Who's Cross about Crossrail

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ProjectChat 2019

The Crossrail Project - London

- £14.8bn original budget
- 10 year project
- 117km track, 21km tunnels
- Start 2008
- Opening date December 2018
- Elizabeth Line once open
- June 2018 project still reporting ‘on-time’ and ‘on budget’

The Crossrail Project Disaster

- August 2018 problems announced
  - Just **4 months** before opening
  - 9 month delay in final completion expected
  - Budget overrun £600 million

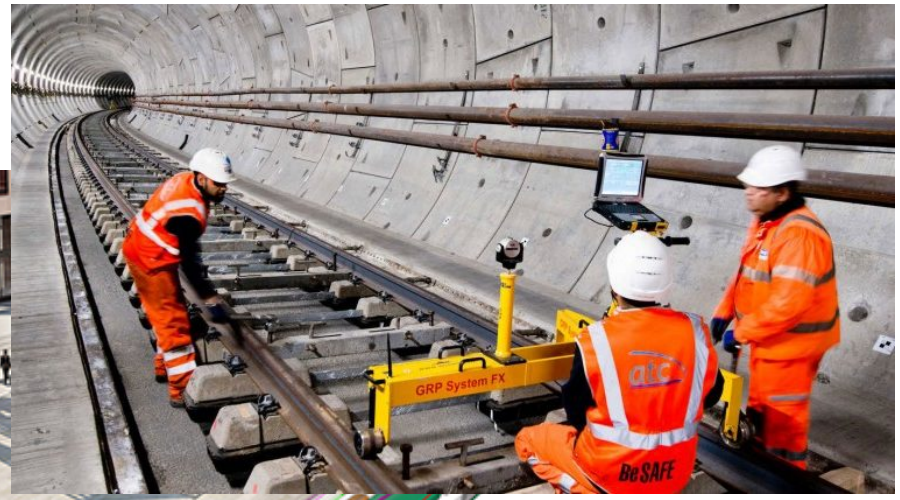
- Current predictions:
  - Final completion in 2020/21
  - Final cost £17.6bn
  - Cost overrun £1.4bn = **$2.6bn (AU)**

