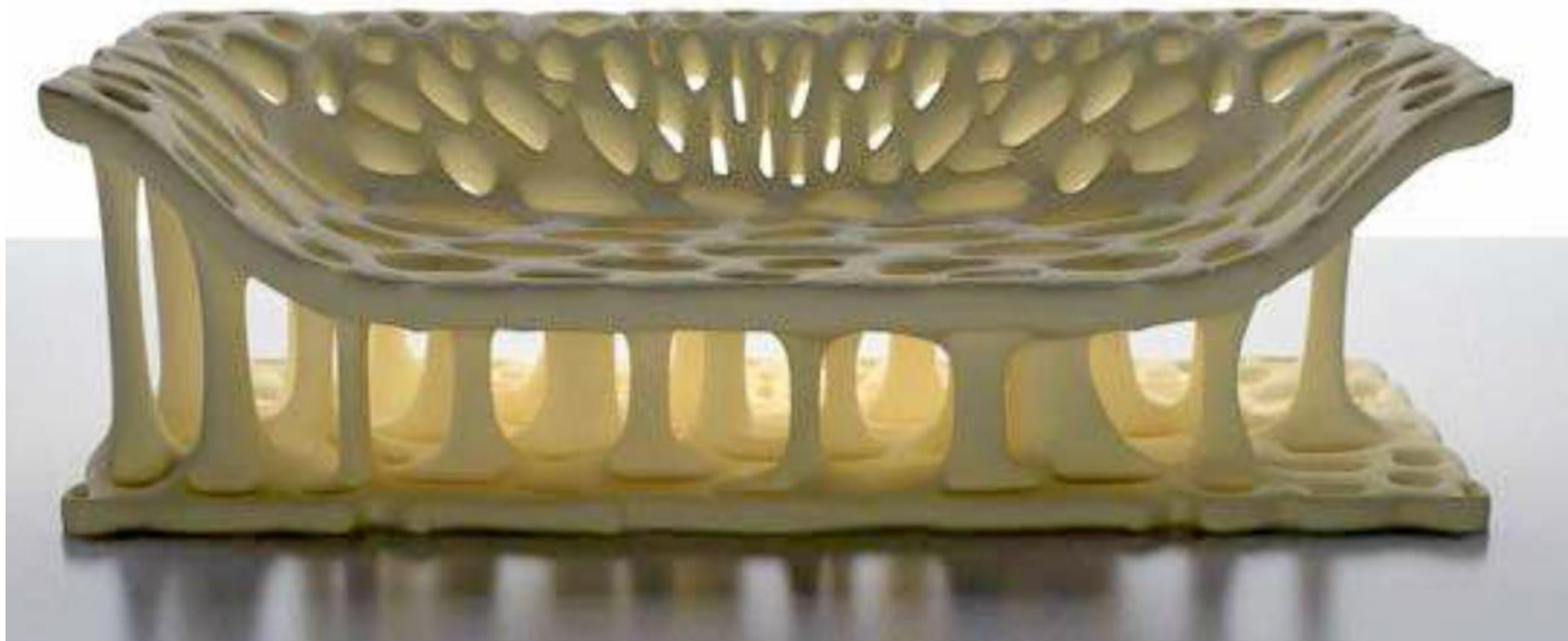
Disruption

Zero lead time



Disruption

Zero constraints



Disruption 8:
Less waste by-product



Disruption Zero skill manufacturing



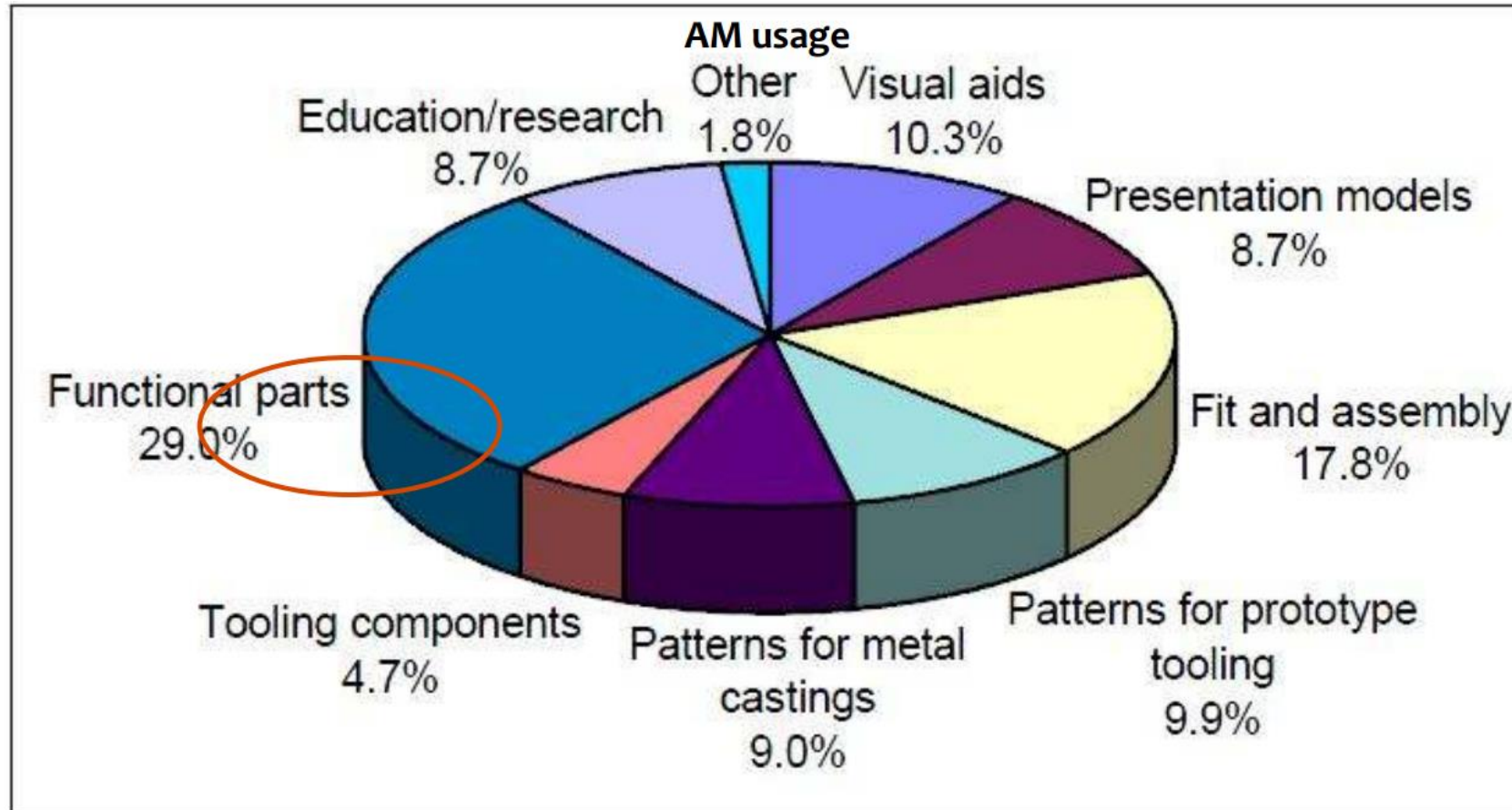
Image: Glen Bull, UVA

Digital Manufacturing



Disruption
Compact, portable
manufacturing

Digital Manufacturing

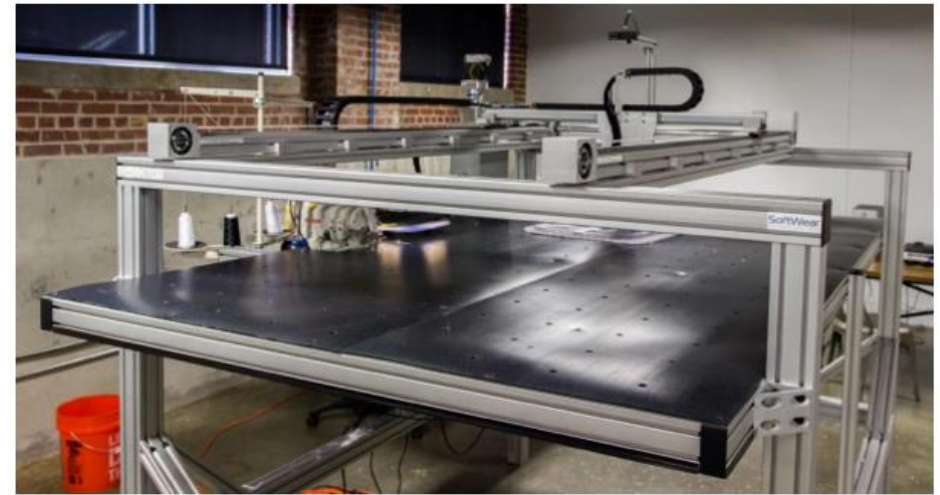


Source: Wohlers Report 2015

