UX Design and Issues in IOT

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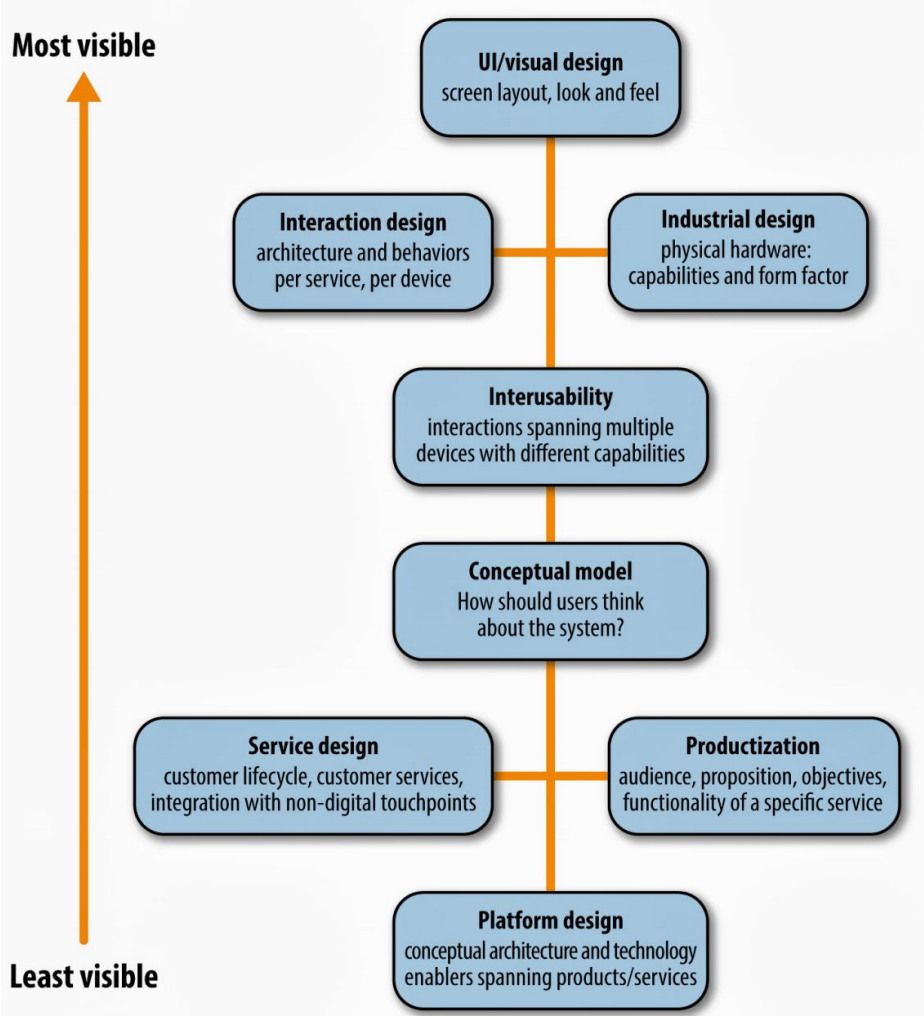
What is UX?

“User experience encompasses all aspects of the end-user's interaction with the company, its services, and its products.”

- *Don Norman and Jakob Nielsen of the Nielsen Norman Group*

UX is not just what user sees or interacts directly with but also the less visible, system-oriented and strategic alignment of the overall system as a whole.

It requires integrated thinking across all the layers.