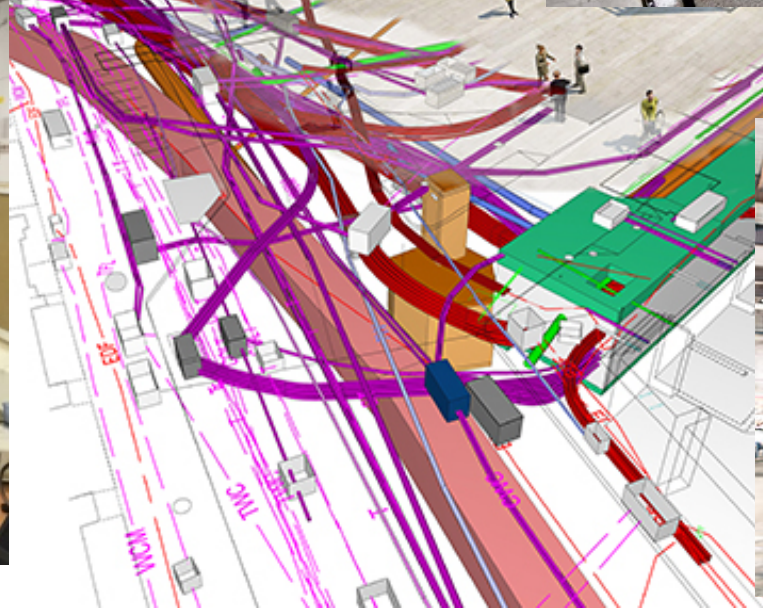
The good stuff

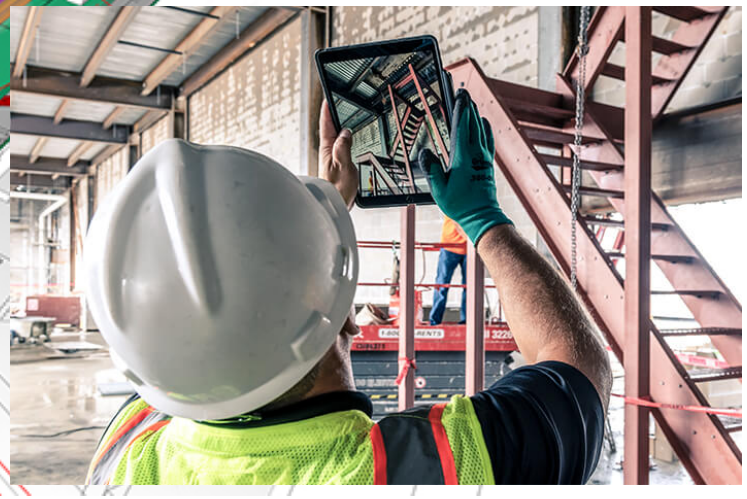
- Environment

The good stuff

- Technology – BIM used extensively
  - Planning
  - Coordination
  - Control



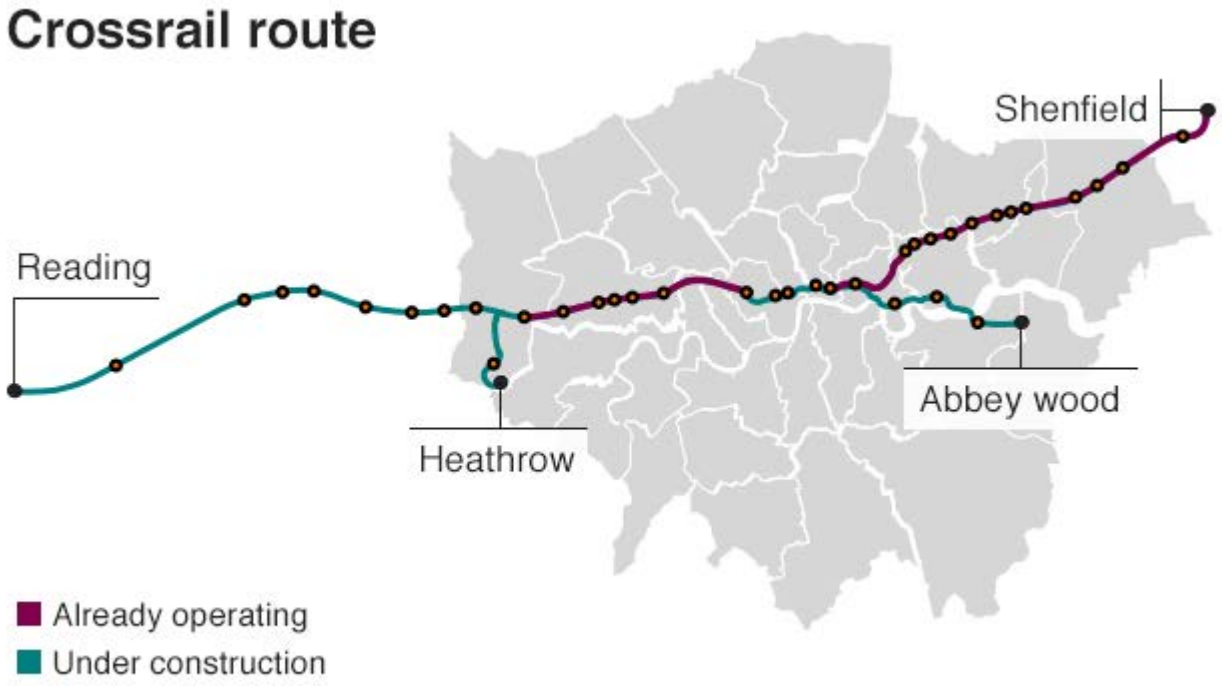




What went wrong?