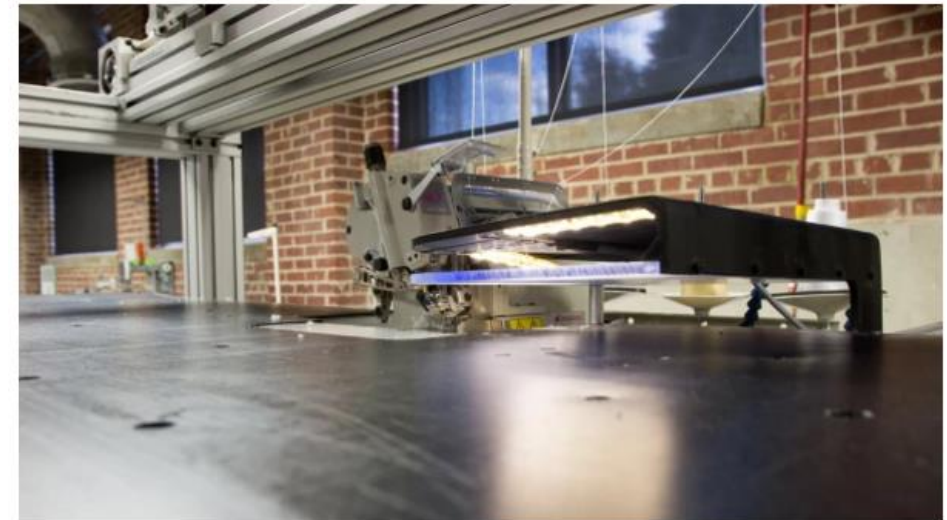
<https://www.fastcompany.com/40454692/this-t-shirt-sewing-robot-could-radically-shift-the-apparel-industry>

This T-Shirt Sewing Robot Could Radically Shift The Apparel Industry

In a soon-to-open Arkansas factory, 21 production lines manned by the Sewbot will be capable of making 1.2 million T-shirts a year—and the ripple effects will soon be felt in garment factories in the developing world.

