Lloyd's Register Foundation

The Risk of Disruptive Technologies

Airmic ERM Forum
7th Nov 2017

Prof Richard Clegg
Foundation Chief Executive

Life matters

Agenda

- Introduction and scene setting
- Background about Lloyd's Register Foundation
- Disruptive technologies and risks
- Public understanding of risk
- Q&A

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Lloyd's Register Foundation

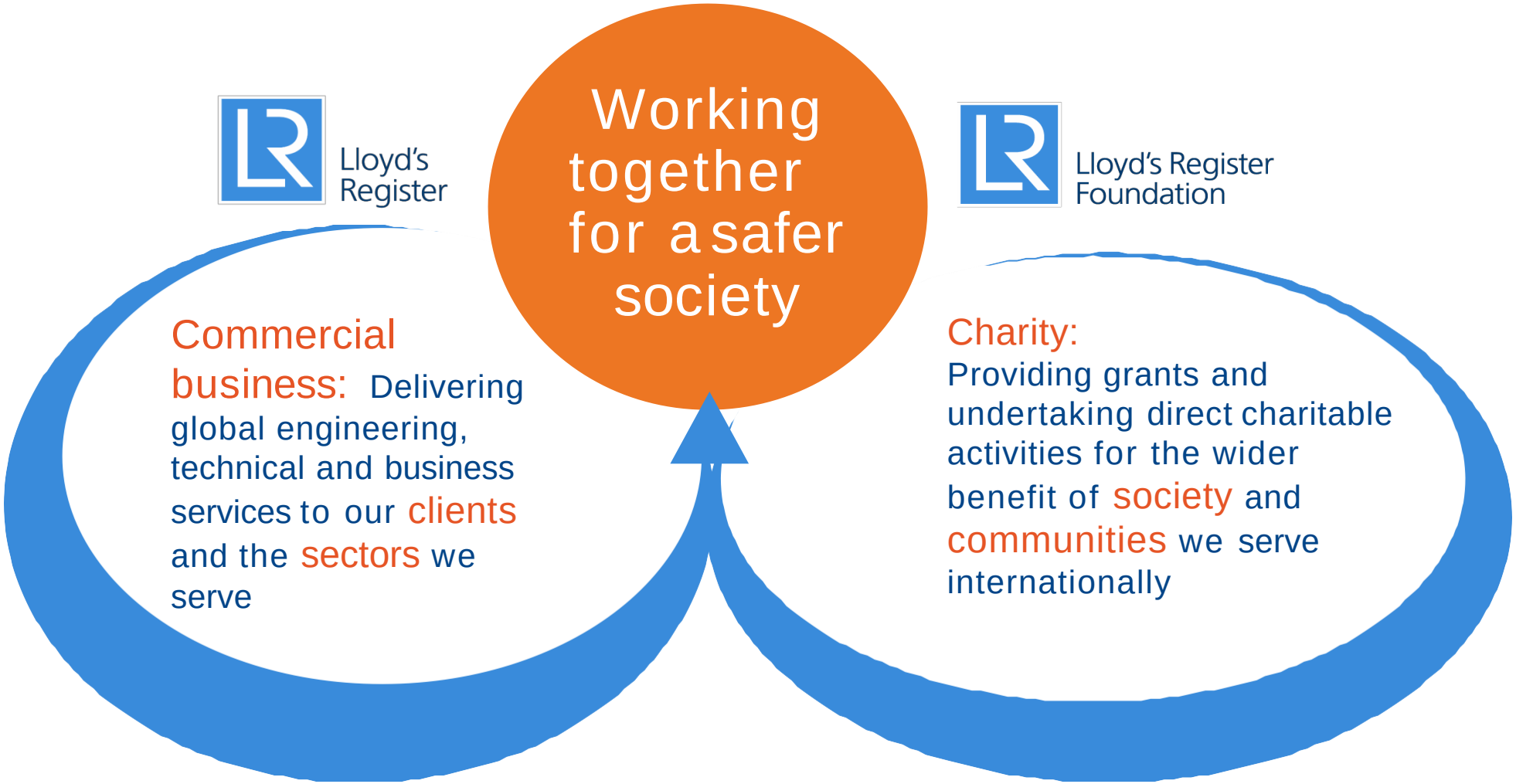
Five things to know about the Foundation

- It is a charity
- Its mission is to enhance safety of life and property, and advance public education
- It is based in the UK but gives grants globally
- It is the sole shareholder of the Lloyd's Register Group
- Impact and excellence are the major grant-giving criteria

Lloyd's Register Foundation

LR's 21st century model for doing social business

Lloyd's Register Foundation



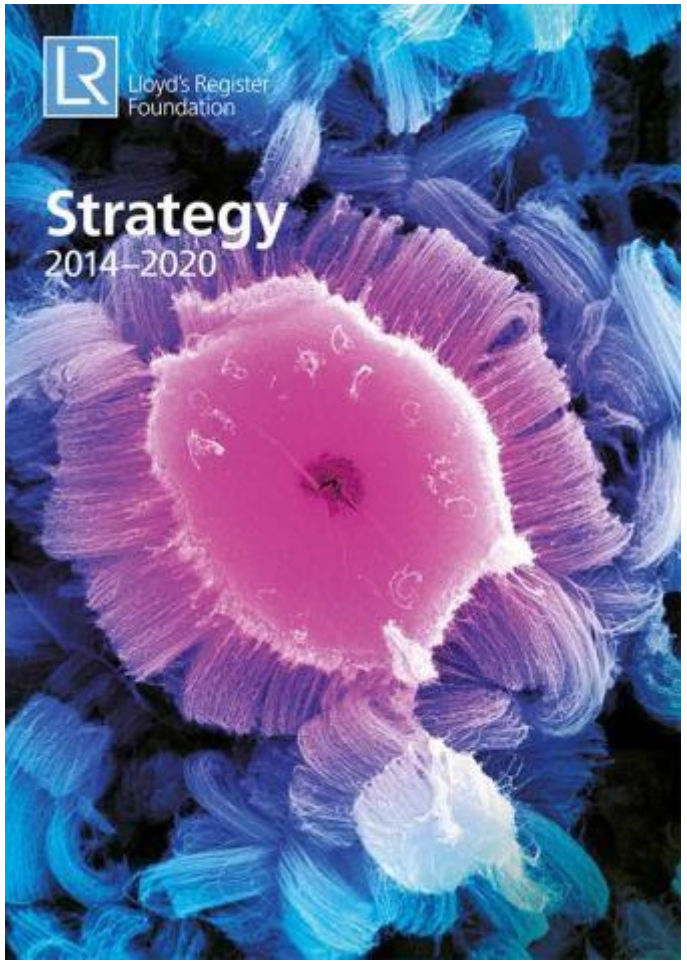
Recap on our strategy

Four Strategic Themes:

