- the postal service, telephone ... to keep us our family and friend
- Ex: In story:
- for *Effortless Mobility* invented **flying carpets**, and even teleportation.
- In reality:
- Through technology, we have invented cars and railways, bicycles, and **aeroplanes.**
- The need for ***Creative Expression***
- Ex: in stories by the enchanted paintbrushes and magic flutes
- In reality:
- from charcoal to paint to computer graphics, or from drums to violins and electronic synthesisers.
- So, **technology** has always been associated with **magic,** and so this will be true almost by default for the Internet of Things.
- A **key element** of many enchanted objects is that above and beyond their practical enchantment they are given a name and a personality—implying an **intelligence greater than strictly necessary to carry out the task for which they are designed.**
- so our connected devices, or Things, have processing and communicating capabilities well beyond the needs of the average lamp or umbrella.
- **WHO IS MAKING THE INTERNET OF THINGS?**
- There are many crossover points between all the disciplines listed.
- Artists may collaborate with designers on installations or with traditional craftspeople on printmaking.
- Designers and engineers work closely to make industrial products, and hobbyist "hackers" (in the sense of tinkerers (unskilled person).
- In the Internet of Things:
- A hacker might tinker at the prototype for a Thing;
- A software developer might write the online component;
- A designer might turn the ugly prototype into a thing of beauty, possibly invoking the skills of a craftsperson
- And an engineer might be required to solve difficult technical challenges, especially in scaling up to production.

Chapter 2
DESIGN PRINCIPLES FOR CONNECTED DEVICES

- **CALM AND AMBIENT TECHNOLOGY:**
- ubicomp is often also referred to as *ambient computing*.
- the term "**ambient**" is **not** something to which we **actively pay attention** and in some cases as something which we seek to remove (e.g., ambient noise in a sound recording).
- the term ***calm** technology*—systems which **don't compete for attention** yet are ready to provide utility or useful information when we decide to give them some attention.

- Proliferation of computing devices into the world comes with all manner of new challenges.
- Issues include configuration, **how to provide power to all these items**, **how they talk to each other, and how they communicate with us.**
- The **networking challenges.**
- **Configuration and user interaction**, however, obviously **involve people** and **so** are **difficult** problems **to solve with just technical solutions.**
- This is where **good design can aid in adoption and usability.**
- Designing a connected device in isolation is likely to lead you to design decisions which aren't ideal when that object or service is placed into the real world.
- In addition to thinking of a device in the physical context one step larger—**"Always design a thing by considering it in its next larger context"** —
- a chair in a room, a room in a house, a house in an environment, an environment in a city plan"—we should do the same for the services.
- For **connected devices** which are just sensing their world, (or **acting as *inputs***), as long as their activity **doesn't require them to query the people** around them, there **shouldn't be any issues**.
- They will **collect information** and **deposit it into some repository online** for processing or analysis.
- When the **devices start interacting with people**, **things get more complicated.**
- Already we're seeing the **number of notifications, pop-ups, and indicator noises on our computers and mobile phones proliferate.**
- **When we scale up this number to include hundreds of new services and applications** and then spread that across the rest of the objects in our world, **it will become an attention-seeking cacophony (an unpleasant mixture of loud sounds).**
- **an antidote** to such a problem is to **design ubicomp** computing systems **to seek to blend into their surroundings;** in so doing, we could keep them in our peripheral perception until the right time to take centre stage:
- ***Calm technology engages both the center and the periphery of our attention, and in fact moves back and forth between the two.***
- A great example of this approach is ***Live Wire***, one of the first Internet of Things devices.
- Live Wire (also sometimes called **Dangling String**) is a simple device: **an electric motor connected to an eight-foot long piece of plastic string.**
- The **power** for the motor is **provided by the data transmissions on the Ethernet network** to which it is connected, so **it twitches whenever a packet of information is sent across the network**.
- Under normal, **light network load,** the string **twitches** (sudden jerk) **occasionally.**
- If the network is **overloaded**, the **string whirls madly**, **accompanied by a distinctive noise** from the motor's activity.
- Conversely, if **no network activity** is occurring, an unusual **stillness** comes over the string.