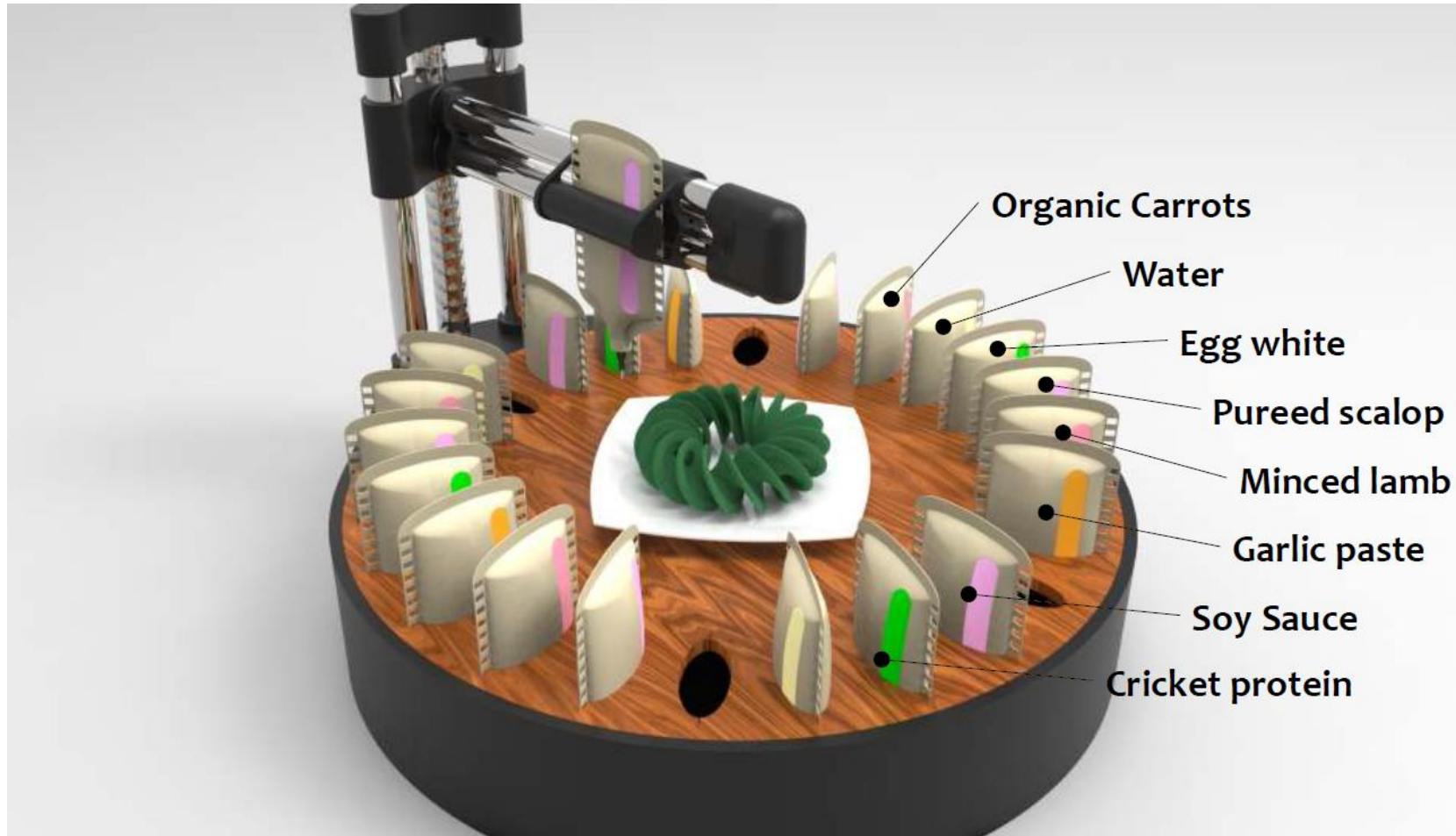


"What we did was approach it and look at it from how a seamstress actually operates." [Photo: courtesy SoftWear Automation]



"People buy 11 billion T-shirts a year. That's an interesting market where automation makes sense, where our robots make sense, because our robots produce a very high volume of product." [Photo: courtesy SoftWear Automation]

Digitally Manufactured breakfast?



Robotics (AI + Cameras + sensors)