- Supporting excellent scientific research
- Accelerating the application of research
- Advancement of skills and education
- Promoting safety and public understanding of risk

Four Research Funding Priorities

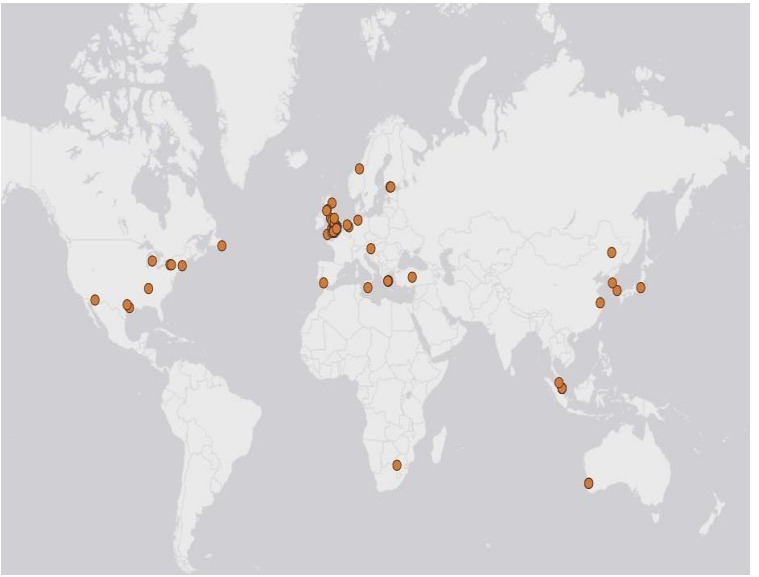
- Structural integrity and systems performance
- Resilience engineering
- Human and social factors
- Emergent technologies



Grant metrics

Lloyd's Register Foundation

£96m	Grants awarded since 2013
75	Active grants
21	Countries
183	Publications by our grants community in 2015/16
1.7 million	Impressions on social media last year
715,000	Young people, teachers and parents engaged through our STEM education grants
14,000	Public enquiries to our Heritage and Education Centre last year
35/140	2016 grants awarded / grants applications



International reach of Foundation grants

http://info.lr.org/grants-map

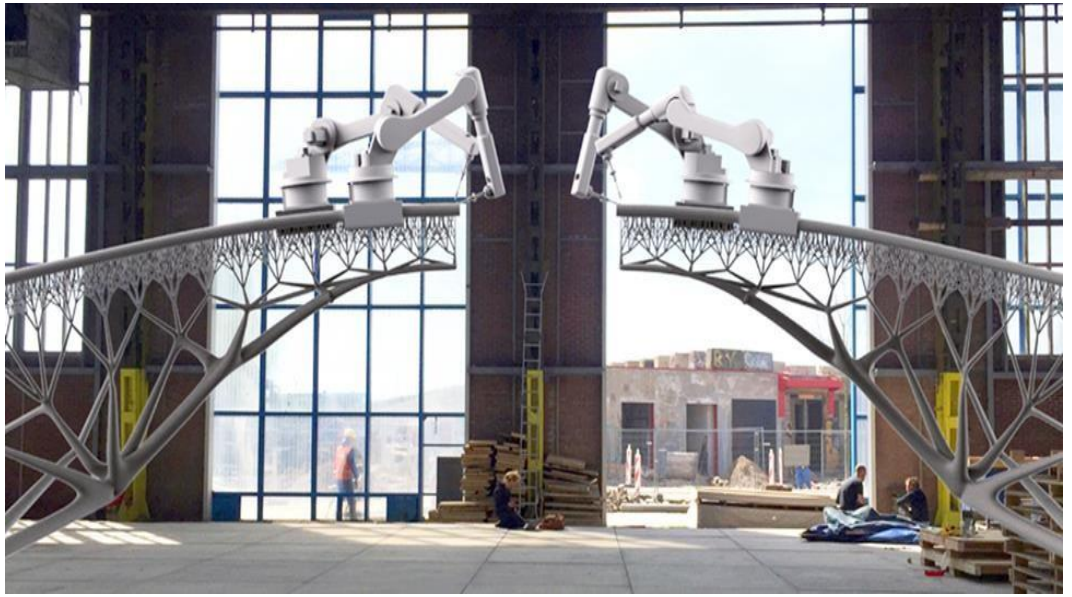
Aims of our foresight reviews

- Describe the technology or issue.
- Identify short and long term opportunities and impacts on the Foundation's mission.
- Establish what needs to be done to exploit the opportunities / benefits and counter the threats.
- Identify where the Foundation can take distinctive action.
- Help target, prioritise and manage major grants.
- Increase public understanding and awareness.
- Influence partners / decision makers.

Examples of our work and impact (1)

The world's largest 3D printed metal structure

- Foundation has awarded funds to MX3D, who are building the world's first steel 3D printed bridge in Amsterdam.
- Embedded sensors and data analytics will enhance safety for everyday public use.
- Data collected will offer insights into how future 3D printed structures can be optimally designed for safety.

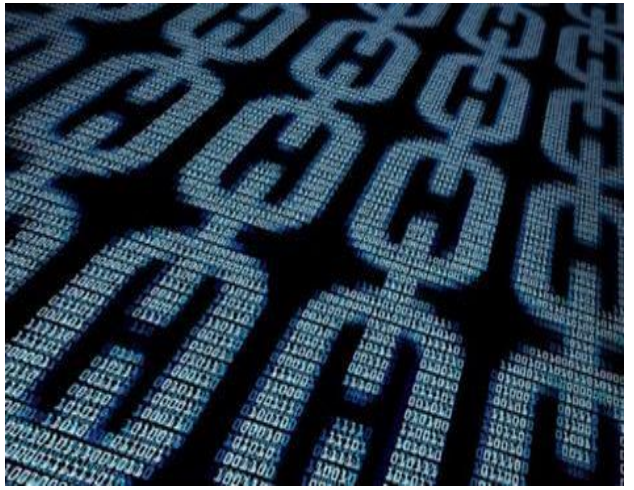


Video: https://www.youtube.com/watch?v=v2moJF8kqIg&feature=youtu.be

Examples of our work and impact (2)