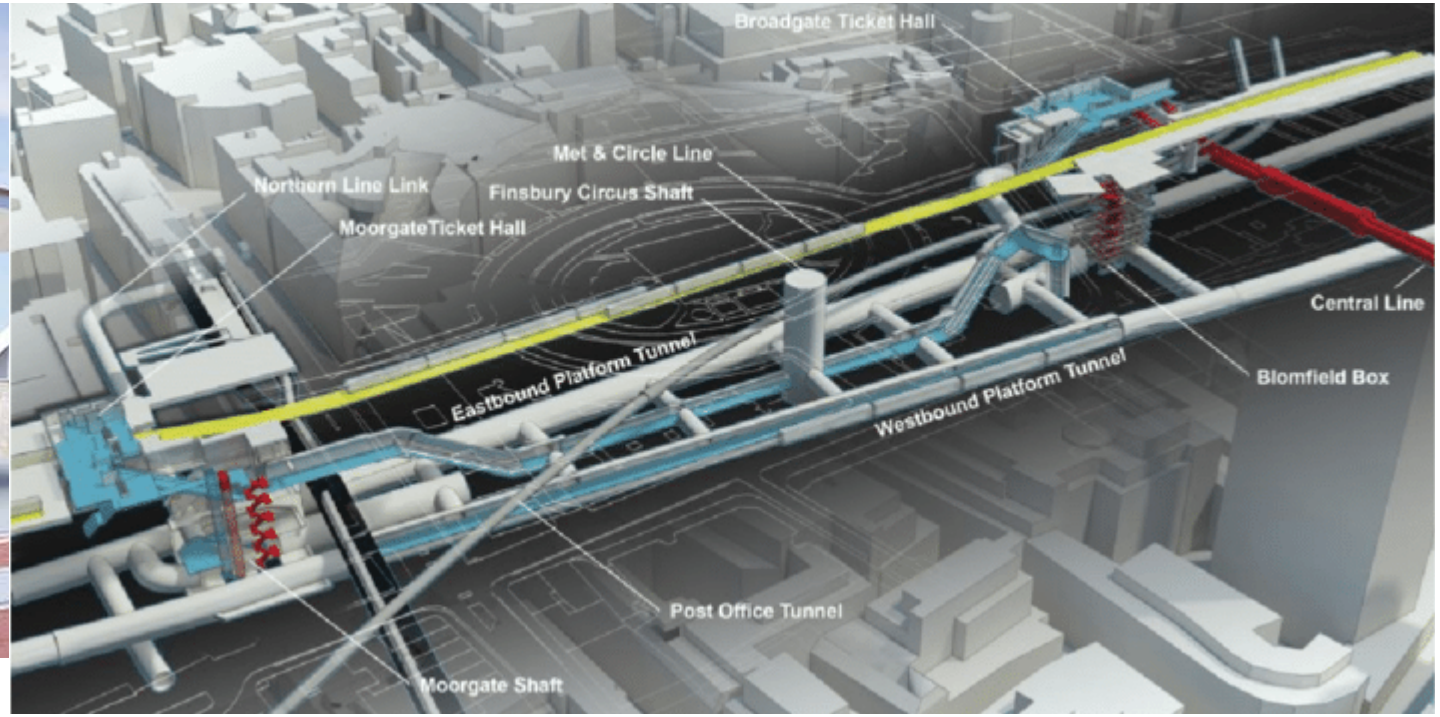
- The small problem: some stations not finished in the West and in the city
- **The BIG problem…….. Signalling**