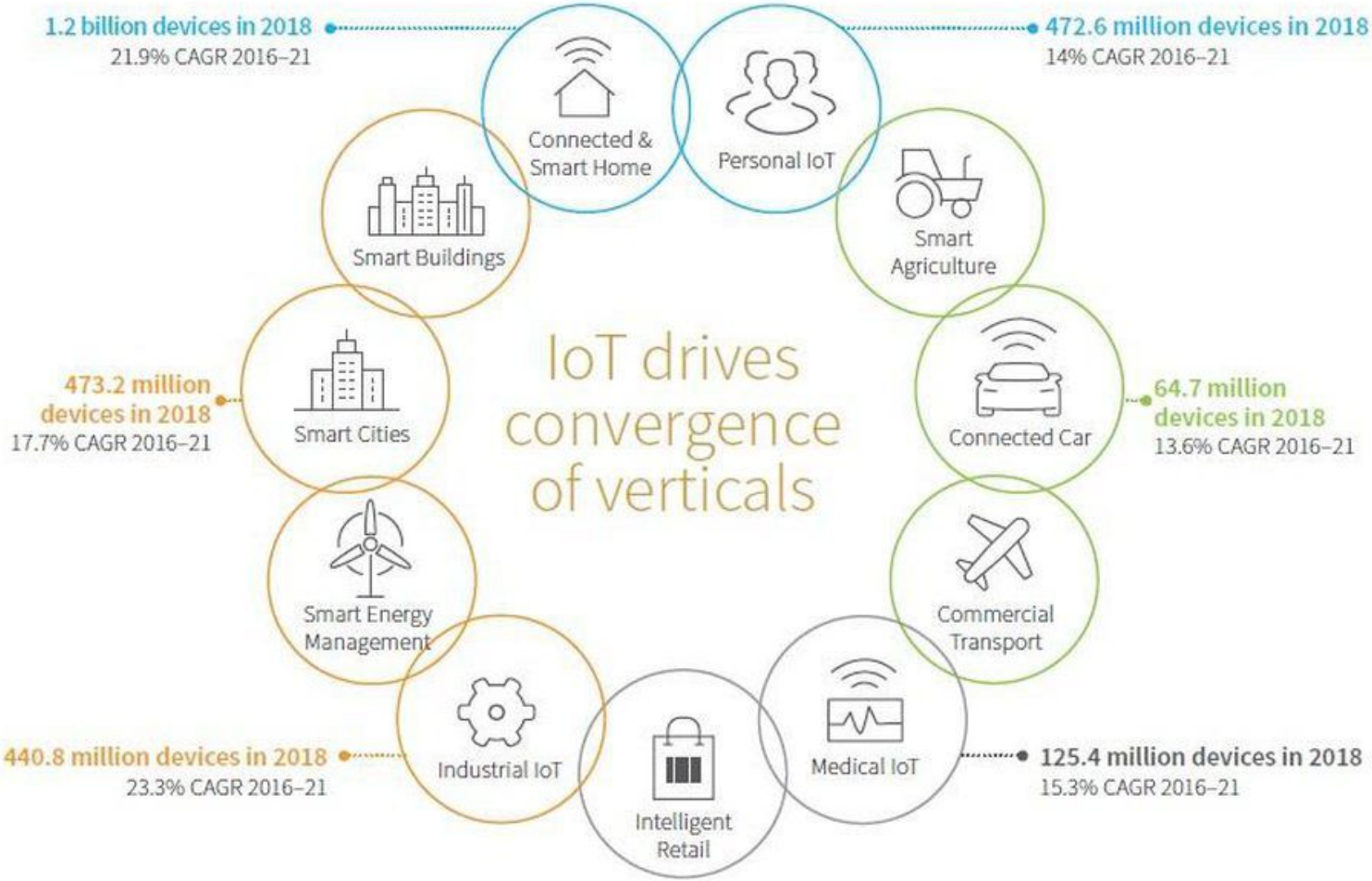


Source: User Experience Design for the Internet of Things (Claire Rowland with Martin Charlier)