Robots as we imagine them

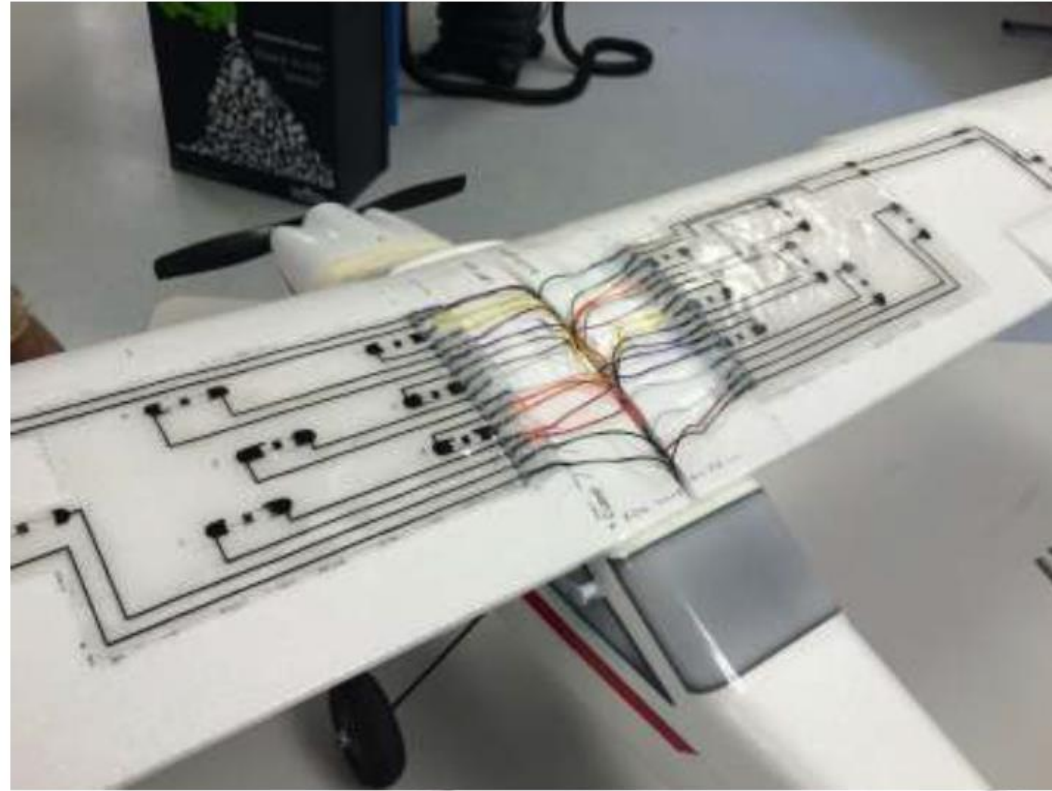


Micro-Robots open up IoT possibilities

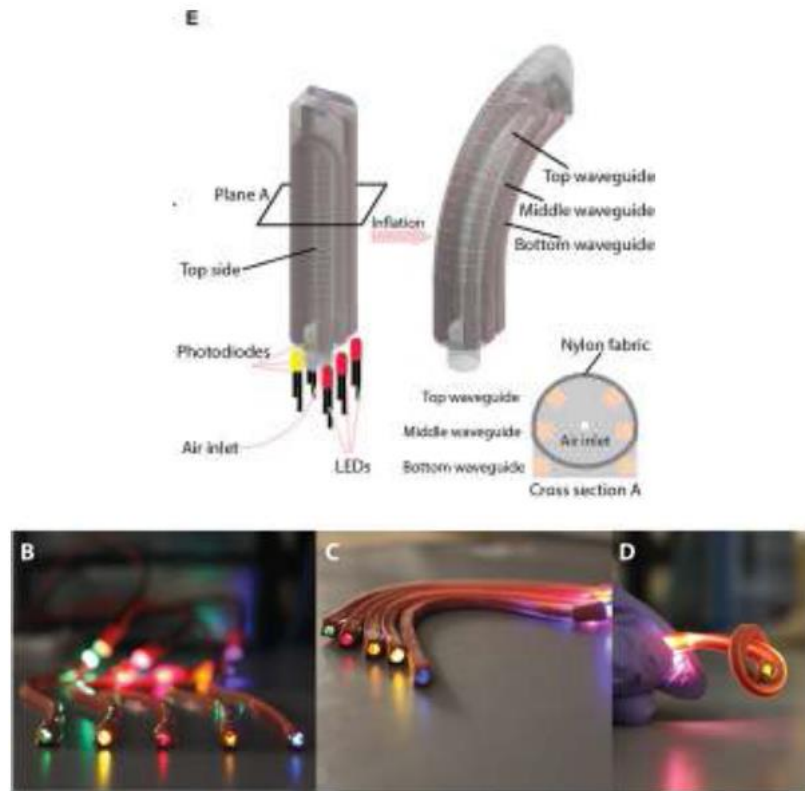


Small size reduces cost and opens up IoT for robots...

Soft Sensors for Robots open up “services”



Object Recognition for Soft Robots



Drones are flying robots



Just as Cars are computers / robots on wheels!

Robots will soon be everywhere ...

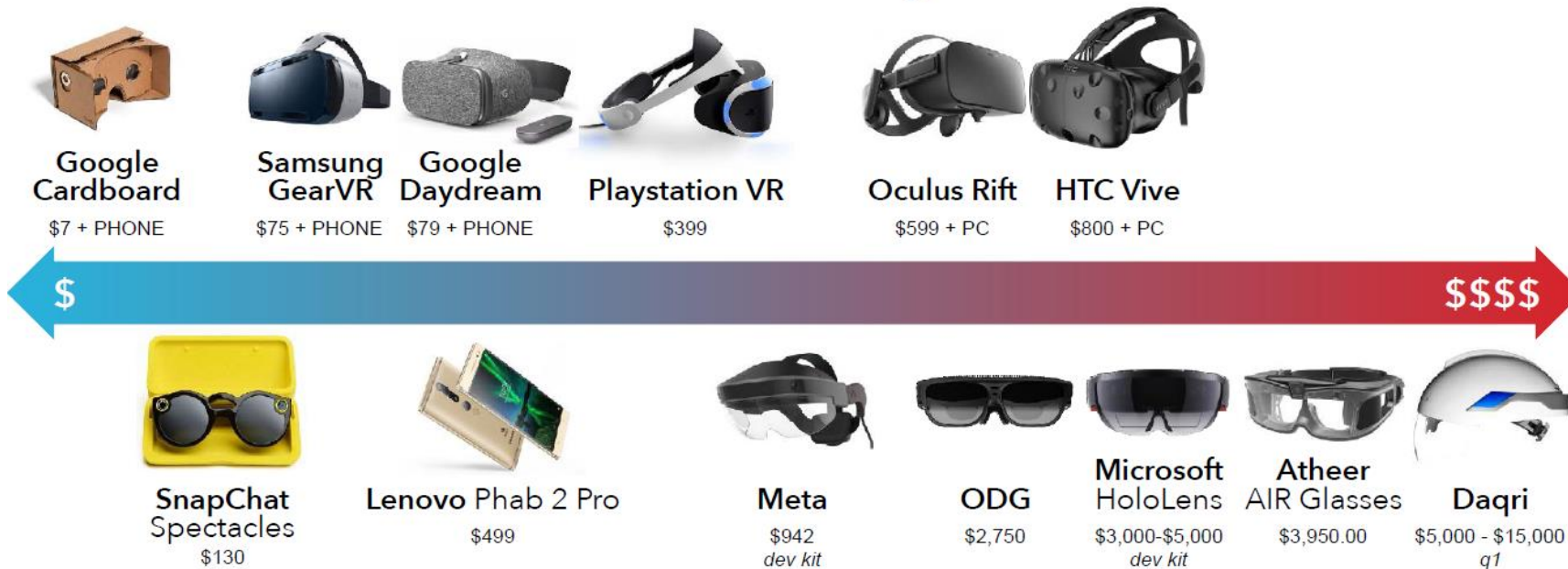


Robots will do more **on their own**, without the need for human intervention

Augmented and Virtual Reality

Virtual & Augmented Reality is here

Virtual Reality HMDs



Augmented Reality HMDs

Reality is not-so-exciting...