- The project's catchphrase ***'on time and on budget'*** has been totally obliterated



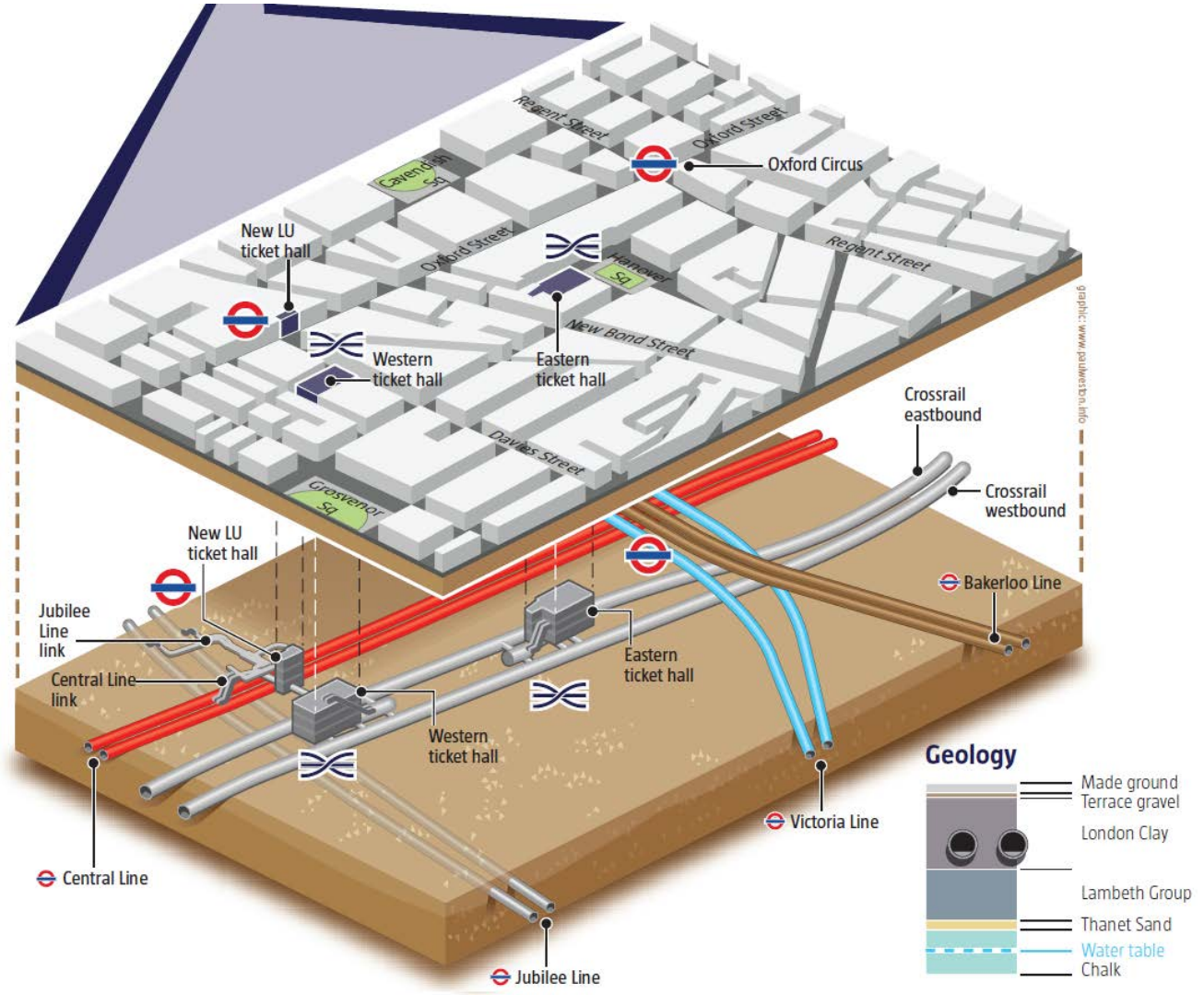
What went wrong?