IoT Market Opportunity

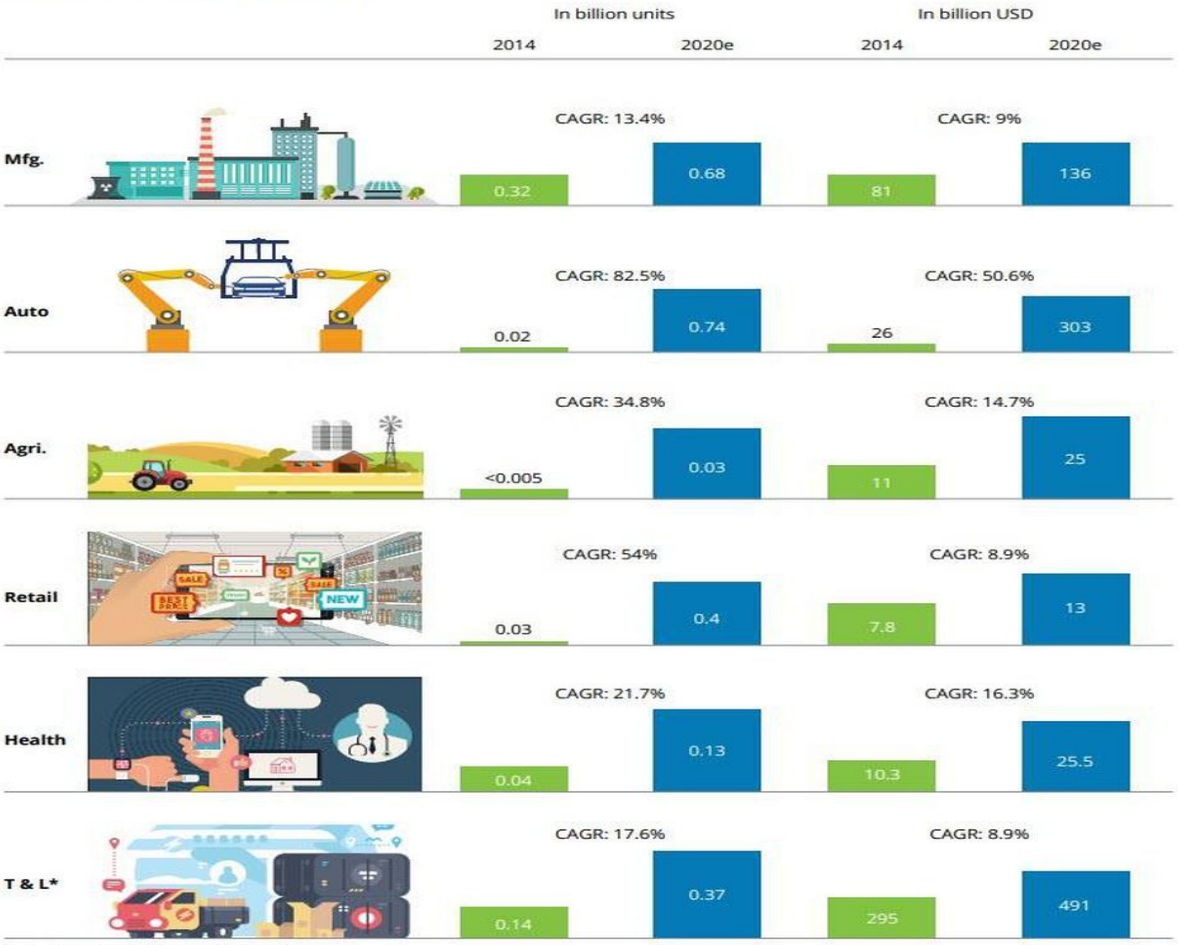
- Worldwide technology spending on the Internet of Things to reach $1.2T in 2022, attaining a compound annual growth rate (CAGR) of 13.6% over the 2017-2022 forecast period according to IDC.
  - Consumer sector will lead IoT spending growth with a worldwide CAGR of 19%, followed closely by the insurance and healthcare provider industries.
  - Discrete manufacturing and transportation will each exceed $150B in spending in 2022, making these the two largest industries for IoT spending.
- IoT Analytics predicts the global market for IoT expected to grow 37% from 2017 to $151B in 2018.
- IoT devices and services will reach an inflection point of 18% to 20% adoption in 2019. DBS Asian Insights is predicting that the IoT installed base will grow from 6.3M units in 2016 to 1.25B in 2030. Source: DBS Asian Insights, Internet of Things The Pillar of Artificial Intelligence, June 28, 2018

Read more at https://www.forbes.com/sites/louiscolumbus/2018/12/13/2018-roundup-of-internet-of-things-forecasts-and-market-estimates/



Source: IHS MARKIT, The Top Transformative Technologies to Watch This Year (2018)