Virtual Reality



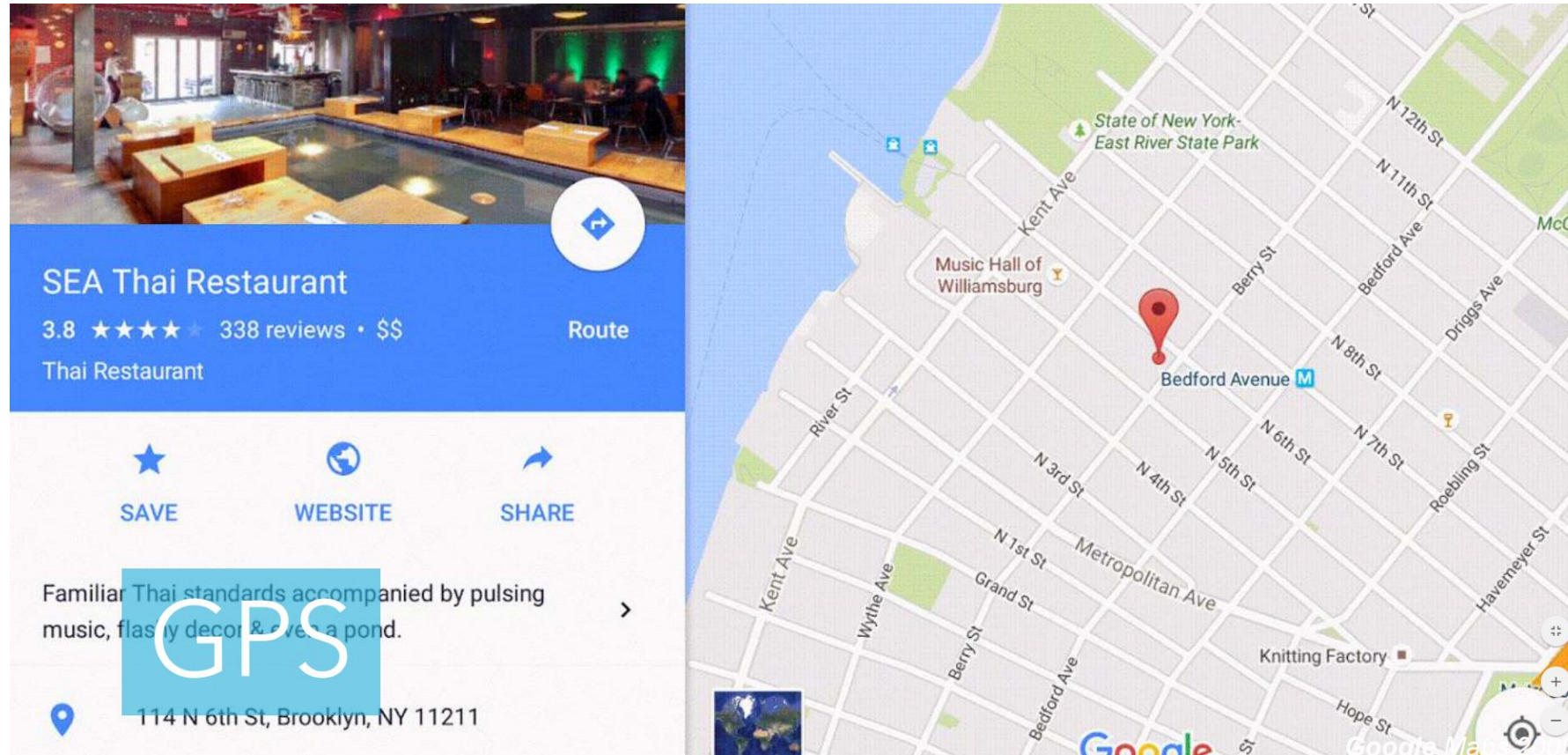
Virtual Reality is bring sports alive

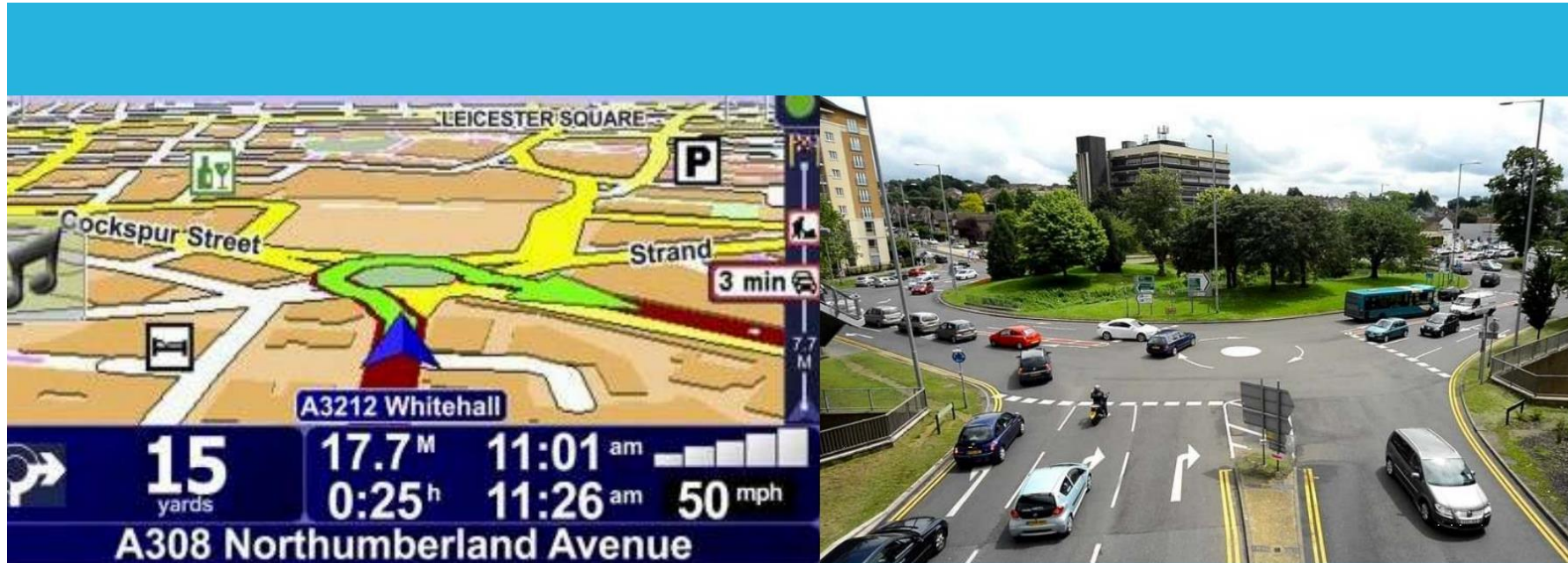


Augmented Reality

**You already use AR
everyday.**

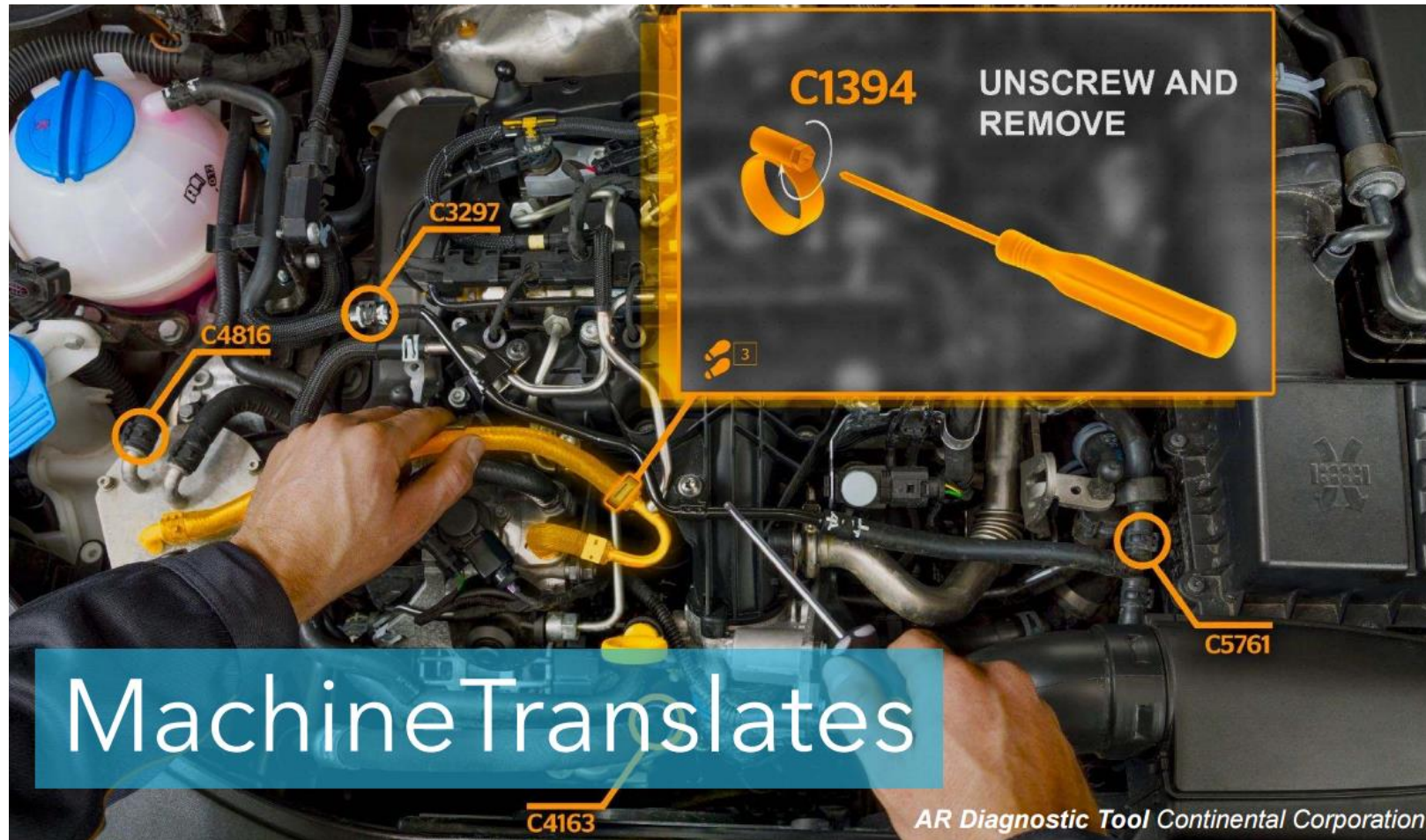
Augmented Reality GPS





Human Translates

Google Glass AR headset



AR = Virtual teleportation



Gaming/AR is the future of technology

I like video games. In fact, that's what got me into software engineering when I was a kid. I wanted