- Station construction
  - 3 yeas late starting some of the design work in the West
  - Building progress is obvious – why were delays ignored?

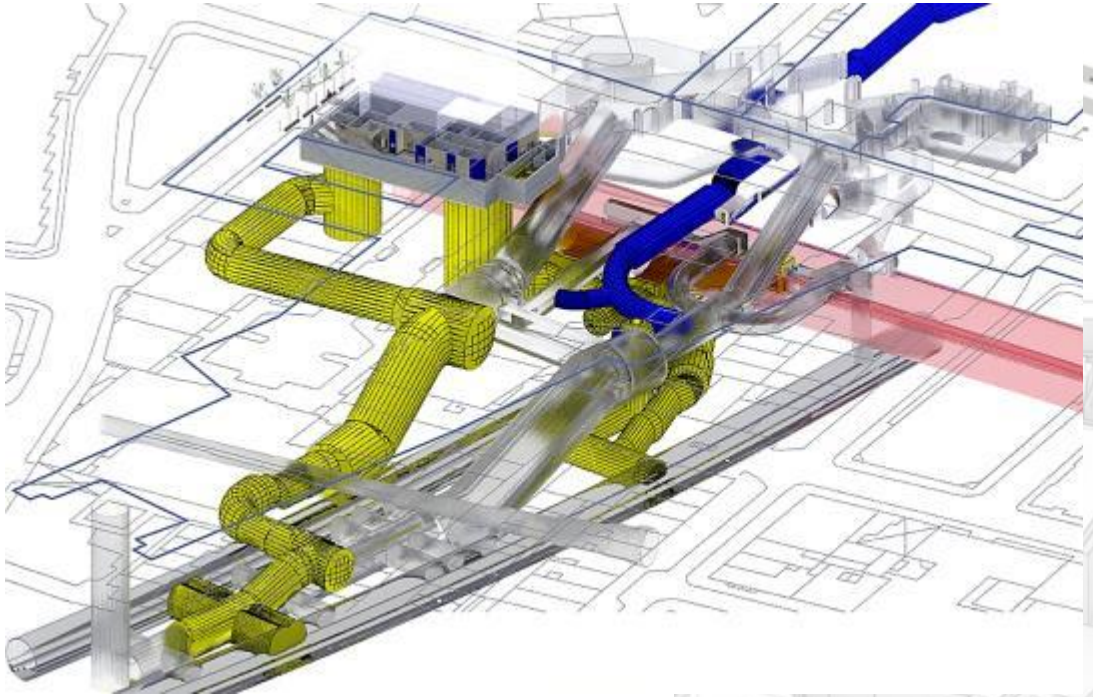


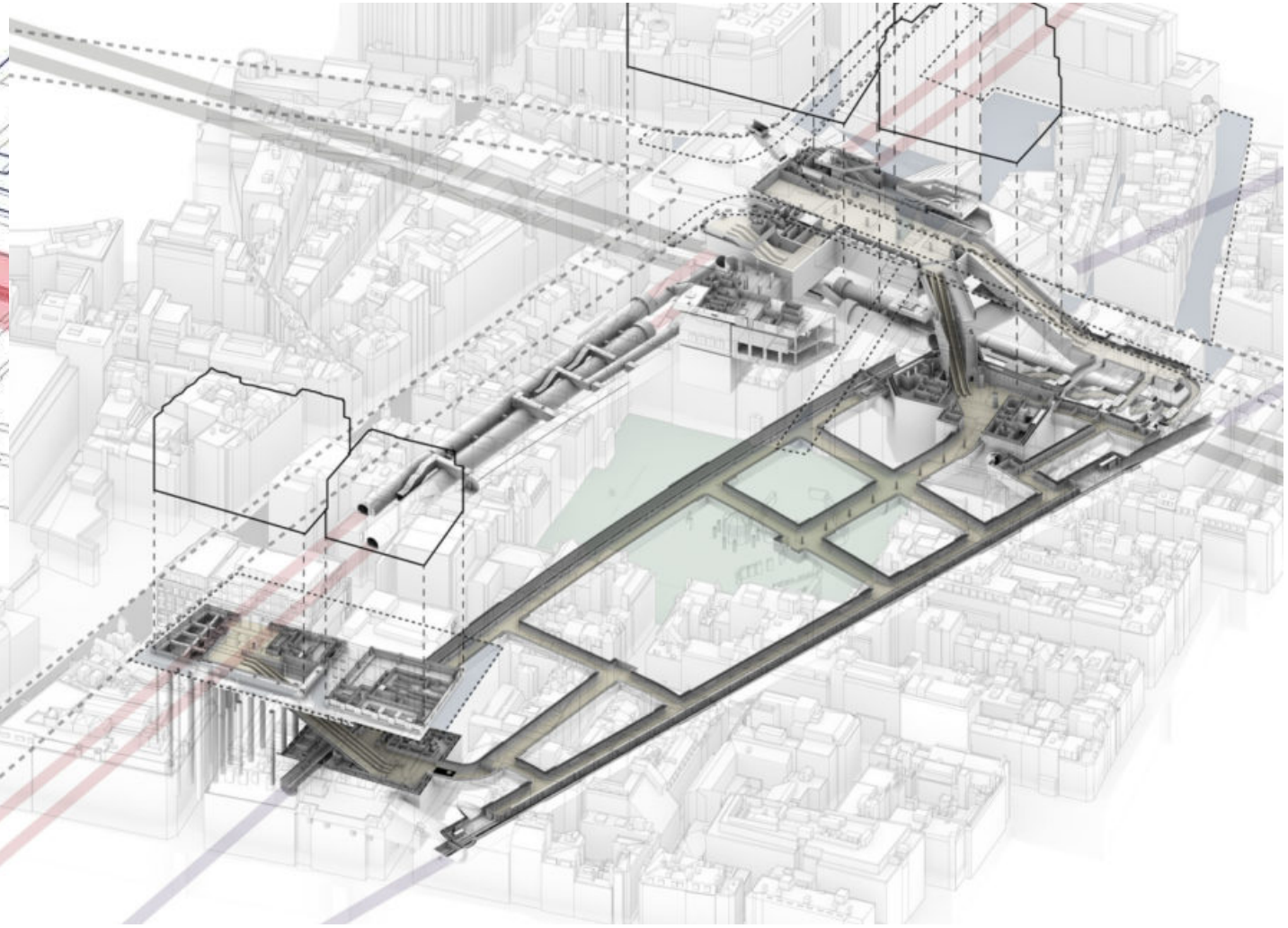
What went wrong?

- West London surface stations finishing next year
- Bond Street station not ready until 2021
  - Tunneling problems in 2014 caused a year's delay
  - Other issues are causing on-going delays – complex!!
  - Focus on running trains through the tunnels (the system can work without the station)