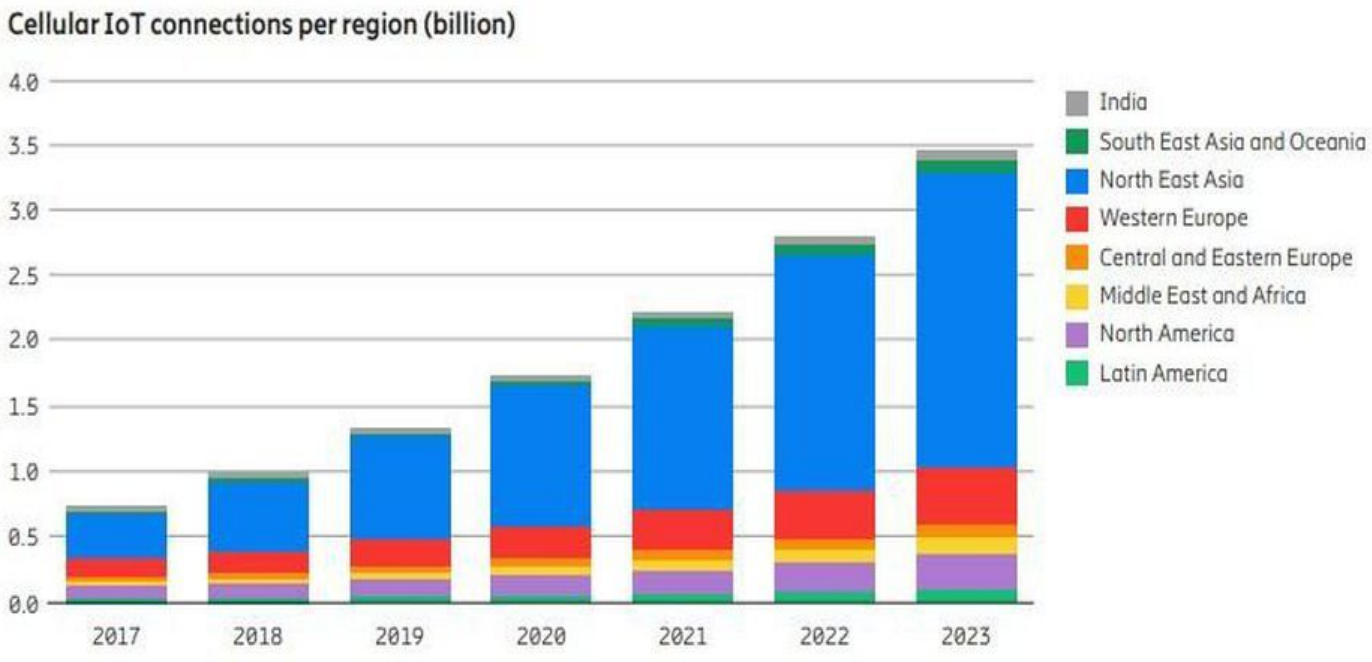
IoT Volumes and Revenues by industry



Source: Deloitte Analysis, Industry reports

Note: Manufacturing units include those from Natural Resources too, Retail units include those from Wholesale Trade, *T & L = Transportation & Logistics All numbers above include only industry specific units and not consumer units. However, units and revenue for Automotive are across industries

Cellular IoT Forecast



Ericcson is forecasting the number of cellular IoT connections is expected to reach 3.5B in 2023, increasing at a CAGR of 30%.

Forecast almost doubled due to ongoing large-scale deployments in China.

Of the 3.5B cellular IoT connections forecast for 2023, North East Asia is anticipated to account for 2.2B.
Source: Ericsson Mobility Report, June 2018

IOT Platforms and Market Segments

3 major IoT Platform Segments: Consumer, Enterprise, and Industrial

	Consumer IoT Platform	Industrial/Agricultural IoT Platform	Enterprise/Commercial IoT Platform
Use case	A car company needs to reach into the home to connect multiple devices to provide an “arriving home” service for consumers, The lights, music, thermostat and appliances are all automated through one application routine called, “I’m Home.”	Sensor data is collected from multiple gas tanks on a farm to monitor fuel levels, provide alerts when tanks are being tampered with and/or when fuel levels are low.	A lighting service is provided through a network of light bulbs that are placed throughout one building to provide a consistent level of lighting during the work day and turned off at night.
Customer	Individuals in the home	Machines, new or legacy systems or devices in a factory or on a farm	Large commercial building, retail space or offices

Source: https://www.yonomi.co/blog/2018/5/10/consumer-enterprise-and-industrial-iot-platforms-whats-the-difference