to make money so I could buy a better computer so I could play better video games.

- Elon Musk, CEO Tesla & SpaceX, 10/16

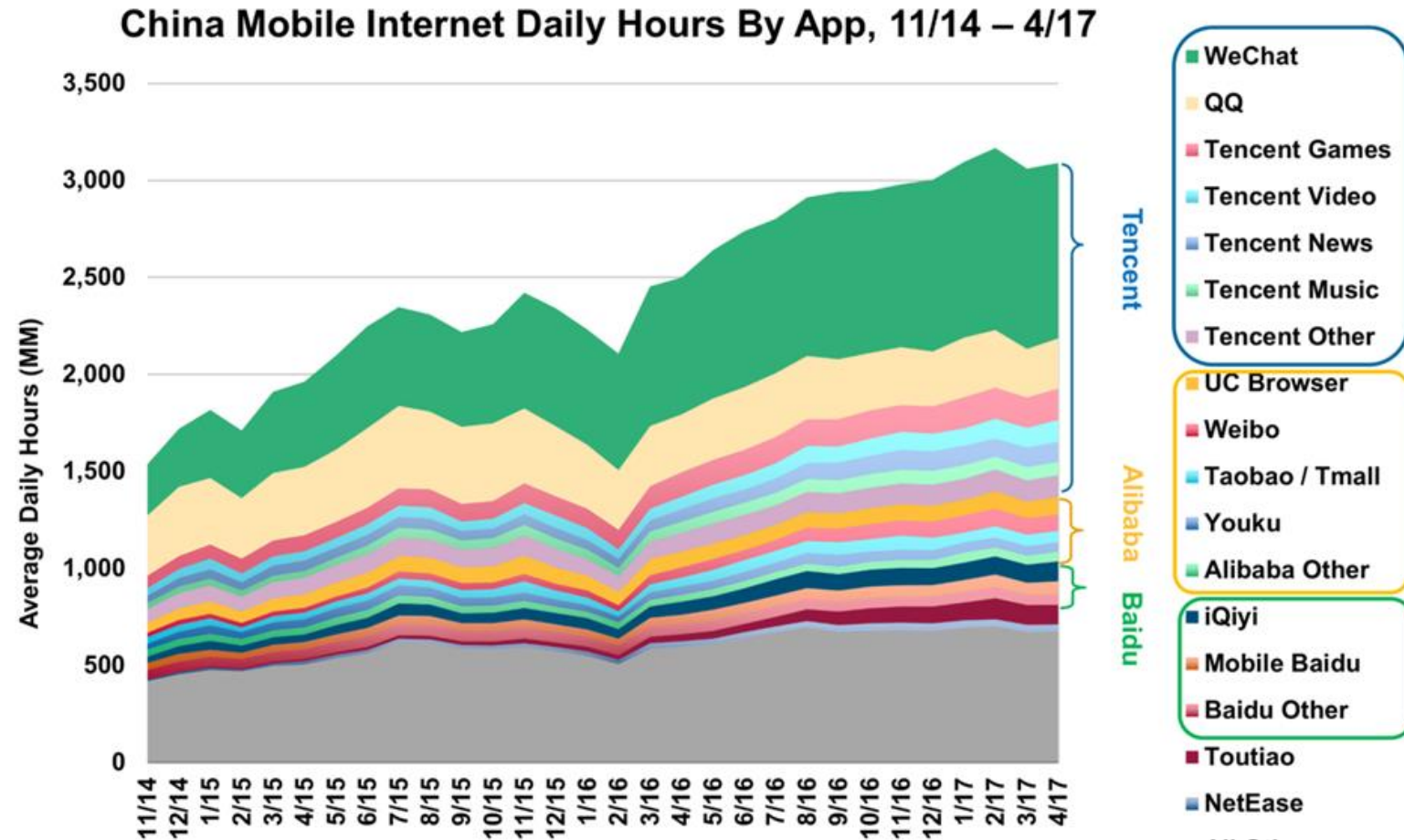
As a child I played a lot of Avalon Hill board games. And each board game is actually a complex set of rules and circumstances... So it was actually in fact my childhood gaming — for being able to build a model of what a game was — that was essentially the fundamental thing that informs my strategic sense.