Alan Turing Institute (ATI) – Data Centric Engineering

- Founding investor in ATI focussing on the engineering applications of data science:
  - How to ensure the resilience of complex infrastructure
  - How to monitor the safety of complex engineering systems
  - Data driven design under uncertainty
  - Outputs include research, trained data-centric engineers, tools and data standards
- Developed Probabilistic Numerical techniques to study the safety and resilience of 3D manufactured load bearing structures. (Now also applied to human heart defect detection.) https://youtu.be/SrrO4OxydO0



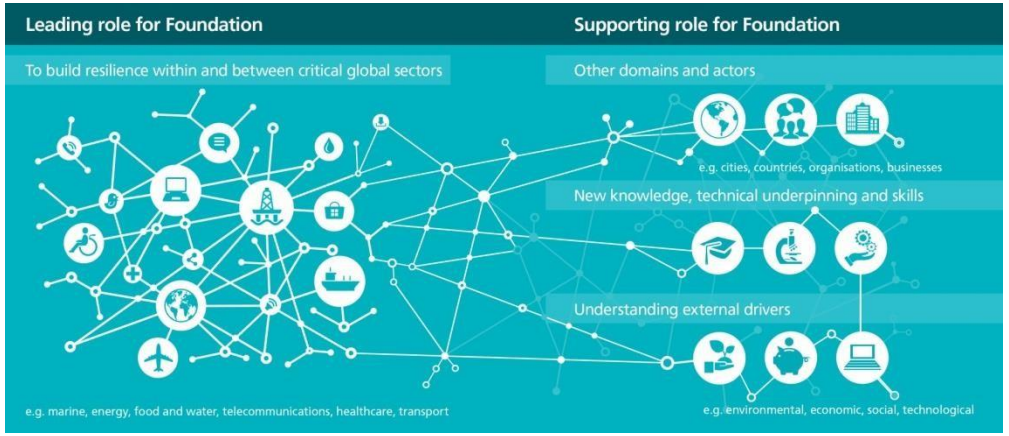
Examples of our work and impact (3)

‘Science Firefly’ in Turkey

- Science education failing in Turkey, ranked lower than most EU countries, North America, and East Asia.
- Mobile learning unit travels to disadvantaged schools, supplementing science programs with an engaging and inspiring science curriculum.
- Inspires a love of science in children, train teachers, and encourages community involvement through engagement of volunteers.
- Focuses on marginalized, low-income, isolated and poorly educated populations.

Examples of our work and impact (4)

Resilience Engineering – ‘Resilience Shift’



- In collaboration with Arup
- Rethinks conventional probabilistic way of thinking of risk
- Focus is on how to enable systems to absorb, bounce back, recover and learn from shocks and disruptive events (e.g. earthquakes, flooding, problematic supply chains) .

Examples of our work and impact (5)

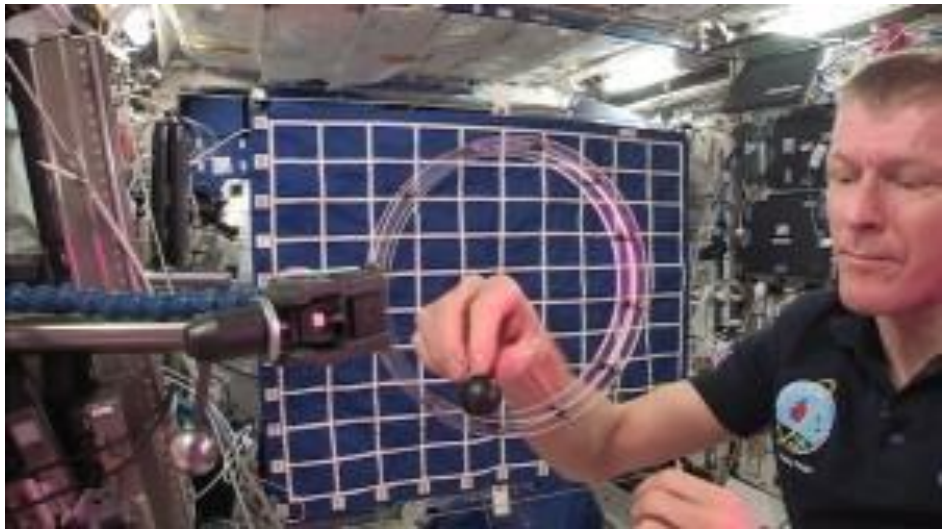
Royal National Lifeboat Institute

- Foundation support began in 2007.
- Funding specifically for (nearly 3,000) crucial lifeboat volunteers' sea survival training.
- In 2016 RNLI lifeboats saved the lives of 270 people.

Examples of our work and impact (6)

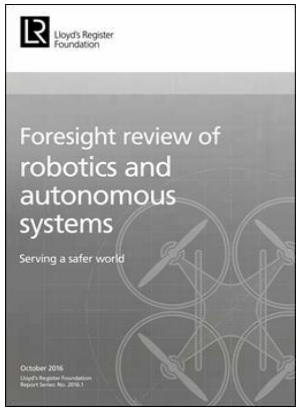
National Space Academy

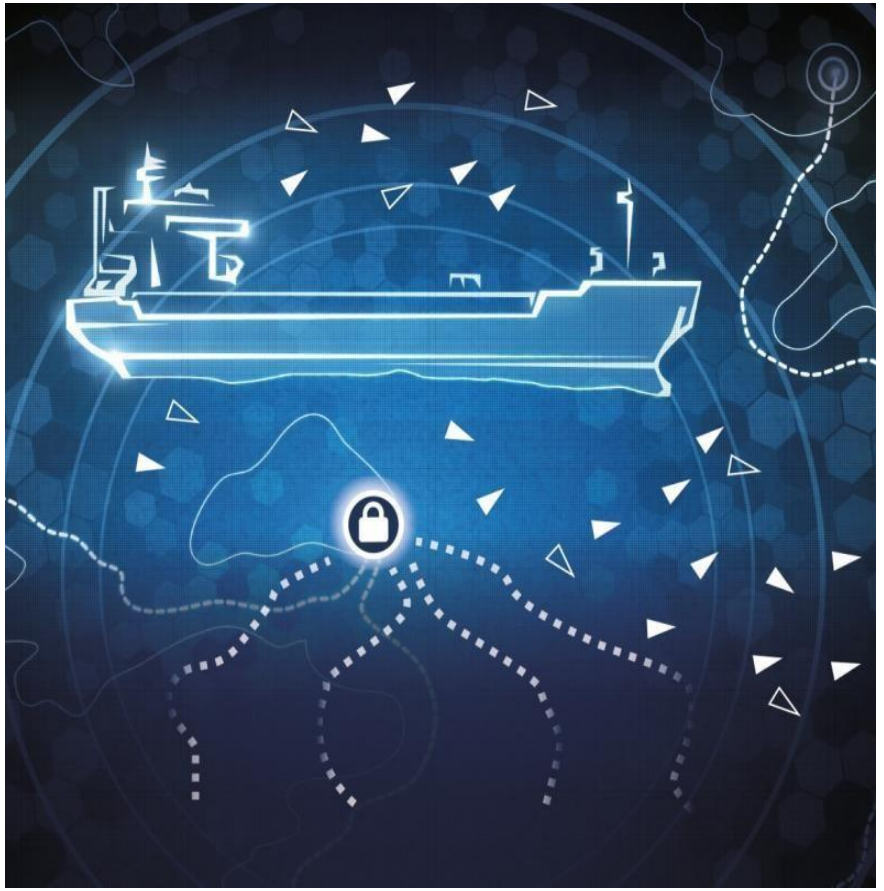
- Funding awarded to the National Space Academy to fund:
  - Head of teaching and learning
  - Lead educators
  - Space engineering course expansion
  - Teacher guides and videos
- Astronaut Tim Peake recorded physics and chemistry demonstrations whilst on the International Space Station which were turned into a training programme for teachers to use in UK classrooms.