More Enterprise and Industrial IoT Examples

- IoT applied in healthcare whereby patients are monitored by physicians who can then consult with their patients via IoT devices that enable live video and audio streaming from anywhere
- Wearable devices provide a sense of security for family members of those with Alzheimer's or autism who might be prone to wandering away from safety
- RFID tags used in retail help keep inventories in check, ensuring items remain in stock and available for customers both online and in stores
- Rockwell Automation's IoT solutions allow its customers to monitor unmanned remote assets, predict equipment failure, avoid the cost of deploying traditional on-premises servers, and boost performance through reduced downtime and optimized processes.
- IoT applied to facilities management will enable the optimization of ventilation, lighting and temperature for efficiency, safety and operational performance
- IoT applied to food safety and the cold chain will improve toxicity testing, refrigeration leak detection, safety and regulatory compliance with remote temperature monitoring
- IoT applied to fleet and asset management will enable industrial field equipment tracking and telematics for tank monitoring
- IoT applied to environmental monitoring will enable greater insight into usage patterns and conservation opportunities for utilities including water, gas and electricity.

Why does UX Matter for IoT?

- **IoT Consumer Examples**
  - Smart watches and fitness trackers
    - Pebble, Android, and Apple watches, Fitbit, Jawbone, Basis bands
  - Smart home devices
    - Wally's smart water leak sensors, Phillips' Hue smart lighting, Cocoon's smart home security, and Google's Nest smart thermostat, Roomba
  - Self-driving cars (levels 0-5)
    - Level 2 (partial automation): Mercedes-Benz Driver Assistance Systems, Audi Traffic Jam Assist, Cadillac Super Cruise.
    - Level 3 (conditional automation): Audi's Traffic Jam Pilot
- User experience (UX) creates value for end users by improving usability, accessibility, and interaction

Good UX is about understanding and then **meeting user expectations**.

Great UX is about understanding and then **exceeding user expectations**.

What happens when you get it wrong?

What Is The World's Most Useless Internet of Things Device?

Source: 9to5mac.com

Early Apple Watch

- Complex and confusing
- Too many icons
- Hard for wide, large fingers to navigate
- Hard for aging eyes to see small icons
- Needed 2 hands to use it
- Overwhelming notifications
- Awkward screen activation issues
- Slow speeds
- Some unexpected conflicts with cultural norms...

Unintended Consequences

- Nest’s wave-to-hush feature allowed users to silence the smoke alarm
- It was deactivated when it was realized that users might wave their arms in panic during a real fire and unintentionally deactivate the alarm