- Reid Hoffman, Co-Founder of LinkedIn, 8/15

I do think this dynamic around kids growing up, building games, and playing games, is an important one because I think this is how a lot of kids get into programming. I definitely wouldn't have gotten into programming if I hadn't played games.

- Mark Zuckerberg, CEO Facebook, 5/15

China Mobile = Games + eCommerce



Financial Services being disrupted

KICKSTARTER

PROSPER

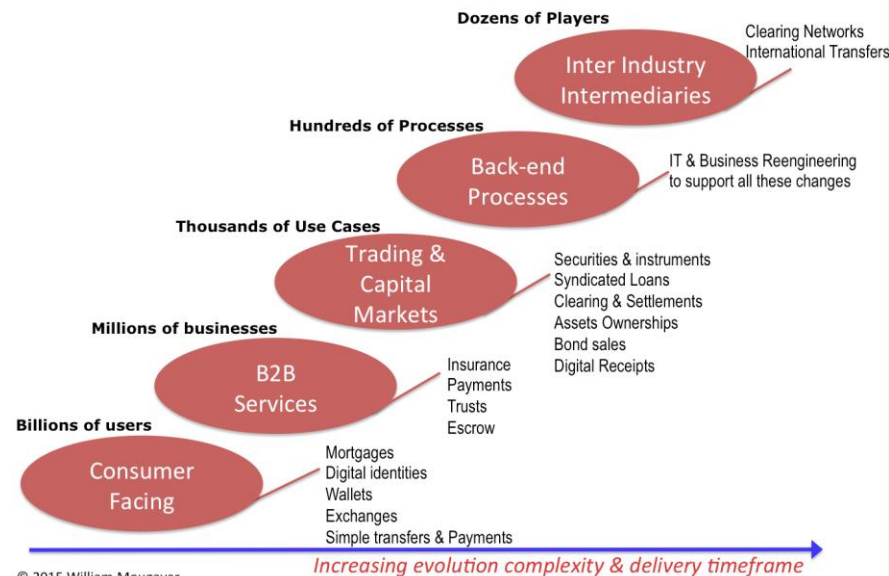
Betterment

Moven

venmo

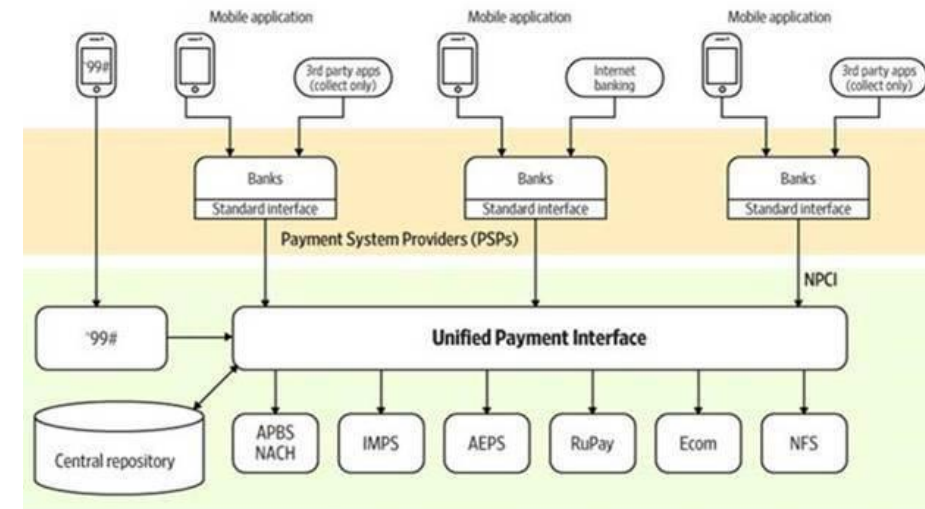
Square

Blockchain in Financial Services



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THE ARCHITECTURE OF UPI



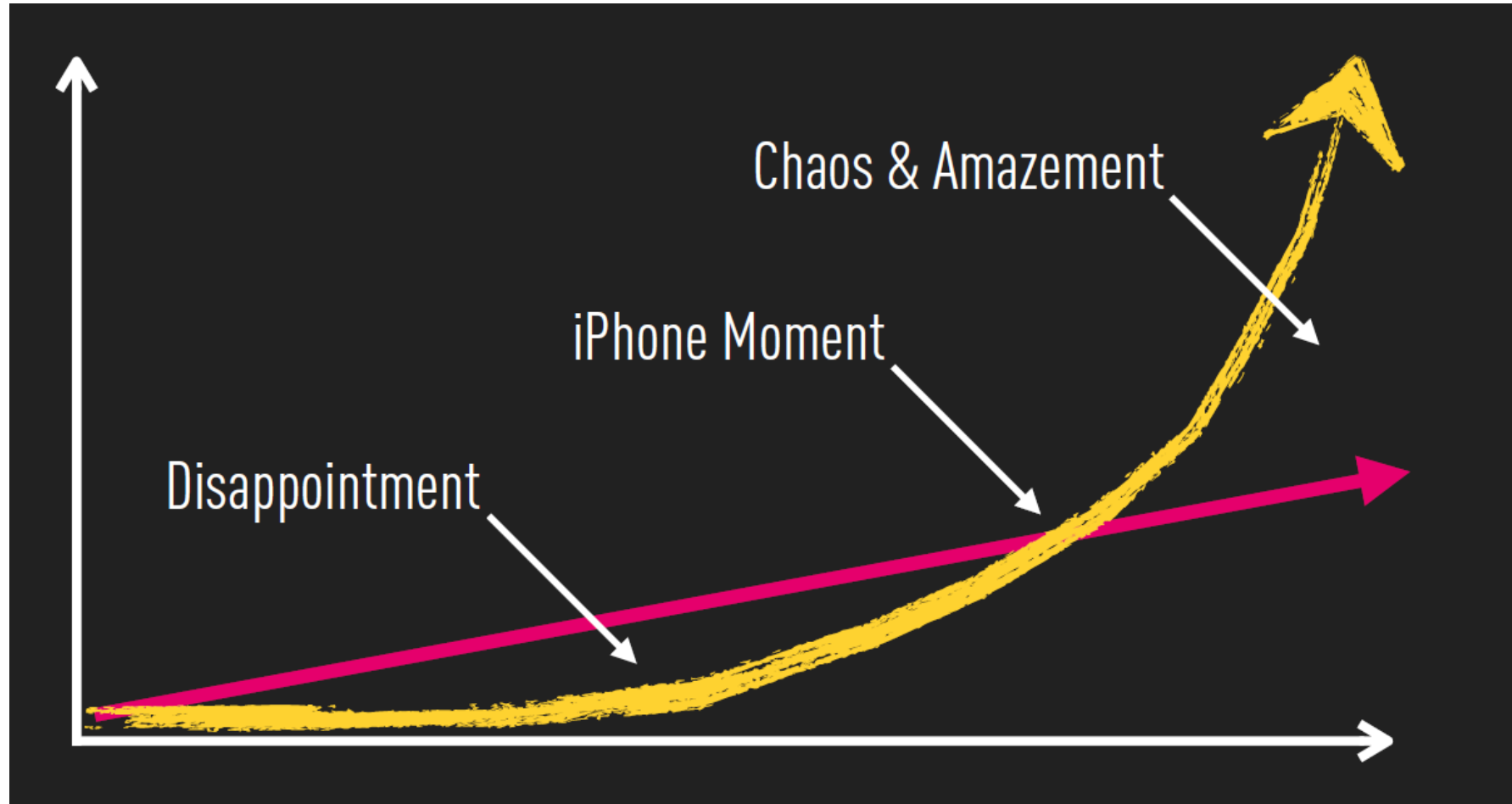
*99#: NPCI USSD service code to access banking service via phone.

Source: NPCI

Chinese Financial Services Platforms

	Payment	Wealth Management	Financing	Insurance	Credit Rating / History