- Both extremes of activity therefore alert the nearby human
- The mention of the distinctive sound from the motor when the Live Wire is under heavy load brings up another interesting point.
- **Moving the means of conveying information away from screens and into the real world often adds a new dimension to the notification.**

MAGIC AS METAPHOR:

- In addition to the technology becoming capable of a particular action, **we** often **need *society***, to be **ready to accept it**.
- There are many examples when the **main difference between a failed technology and** a wildly **successful one is** that the **successful one arrived a few years later, when people were more receptive to what was offered.**
- Technology blogger Venkatesh Rao came up with a good **term** to help **explain how new technology becomes adopted.**
- He posits (suggest something as a basic fact) that **we don't see the present, the world that we live in now, as something that is changing.**
- **If we step back for a second, we do *know* that it has changed**.
- Rao called this concept **the *manufactured normalcy*** *(situation in which everythong is normal)* ***field.***
- **For a technology to be adopted, it has to make its way inside the manufactured normalcy field.**
- As a result, the **successful user-experience designer** is the one **who presents users with an experience which doesn't stretch the boundaries of their particular normalcy field too far, even if the underlying technology being employed is a huge leap ahead of the norm.**
- For example, the **mobile phone** was first introduced as a **phone that wasn't tethered to a particular location.**
- Now broadly the **same technology** is used to **provide a portable Internet terminal**, which can play movies, carry your entire music collection, and (every now and then) make phone calls.
- **The way that portable Internet terminals made it into our manufactured normalcy field was through the phone metaphor.**
- **Introducing technology to people in terms of something they already understand is a tried and tested effect:** computers started off as glorified typewriters; graphical user interfaces as desktops....
- Arthur C. Clarke has claimed that **"any sufficiently advanced technology is indistinguishable from magic,**" and given that the Internet of Things commonly bestows semi-hidden capabilities onto everyday objects, maybe the enchanted objects of magic and fairy tale are a good metaphor to help people grasp the possibilities.
- **Some Internet of Things projects draw their inspiration directly from magic.**
- For example, John McKerrell's **WhereDial** takes its lead from the **clock in *Harry Potter*** which tracked the location of the members of the Weasley family.

- The WhereDial, by comparison, has to rely on mere technology for its capabilities;
- however, **with the GPS chipsets in smartphones and location check-in services like FourSquare,** it isn't much of a leap to also own **an ornament which updates to show when you are at work, or travelling, or at a restaurant.**

The WhereDial.

- The **ambient orb** is a "single-pixel display" that can **show the status of a metric of its user's choosing—the price of a stock, the weather forecast etc.**
- Ambient Devices then took the idea one step further and built an **enchanted umbrella**.
- **It can read the weather forecast, and the handle glows gently if rain is expected,** alerting you to the fact that you may need to pick it up as you head out of the house.
- Everyday sort of magic that makes tasks a bit easier and lives a little more fun.
- **Using our understanding of magic and fairy tales to help make sense of these strange new gadgets.**
- **PRIVACY:**
- With more sensors and devices watching us and reporting data to the Internet, **the privacy of third parties who cross our sensors' paths is an important consideration.**
- Designers of an Internet of Things service will need to balance these concerns carefully.
- **KEEPING SECRETS:**
- An example from an early **instrumented car park** in a Westfield shopping mall in Australia.
- **Each parking bay is overlooked by a small sensor from Park Assist, which uses a cheap camera to tell whether the space is occupied.**
- The sensors are all networked and presumably can **provide analytics to the owner of the car park as to its usage.**
- A light on the sensor can help guide drivers to a free space.
- **The shopping mall provided a smartphone app for visitors to download so that they could find out more information about the facilities.**