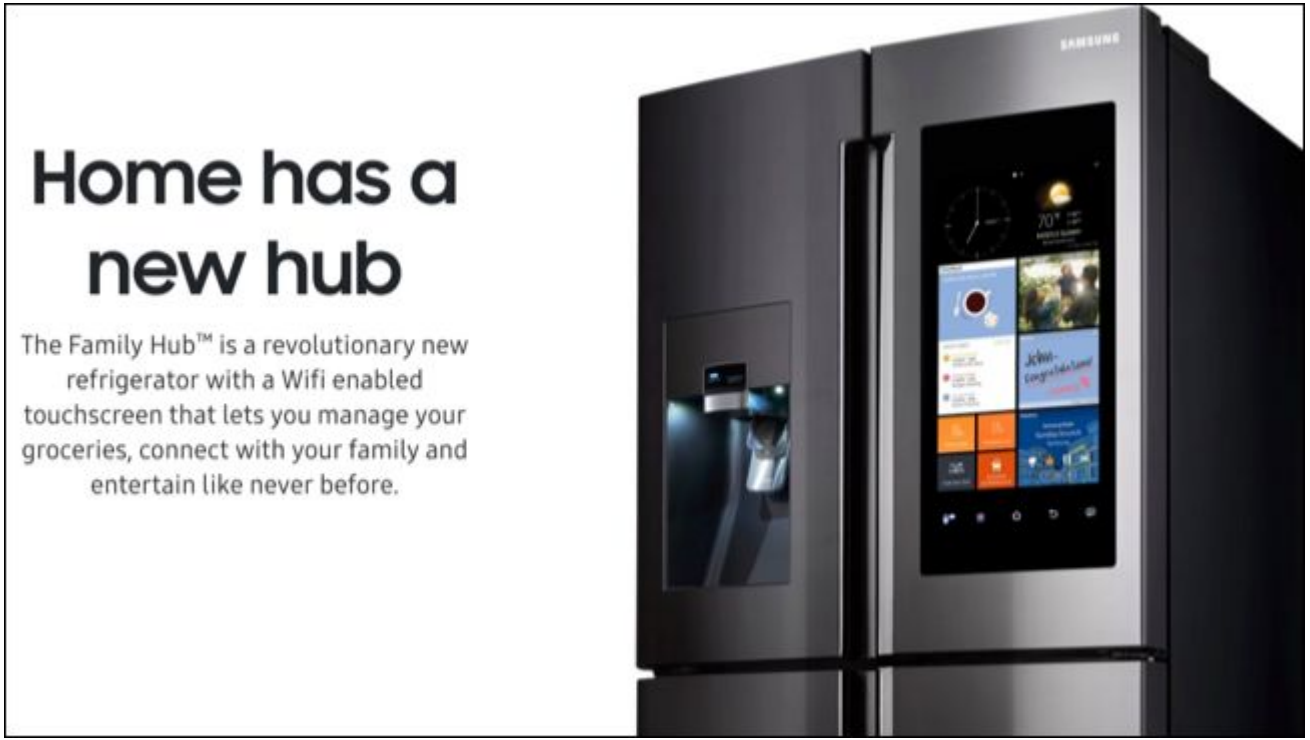
Source: Nest

Unintended Cultural Consequences

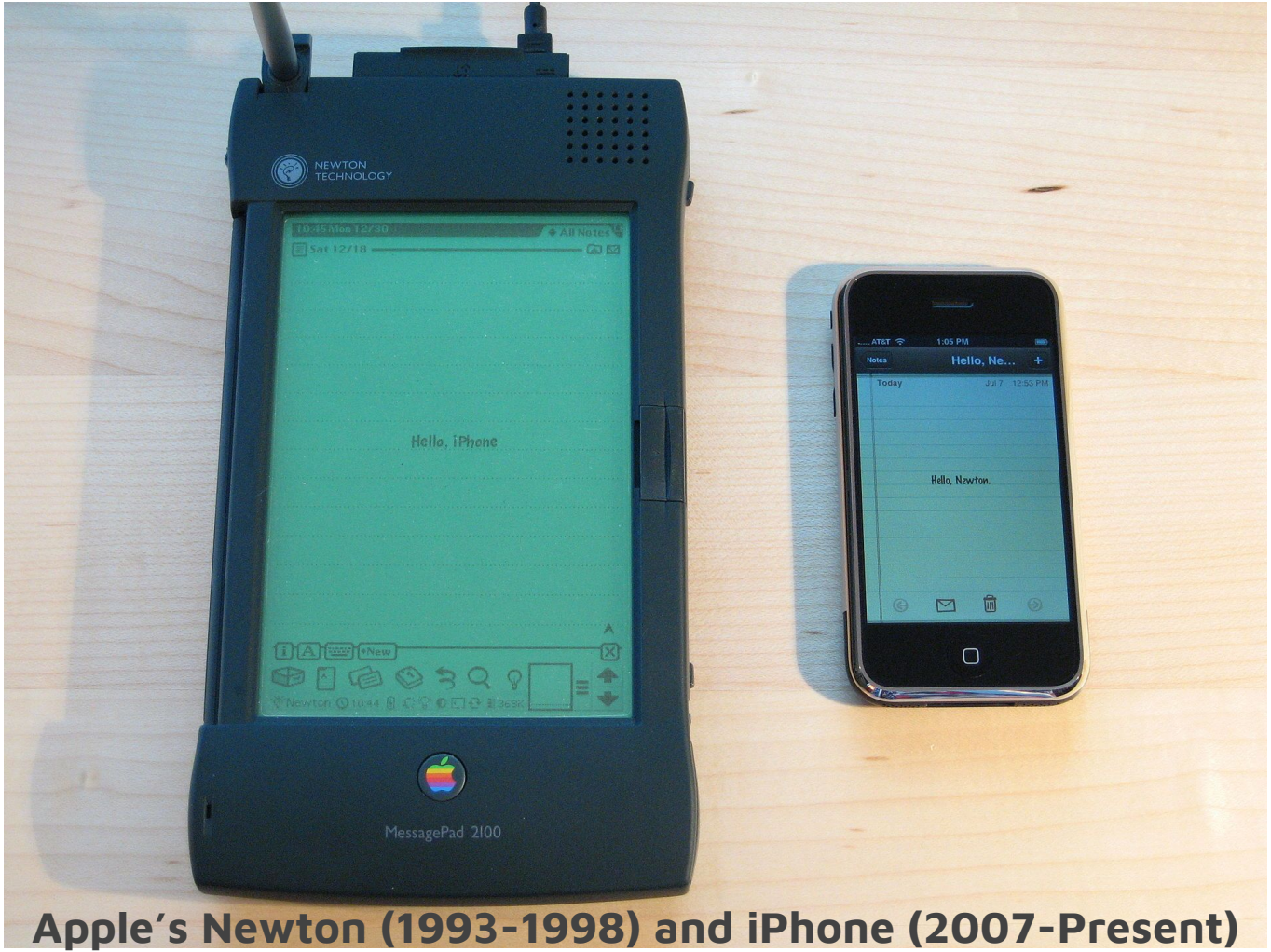
“It turns out that checking your Watch over and over again is a gesture that carries a lot of cultural weight,” said Patel. “Eventually, Sonia asks me if I need to be somewhere else. We’re both embarrassed, and I’ve mostly just ignored everyone.” - The Verge’s Patel