What went wrong? – Complex engineering

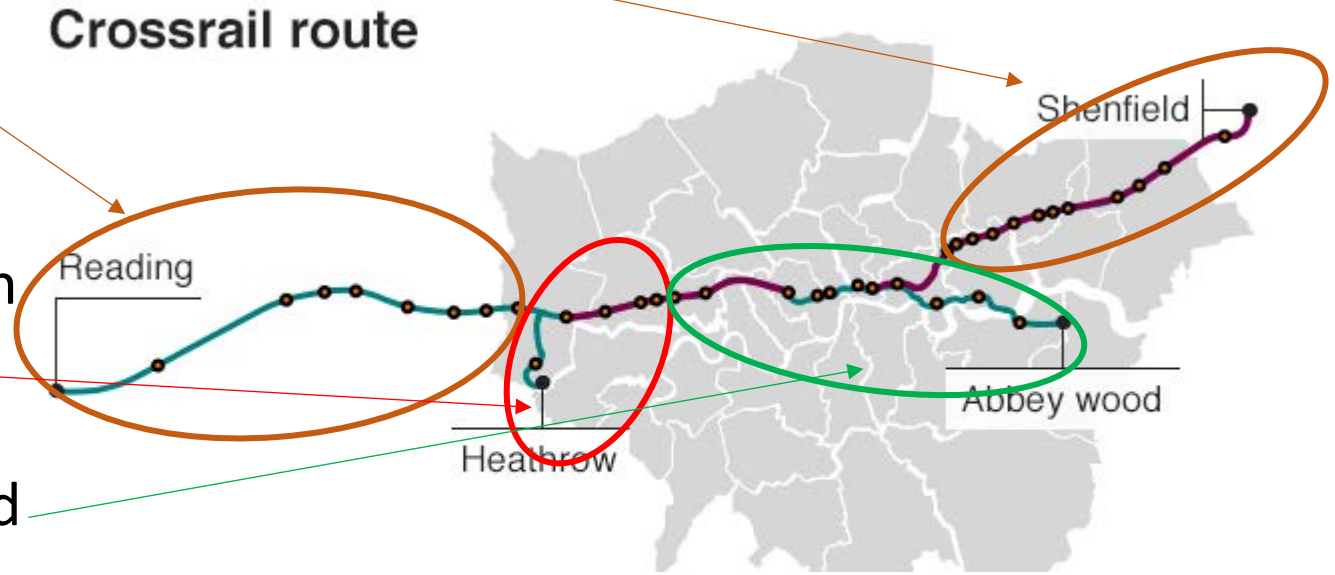




Bad ground, tunneling delays and very restricted access!

What went wrong? - Signalling

- Signalling required the integration of three separate systems:
  - West of Heathrow and east of Stratford, the train uses Network Rail legacy systems with safety enhancements
  - The section between Paddington and Heathrow uses the European Train Control System (ECTS)
  - The central (tunnel) section uses a modern communications-based train control system



Train frequency: 24 per hour = train every 2.5 minutes.
Each train is 200 metres long, carrying up to 1,500 passengers

What went wrong?

- The ‘story’ used in 2018:
  - An electrical transformer explosion at an east London station in Nov. 2017
  - Delayed tunnel trials until Feb 2018
  - Those tests have not gone as well as Crossrail management ***hoped***
- ***Hope is not a strategy!***
- The location was at the interface between Network Rail infrastructure in the east and the central section of Crossrail

What went wrong?

- Crossrail chief executive Simon Wright and chairman Terry Morgan
  - Morgan: “problems that emerged were mostly due to difficulties with developing software to allow Crossrail trains to travel safely at speed through three separate signalling systems”
  - Wright: “We were testing on incomplete systems. Productivity was under stress, but we fought hard to maintain the schedule and thought all along that we could find a solution to bring it back, just like we have done on countless other problems that occurred during the construction programme,”

- **Civil engineers don’t understand software (neither do most managers)!**

Evidence to **The London Assembly** – Sept. 2018

What went wrong?

- **The delay did not start in November 2017!**
- In 2015, *The Independent* reported that engineers and rail experts were struggling to create interfaces that would allow trains to switch from legacy signalling systems to newer ones
- In October 2018, Crossrail's head of technical assurance said that integration was still a massive challenge
- In April 2019, the new management team "many risks and uncertainties remain in the development and testing of the train and signalling systems….."

What went wrong?

- In April 2019, “As the programme to complete and test the railway progresses, Crossrail Ltd will be able to provide increasing certainty about when the Elizabeth line will open”
- At least this is an honest assessment – the window for completion of the central section is end of 2020 +/- 3 months

- The western surface line between Paddington and Reading will commence in December 2019
- The eastern surface line is already working

Working on the recovery

- There are four major tasks that must be completed:
  - Build and test the software to integrate the train operating system with three different signalling systems (ie, software)
  - Install and test vital station systems (ie, software)
  - Complete installation of the equipment in the tunnels and test communications systems (software + hardware)
  - And when this is done, trial run the trains over many thousands of miles on the completed railway to shake out any problems and ensure the highest levels of safety and reliability when passenger service begins – ***now happening***
- The to-do list to complete the railway was 250,000 items long