- **One of the features of the app was a Find My Car option.**
- Choosing that, **you were prompted to enter the first few characters of your licence plate, and the app would then return four small photos of potential matches—**from optical character recognition software processing the sensor data on the mall's server.
- **security professional** Troy Hunt **was able to watch what information the app was requesting from the server and found that it was a simple unencrypted web request.**
- The initial request **URL had a number of parameters, including the search string**, but also including information such as the number of results to return.
- That **request returned** a chunk of data, which included the URLs for the four images to download, but **also included some additional pieces of information.**
- It was **easier for** the developer of the **web service to just return all the available data than to restrict it to just what was needed** in this case.
- The **extra data included**, for example, **the IP addresses of each of the sensor units**, but more importantly, **it also included the full licence plate for each vehicle and the length of time it had been parked in the space.**
- **By altering the search parameters, Troy found that he could request many more than the four matches, and it was also possible to omit the licence plate search string.**
- That meant he **could download a full list of licence plates from all 2550 parking spaces in a single web request, whenever he liked.**
- Once alerted to the problem, Westfield and Park Assist were quick to disable the feature and then work with Troy to build a better solution.
-
- **Important points:**
- ***Don't share more than you need to provide the service.***
- **"The best way to keep a secret is to never have it".**
- **If you can avoid gathering and/or storing the data in the first place, you need not worry about disclosing it accidentally.**
- In this day and age, **it is standard practice to never store passwords as cleartext**.
- You could also **consider applying** the standard mechanisms for **password encryption**, such as the **one-way hash**, to other pieces of data.
- One-way hashing is a cryptographic technique used to **condense an arbitrarily sized chunk of data into a fixed-sized piece, called the hash.**
- It's called one-way hashing because **there isn't an easy way, given the resultant hash, to work out what the original data was.**
- Hashing algorithms are so designed such that even a small difference in the input data leads to a huge difference in the output hash.

WHOSE DATA IS IT ANYWAY?

- With the number of sensors being deployed, it isn't always clear whose data is being gathered.

- Consider the case of **a camera deployed in an advertising hoarding which can check to see whether people are looking at the different adverts.**
- Does the data belong to the company that installed the camera or to the members of the public who are looking at the adverts?
- Adam Greenfield, a leading practitioner of urban computing, makes a convincing argument that **in a public space this data is being generated by the public, so they should at least have equal rights to be aware of, and also have access to, that data.**
- **On private property**, you can more easily claim that the members of the **public don't have such a right**, but perhaps **the property owner might assert rights** to the data rather than whoever installed the camera.

WEB THINKING FOR CONNECTED DEVICES:

- When you are thinking of the networked aspect of Internet of Things objects, it might help to draw on **experiences and design guidelines from existing network deployments.**
- You should aim to get into the mindset of the web and **create devices which are *of* the web rather than those which just exist *on* the web.**
- **SMALL PIECES, LOOSELY JOINED:**
- Even if you are building all the components of your service, **it makes sense not to couple them too tightly together.**
- The **Internet** flourished not because it is neatly controlled from a central location, but because it isn't; it **is a collection of services and machines following the maxim of *small pieces, loosely joined*.**
- **each piece should be designed to do one thing well and not rely too much on tight integration with the separate components it uses.**
- **make the components more generalised** and able to serve other systems which require a similar function.
- That will **help you**, and others, **to reuse and repurpose the components to build new capabilities**
- **Where possible, use existing standards and protocols rather than inventing your own.**

FIRST-CLASS CITIZENS ON THE INTERNET:

- What do we mean by that?
- Where possible, you should use the same protocols and conventions that the rest of the Internet uses.
- a good rule of thumb for the past 20 years or more has been to **expect the IP protocol to penetrate everywhere.**
- We see no reason for it not to continue into the Internet of Things.
- **In the few cases where the existing protocols don't work,** such as in extremely low-powered sensors, a better solution is to **create new open standards which address the issue.**
- **When mobile phones were first being connected to the Internet**, it was deemed too difficult for them to talk to web servers directly, and a whole suite of **new protocols, Wireless Application Protocol (WAP), were developed.**