“All these new functions, notifications, and tapping do make the Apple Watch very distracting. In some ways, it can be more distracting than your iPhone, and checking it can feel more offensive to people around you than pulling out your phone. The watch wants and needs you now, as its insistent taps make painfully clear.... If while you’re talking to someone, you check your regular watch, it can feel as if you’re sending a not-so-subtle ‘let’s wrap this up’ message. With the Apple Watch, factoring in the animated wrist-whip and the length of some of the notifications you receive, it’s downright rude.” - Bloomberg’s Topolsky

Samsung Smart Fridge



Source: Samsung



Apple's Newton (1993-1998) and iPhone (2007-Present)

Source: Wikipedia

Listen for Pain Points

- “We’re spending too much money on inventory because we don’t know what’s on our shelves.”
- “Our salespeople spend too much time calling customers to see whether they need to replenish their supplies.”
- “The downtime on our equipment is costing our customers too much money.”
- “Our mobile repair people never have the right parts with them when they go on a service call.”
- “Our margins are shrinking and we need to reduce the cost of servicing our equipment.”
- “We’re in a highly competitive space and we need to enhance the value of our products and services.”
- “We need to increase the “stickiness” of our products and services to increase customer loyalty.

Why UX for IoT Is Different?

- Specialized nature of IoT devices
- Ability to bridge the digital and physical worlds
- Many IoT products are distributed systems of multiple devices
- Quirks of networking
- Maturity of technology
- Context of use, or user expectations
- Complexity of the service (e.g. number of devices user interacts with to use it)

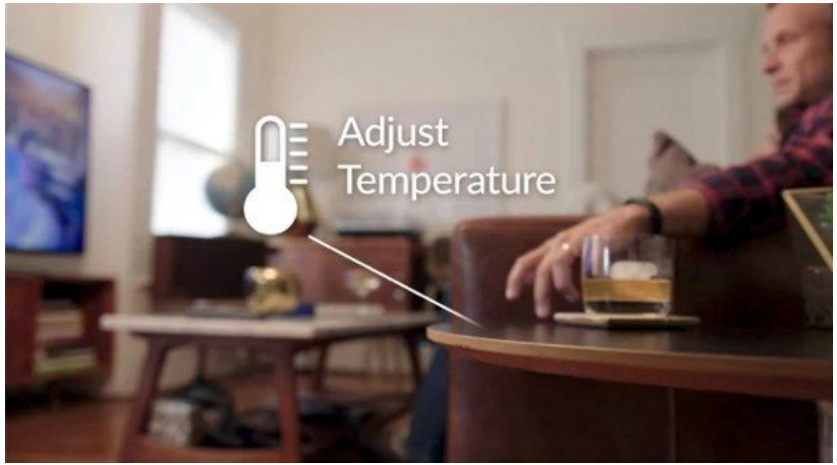
New Opportunities in UI and Interaction Design