Working on the recovery

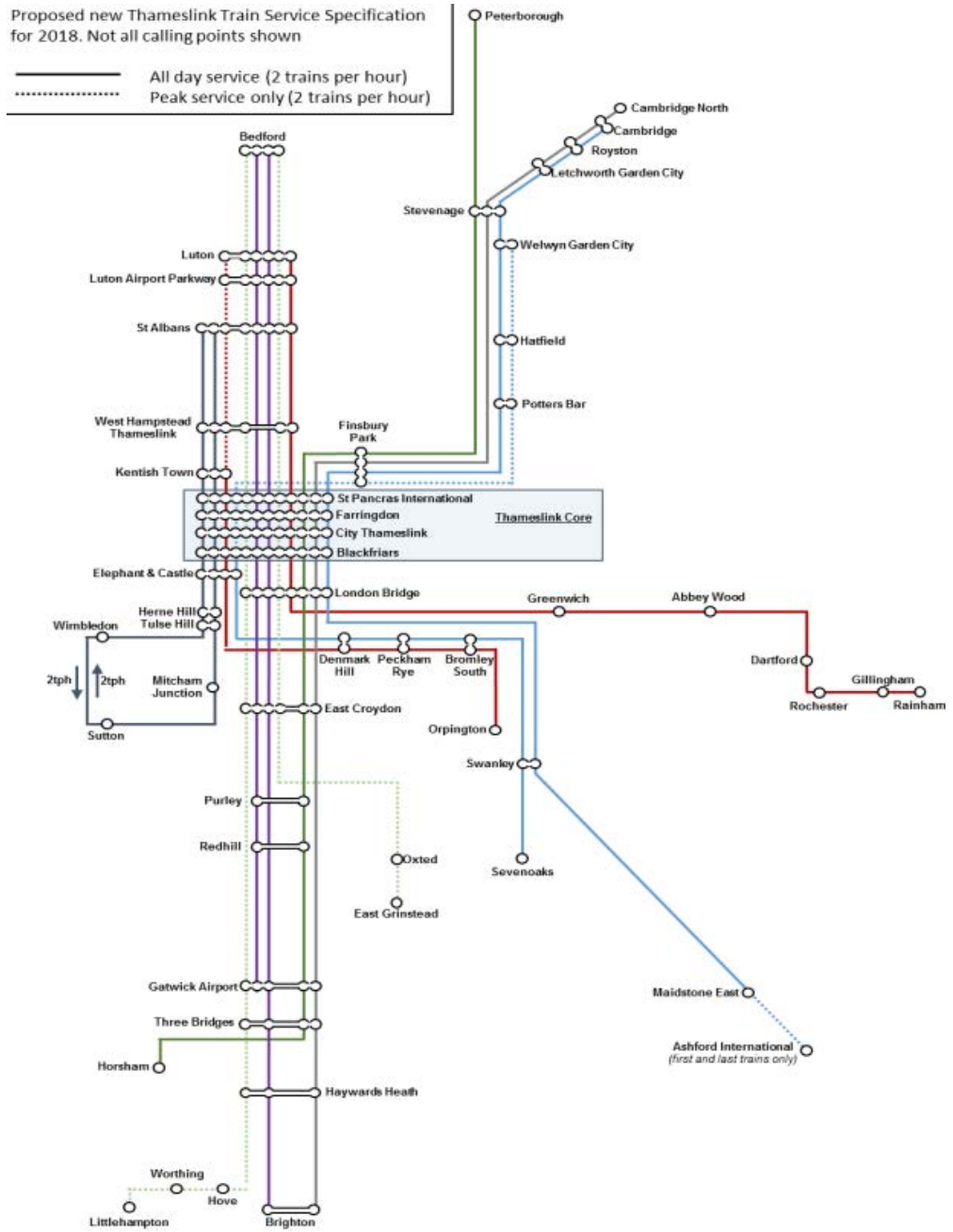
- New CEO, Mark Wild:
  - “the amount of software development still to do on the project was the reason there was still so much variability in opening dates despite the detailed plans”
  - “Crossrail, excluding Bond Street station, would open sometime between October 2020 and March 2021”
- New chair Tony Meggs:
  - “The window is not an attempt to avoid accountability, it is really a reflection of the reality of the considerable amount of work that still needs to be done and the uncertainty about exactly how long some of those things will take, in particular the amount of software development we have to do.”