Examples of our work and impact (7)

Robotics and Autonomous Systems





Starting 2017

Framework for regulation of autonomous systems

International demonstrators across sectors

UNIVERSITY of York

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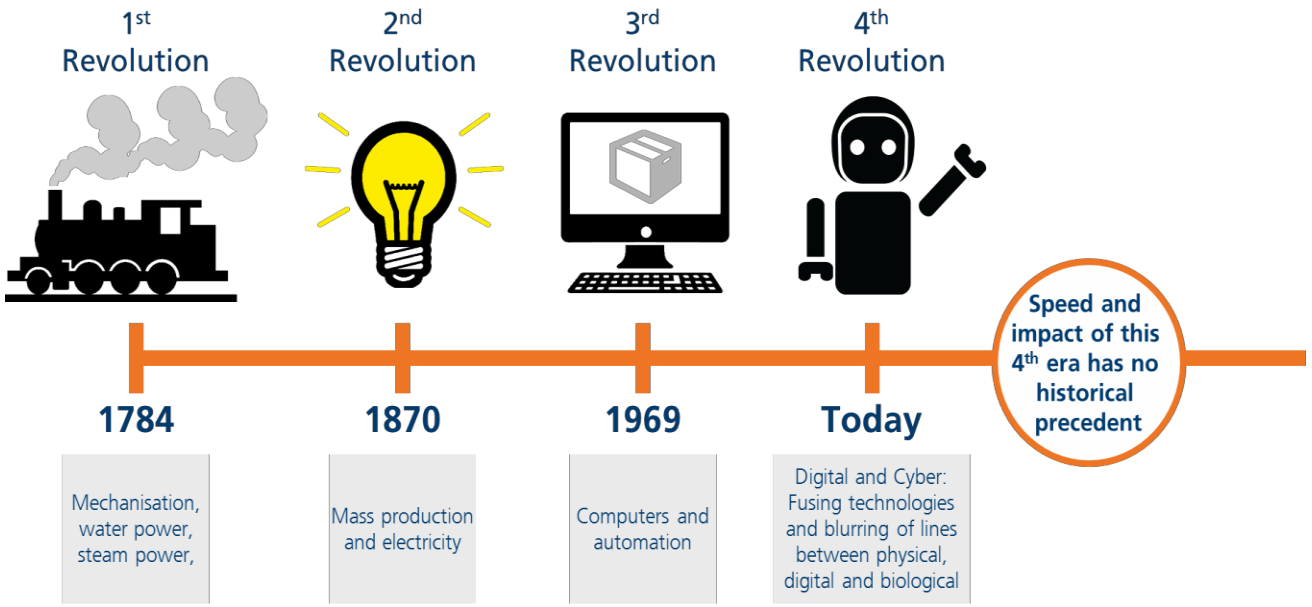
Lloyd's Register Foundation

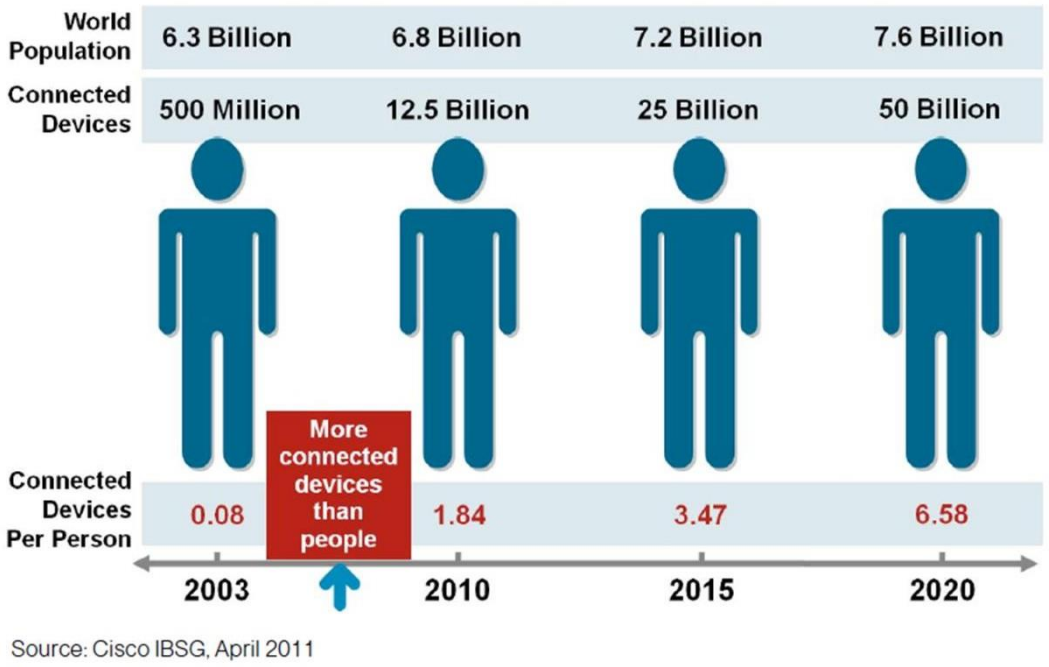
The pace of technology development is increasing



Source: World Economic Forum

- We're increasingly living in an interconnected and autonomous world.
- It took more than a century from the steam age to the computer age.
- It's taking just decades from computers to the age of data and digital we're now entering
- Disruptive technologies don't just displace existing ways of doing things – they create new markets and bring new risks and benefits.