Ant Financial	 支付宝 ALIPAY 451MM Annual Active Users ¹	 余额宝 YUE BAO >300MM Cumulative Users ²	 蚂蚁花呗 ANT CREDIT PAY 蚂蚁借呗 ANT CASH NOW 蚂蚁小贷 ANT MICRO LOAN >100MM Cumulative Consumer Finance Users ³ , >5MM Cumulative SME Borrowers ⁴	 蚂蚁保险服务 Ant Insurance Service 380MM Cumulative Users ⁵	 芝麻信用 ZHIMA CREDIT 130MM Cumulative Users ⁶
Tencent	 WeChat Pay >600MM MAU ⁷	 腾讯理财通 >80MM Cumulative Users ⁸	 微粒贷 >30MM Cumulative Users ⁹		 腾讯信用
JD Finance	 京东支付 JD Pay 119MM Annual Active Users ¹⁰	 小金库 JD Golden Wallet >20MM Cumulative Users ¹¹	 白条 Credit Pay 金条 Cash Loan 京保贝 JD Bao Bei >30MM Cumulative Users ¹¹	 保险 京东金融 JD Finance Insurance 168MM Cumulative Users ¹¹	 小白信用 JD credit >35MM Cumulative Users ¹¹

What will you disrupt?

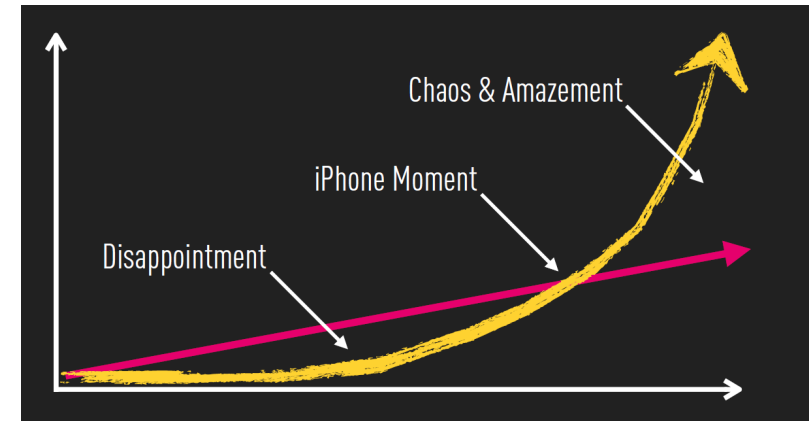


Tobacco: Heat not Burn tech is here



Success in Japan – menthol flavour market
Regulators find it less harmful
Energy costs/ Upfront costs ?

JUUL acquired for ~ USD 38 billion!
(revenues of ~ USD 2 billion)



Questions

**"He who knows all the
answers has not been
asked all the questions."
– Confucius**