GRACEFUL DEGRADATION:

- The **endpoints have** a massively **disparate and diverse range of capabilities.**
- As a result, **building services which can be used by all of them is a nearly impossible task**.
- However, a number of **design patterns have evolved to mitigate the problem:**
- **1)** If you need to come up with a format for some data being transferred between devices, **include a way to differentiate between successive versions of the formats**—ideally in such **a way that older devices can still mostly read newer formats.**
- This is known as ***backwards compatibility***.
- The **HTML format** does this by stating that **any client should ignore any tags** (the text inside the <>) **that it doesn't understand**, so newer versions can add new tags without breaking older parsers.
- The **HTTP protocol** uses a slightly different technique in which **each end specifies the version of the protocol that it supports, and the other end takes care not to use any of the newer features for that particular session**.
- The other common technique is to use something called ***graceful degradation*.**
- This technique involves aiming to **provide a fully featured experience if the client is capable of it but then falling back—potentially in a number of levels—to a less feature-rich experience on less capable clients.**
- Such as in Gmail, the **coder wants to use advanced JavaScript features in modern browsers.**
- Well-written **apps check that the features are available before using them, but if those features aren't available, the apps might limit themselves to a version using simpler** (and more common) **JavaScript code.**
- And **if JavaScript isn't available at all, they fall back to basic HTML forms.**
- This experience is not as nice as the full one but better than no experience at all!

AFFORDANCES:

- Donald Norman defines *affordances* as follows:
- *Affordances provide strong clues to the operations of things.*
- *Knobs are for turning.*
- *Balls are for throwing or bouncing.*
- *When affordances are taken advantage of,* ***the user knows what to do just by looking:***
- ***no picture, label, or instruction is required.***
- *Complex things may require explanation, but simple things should not.*

- ***When simple things need pictures, labels, or instructions, the design has failed.***
- What are the affordances of digitally enhanced objects?
- How do we convey to the user of an object that it can communicate with the cloud?
- An important start is to keep the existing affordances of the object being enhanced.
- **Users who don't realise that a device has any extra capabilities should still be able to use it as if it hasn't**.
- Similar rules apply when designing physical interfaces.
- Don't overload familiar connectors with unfamiliar behaviours.

Chapter 3
INTERNET PRINCIPLES

- **INTERNET COMMUNICATIONS:AN OVERVIEW**
- **IP (Internet Protocol)**
- **Data is sent** from one machine to another **in a packet**, with a destination address and a source address **in a standardised format (a "protocol").**
- Most of the time, the packets of data **have to go through a number of intermediary machines, called *routers***, to reach their destination.
- The underlying networks aren't always the same.
- a postcard was placed in an envelope before getting passed onwards.
- This happens with Internet packets, too.
- So, **an *IP packet*** is a block of data along with the same kind of information you would write on a physical envelope: **the name and address of the server**, and so on.
- There is **no guarantee**, and you can send only what will **fit in a single packet**.

TCP

- What if you wanted **to send longer messages** than fit on a postcard?
- Or wanted to **make sure your messages got through**?
- TCP is **built on top of the basic IP protocol** and adds **sequence numbers, acknowledgements, and retransmissions.**
- This means that a message sent with TCP can be arbitrarily long and give the sender some assurance that it actually arrived at the destination intact.

THE IP PROTOCOL SUITE (TCP/IP)

- whole suite or stack of protocols layered on top of each other, each layer building on the capabilities of the one below.
- The low-level protocols at the ***link layer*** manage the **transfer of bits of information** across a network link.
- The ***Internet layer uses IP address***.
- Then TCP, which lives in the ***transport layer*,** sits on top of IP and extends it with more sophisticated **control of the messages passed.**