There are more interconnected devices on earth than there are people



Source: Cisco IBSG, April 2011

5 EB All words ever spoken by humans on planet earth

44 ZB Size of the Digital Universe by 2020 increase from 4.4ZB in 2014

90% Of all data in world created in past 2 years

60% In 2013 mature markets represented 60% of the digital universe. By 2020 it will swing to 60% developing markets

21% Data in Digital Universe from embedded systems by 2020 up from 8% in 2014

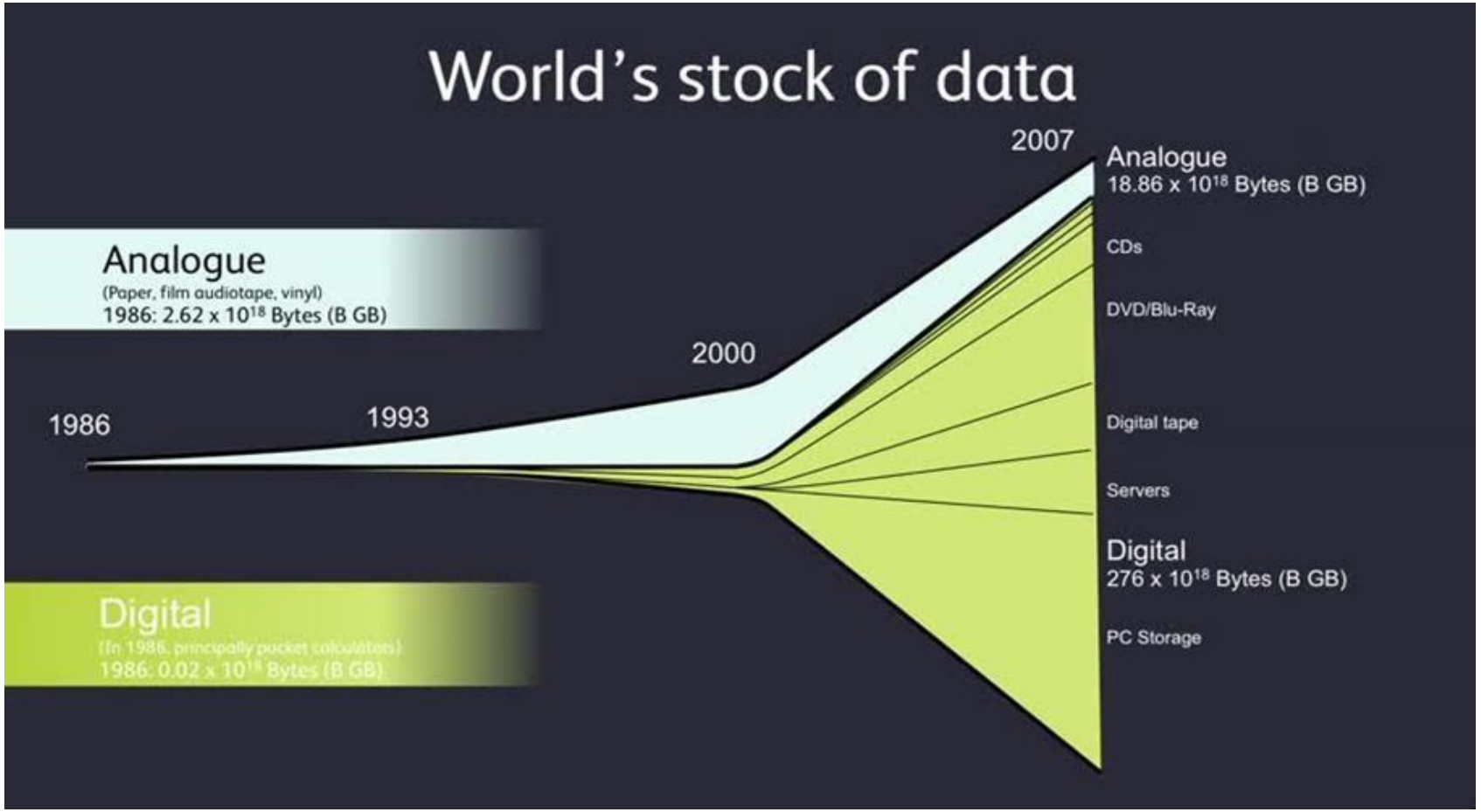
Putting the size of the digital universe in context

Size of the Digital Universe by 2020 will be **44ZB**, a ten fold increase since 2014