Input	Where It May be Used
Touch, Press	Physical controls, touchscreen
Movement and manipulation	Tangible UIs
Speech	Speech recognition, Voice searches
Whole body	Gesture recognition, proximity sensing
Galvanic skin response	Stress detection
Thoughts	Brain-computer interfaces
Heart rate	Determining stress, anxiety, sleep

New Opportunities in UI and Interaction Design (contd.)

Output	Where It May be Used
Seeing	LEDs, screens, glasses
Hearing	Sound, voice output, knocking
Tactile sensing	Vibration, force feedback, shape
Smell	Scent messaging
Temperature sensing	Temperature output

Rethinking Knocking



Source: TechTarget

Knock [anywhere] as an interface, via Knocki

- Knocki converts any ordinary surface into a control interface
- Triggered by how many times a user knocks on a surface
- Users can customize (via mobile app) what specific actions are triggered by number of knocks.
- Examples: users can program complex requests like knocking twice to automatically push snooze on the alarm and start the coffee maker, or simple ones like knocking three times to locate a lost smartphone.

Hands as an Interface

Source: TechTarget

Hand as an interface, via Augumenta

- Augumenta combining hardware (connected eyewear), software, augmented reality and body as an interface.
- When wearing smart glasses, users' own hands become configurable dashboards, keypads, sliders, control knobs, etc.
- You can use hand gestures to operate machine controls.
- Augumenta offers its SDK to developers and is working with leading industrial device and controls suppliers to prove industrial use cases, with a long-term objective of supporting consumer AR use cases

The Top 3

Designing great UX and UI in the IoT relies on 3 core principles:

simplicity, interoperability and value appreciation

Design Lesson #1: Make It Easy to Use

Source: TechTarget

What Simple Looks Like

- Voice interaction primary; mobile app secondary
- Simple setup
- Minimal aesthetic design
- Offers frequent suggestions for exploring device capabilities
- Machine learning enabling speech recognition optimization and personalization over time
- Weekly emails communicating new features and how to sample them

Design Lesson #2: Interoperable and Ecosystem-driven

Source: TechTarget

Interoperability and Ecosystem

- Interoperability across Amazon devices
- Interoperability across dozens of other connected devices
- Interoperability across dozens of other service providers through APIs
- Open SDKs offer integration capabilities for anyone (enterprise, startup, DIY)
- Machine-learning capabilities allow constituencies to observe user adoption and preferences

Design Lesson #3: Value Appreciates over Time

- Device learns user behaviors over time (individual and across broader user base)
- Users enjoy more features (including new skills) over time
- Sensors and software collect information designed to inform improvements and decision-making
- Interoperability allows device to support broadening range of use cases
- Supports new revenue for Amazon through enabling new partnerships
- Supports new (in-home) channel for partners' customer programs

Key Design Takeaways

- Enhance the Experience
  - What if my coffee pot were connected to my watch? Why and how?
- Physical context
  - Environment conditions, e.g. noise, weather, noise interference
  - Don’t assume always-on internet connectivity, network latency, etc.
- Upgradeable
  - Not every device has short life cycles. E.g. washing machines have a 5-10 year lifespan
- Extendable
  - API to enable interactions between devices
- Secure
  - Design for security from the outset, privacy

Other Design Considerations

- Regulatory Requirements
  - Radio interference, waste recycling standards, safety, etc.
- Accessibility
  - Disabilities, e.g. sensory, motor, cognitive)
- Consistency
  - “Users should not have to worry whether different words, situation or actions mean the same thing. Follow platform conventions.” - Jakob Nielsen
- Social Impact and relationships
  - Social, cultural, legal and ethical issues
  - Social Internet of Things (SIoT)

IoT is Not a Strategy!

- IoT is an enabler
- IoT is a toolbox you can use to fix a business problem
- You need to identify that business problem first
- If you start by asking, “How does IoT fit into our business?” you’re already going down the wrong path!
- Embrace design thinking and a holistic view when designing an IoT solution