= 1408 Billion 32 GB iPads

= 612 times higher than Mt. Fuji

50x increase in world data from 2010 to 2020

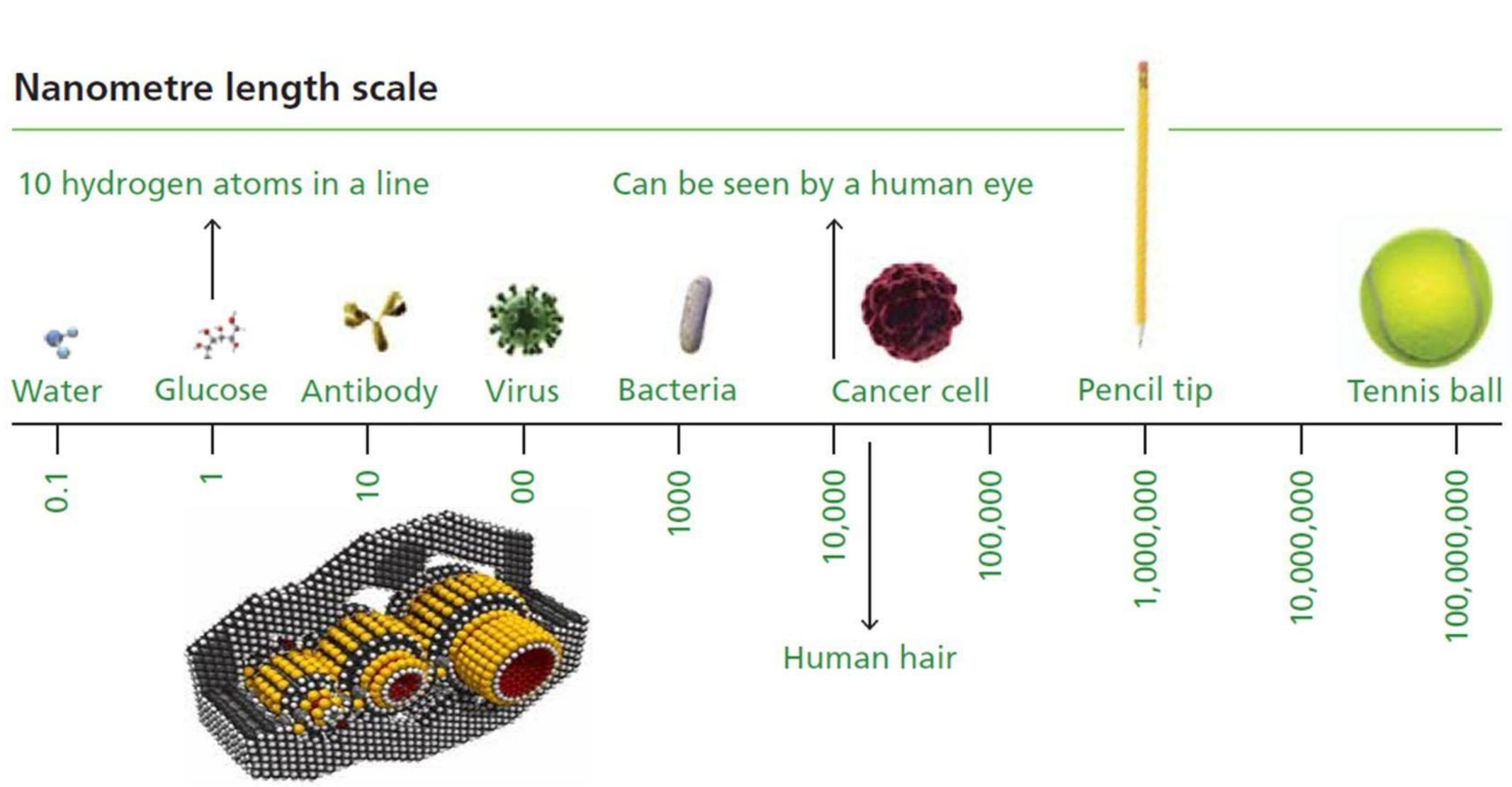


In 1986 41% computing power was pocket calculators

12 Potentially economically disruptive technologies published by McKinsey and Company

Mobile Internet	Increasingly inexpensive and capable mobile computing devices and Internet connectivity
Automation of knowledge work	Intelligent software systems that can perform knowledge work tasks involving unstructured commands and subtle judgments
The Internet of Things	Networks of low-cost sensors and actuators for data collection, monitoring, decision making, and process optimization
Cloud technology	Use of computer hardware and software resources delivered over a network or the Internet, often as a service
Advanced robotics	Increasingly capable robots with enhanced senses, dexterity, and intelligence used to automate tasks or augment humans
Autonomous and near-autonomous vehicles	Vehicles that can navigate and operate with reduced or no human intervention
Next-generation genomics	Fast, low-cost gene sequencing, advanced big data analytics, and synthetic biology ("writing" DNA)
Energy storage	Devices or systems that store energy for later use, including batteries
3D printing	Additive manufacturing techniques to create objects by printing layers of material based on digital models
Advanced materials	Materials designed to have superior characteristics (e.g., strength, weight, conductivity) or functionality
Advanced oil and gas exploration and recovery	Exploration and recovery techniques that make extraction of unconventional oil and gas economical
Renewable energy	Generation of electricity from renewable sources with reduced harmful climate impact

Nanotechnology implications (1) – how *small is nanotechnology?*



Nanotechnology implications (2) – *like looking at the eye of a fly from 2,000km in space*

Nanotechnology implications (3) – *working with the Nobel Prize winner Prof Sir Andre Geim on advanced materials*

Examples of companies that have been leapfrogged by technology

Wang Laboratories

Napster

Atari

Polaroid

palm

Commodore

Sega

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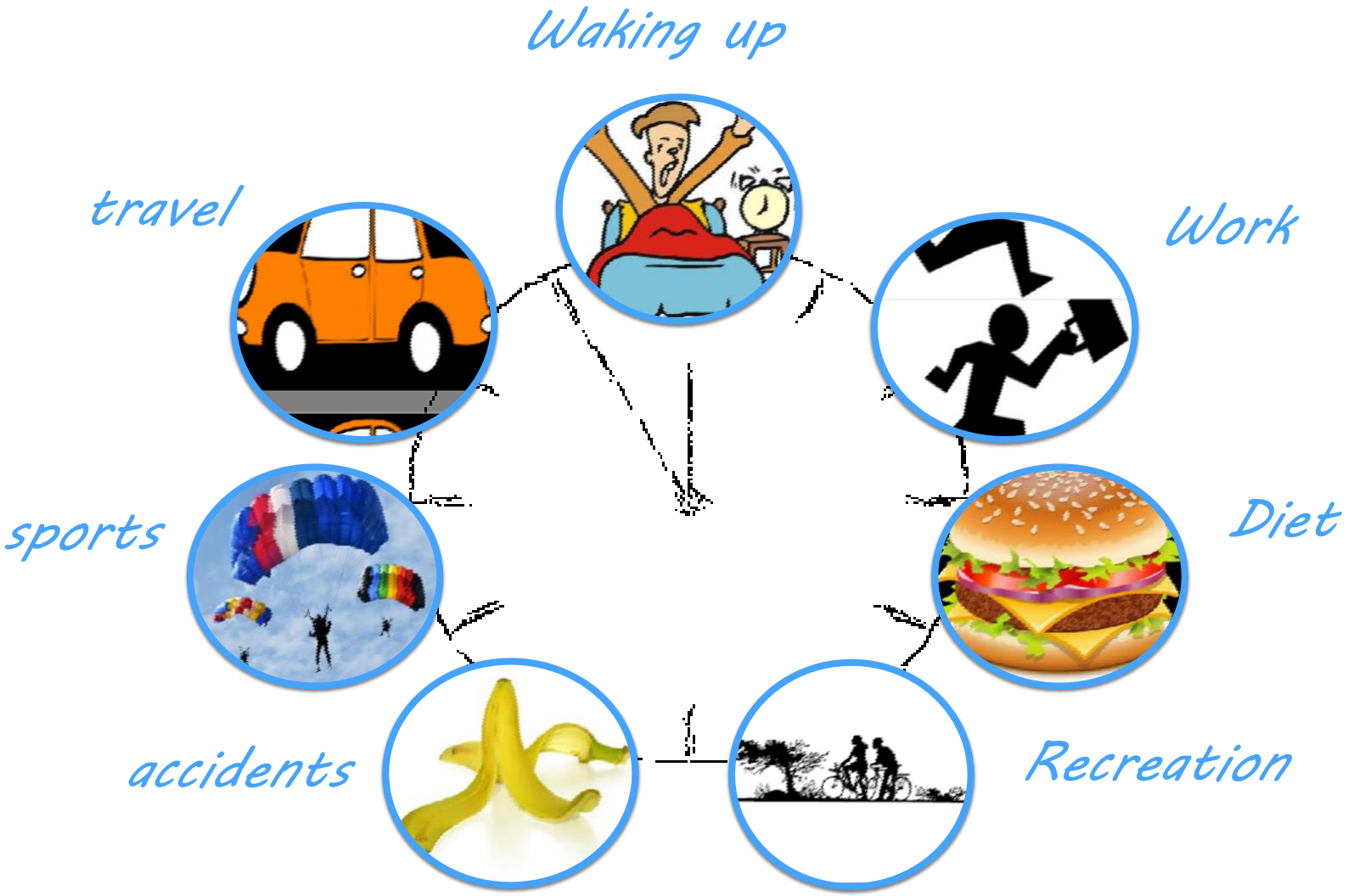
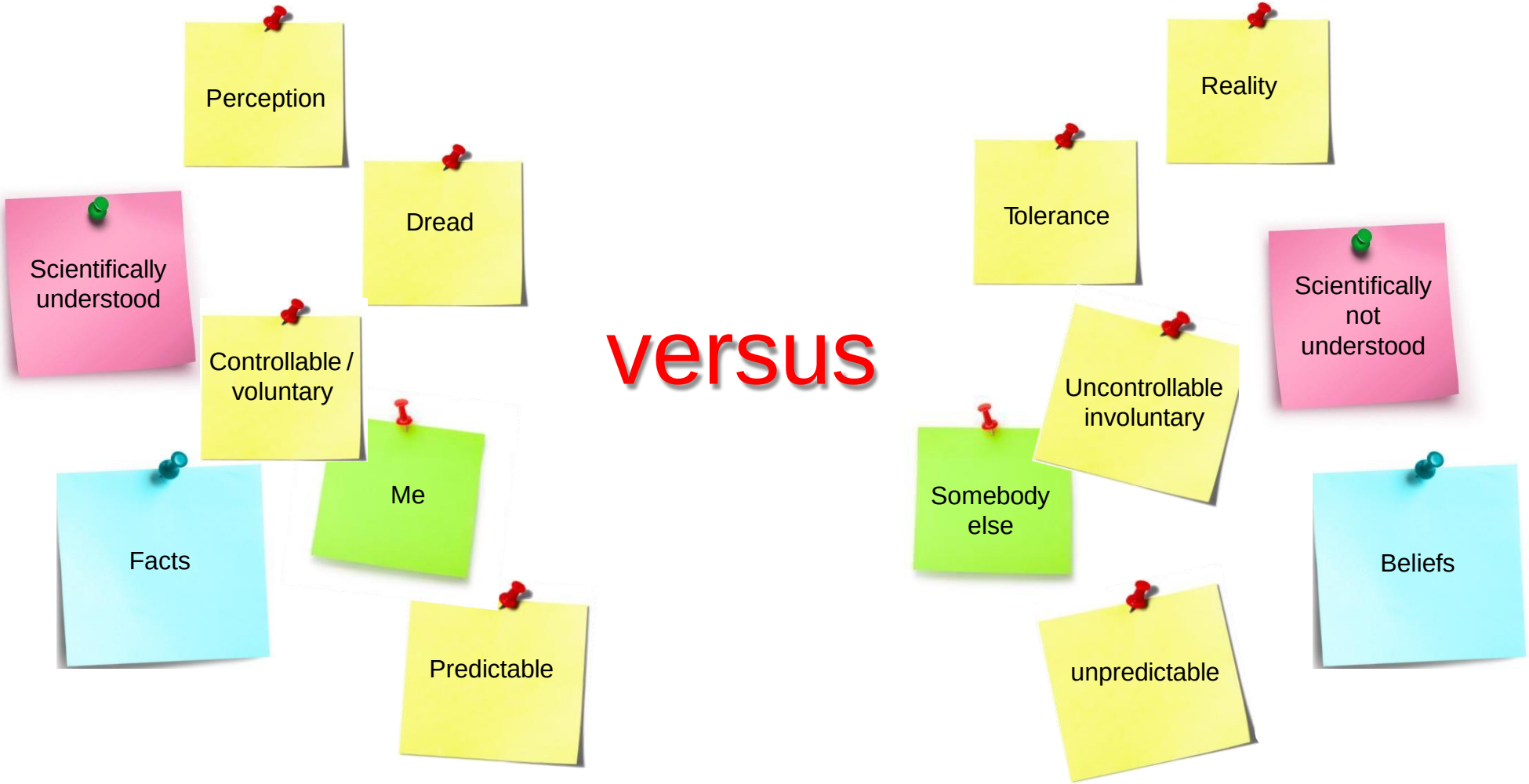
Lloyd's Register Foundation

We face danger and risks every day of our life



The psychology of risk is predictably irrational!



People sometimes hold views inconsistent with the evidence.
Enlightening them with more scientific facts doesn't always help!

What is risk

Risk = likelihood x consequence

=

x

Measurement of risk

The Micromort:

- Useful unit of measurement that makes risks comparable on same scale
- A micromort equals 1 in a 1,000,000 chance of death
- The same probability as flipping 20 coins and them all ending up heads

Every day activities expressed in Micromorts

7 Micromorts
running a marathon

33 Micromort
driving 10,000 miles

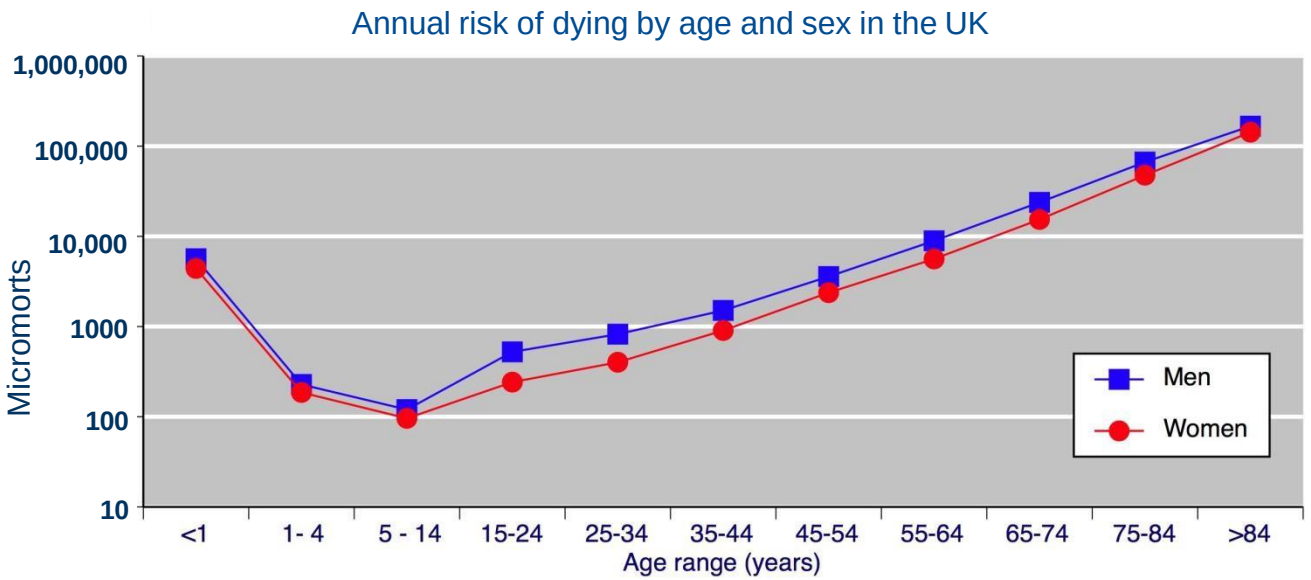
39,427 Micromorts
Climbing Everest

0.1 Micromorts
Struck by lightning in a year

1 Micromorts
Fatal cooking appliance fire

4 Micromort
28 motorcycle miles

1 Micromort
Smoking 1.4 cigarettes



Looking at the numbers

- The previous graph shows that 7 years old is the safest age to be in terms of mortal risk
- The annual risk aged 7 is about 100 micromorts
- By comparison, this equates to motorcycling 30,000 miles

Comparing risks

- Comparing risks by drawing analogies can be helpful.
- To understand risks from radiation, the ‘banana equivalent dose’ has been used.
- Bananas contain Potassium-40 and are naturally radioactive (half-life 1.25 billion years). One banana emits about 15 radioactive disintegrations per second.

Exposure	Bananas	Cigarettes
Average annual radon dose to people in Cornwall	80,000	300
Approximate dose at Fukushima Town Hall in 2 weeks following accident	1,000	4
Flight from London to New York	700	2
Dental X-ray	50	0.2
Sleeping next to someone	0.5	Small puff

Value of a human life

- What monetary value would you put on your own life or somebody else's?
- As already mentioned, flipping 20 coins and them all coming up heads has a chance of 1 in 1,000,000
- If somebody tried and gave you £5 every time they failed (to get 30 heads) - but you had to forfeit your life if they succeeded - would you take the bet?
- If so, you've valued one micromort of your life at £5
- For comparison, Department of Transport values 1 micromort at £1.60.

Coincidence

- Coincidence or luck might be regarded as the ‘upside’ of risk
- In large data sets improbable and unlikely coincidences happen. Some catch our attention. Others we dismiss as boring and insignificant.
- The numbers opposite show my numbers and actual results on the lottery
- I lost and so dismissed the occurrence as boring. But the chance of my 6 numbers and the winning 6 numbers being in this combination of 12 numbers, has a chance of 1 in 200 trillion (1 in 200,000,000,000,000). The same as flipping 48 coins and them all coming up heads

Coincidence

- There's a 50% chance if 23 people meet that 2 of them will share the same birthday.
- This means in 50% of football matches on the television that 2 of the players or referee share the same birthday
- If you have 28 people in a room and bet that 2 of them will have a birthday within +/- 1 day of each other, you'll have a 95% chance of winning. A sure fire bet!
- Most people if they experienced it would think it a massive coincidence and highly significant. Their perception exceeds reality. The same can happen with our perception of risk, as the next slide shows……..

Public perception of risk versus actual

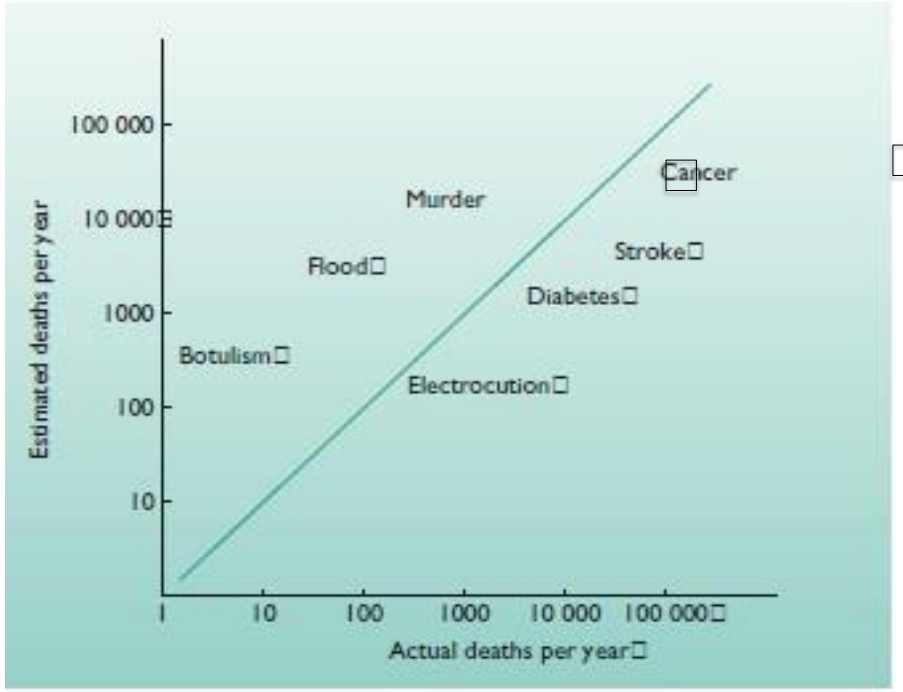


Figure 3.7 Perception of risk of death from various causes. The line indicates a one-to-one correlation where the perception is the same as the actual risk

The perception of risk of death from various sources. The line indicates a one-to-one correlation where the perception is the same as the actual risk

People tend to:

overestimate the risk of death from low probability causes

&

underestimate the risk of death from high probability causes

Summary

- We face the dangers of life every day
- Risk is a science, but human nature overlays anxieties and gives heightened significance to chance and coincidence
- Our tolerance of risk is complex and emotive. People often hold views inconsistent with the evidence
- People tend to overestimate the risk of death from low probability causes, and underestimate the risks from high probability causes
- **Humans are predictably irrational**

Lloyd's Register Foundation

Thank you

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