Project management issues

- Arguing about who knew what in 2018 is irrelevant
- Management failures:
  - **Wrong culture**, protecting the mantra ***'on time and on budget'*** seemed to be more important than solving issues!
  - **Lack of transparency** – but bad news does not get better with keeping….
  - Lack of rigour in reporting
  - Lack of effective independent oversight (TfL and Dept. of Transport failed)
- **The software problems could have been identified in 2015 if someone had looked properly!**
- **Bond St station is just a nasty construction problem……**

Effective project controls

- A different rail project in London…..
- Thameslink
  - £7bn budget
  - Largely complete and working
  - But focused on upgrading existing infrastructure



Effective project controls

London Bridge Station – totally rebuilt with 80 trains per hour still using the facility

Problems were independent and sequential

Key differences

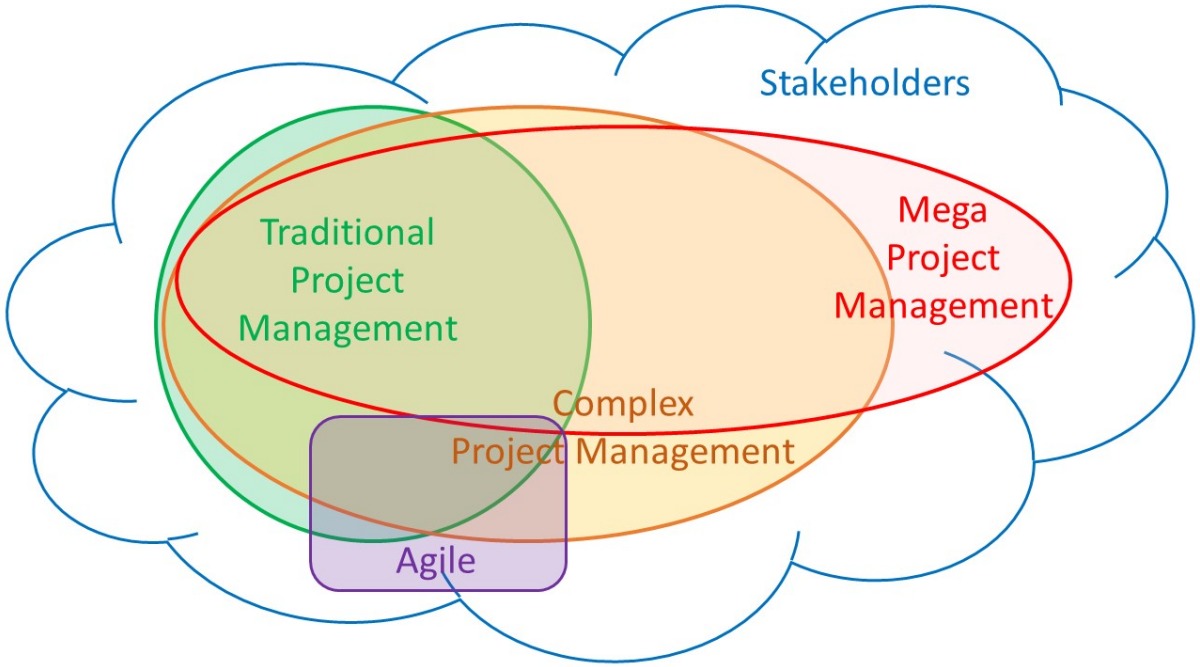
- Accountability
  - Thameslink owned by Network Rail , funded Dept. Transport
  - Crossrail independent company created by Act of Parliament, reporting to and part funded by TfL and Dept. Transport, interconnected to Network Rail

- Project structure
  - Thameslink has many strands of work in an overall program – lots of flexibility
  - Crossrail one major project with messy elements at each end – limited flexibility

Key differences

- Technology
  - Thameslink incremental upgrade of existing infrastructure, limited new build
  - Crossrail major new facility, new signaling systems, new stations, new control systems, etc., BUT: needing to interface to Network Rail

- Complexity
  - Thameslink business as usual, just more of it
  - Crossrail highly complex series of relationships and interconnections



Lessons #1

- Avoid single points of failure:
  - Thameslink had very flexible ‘opening’ options
  - The core of Crossrail (the central London tunnels) is a single point – trains either run, or don’t run through the tunnels
- Avoid complex oversight structures
  - Thameslink was ‘owned’ by Network Rail, reporting to the government (DoT)
  - Crossrail had a degree of independence (to avoid political interference) two oversight agencies (DoT and TfL), Network Rail as a key stakeholder for the trains, TfL as a key stakeholder for all of the interconnections with the London Underground ……

Lesson #2 (Bond Street Stn.)

Risk is an inevitable certainty – live with it

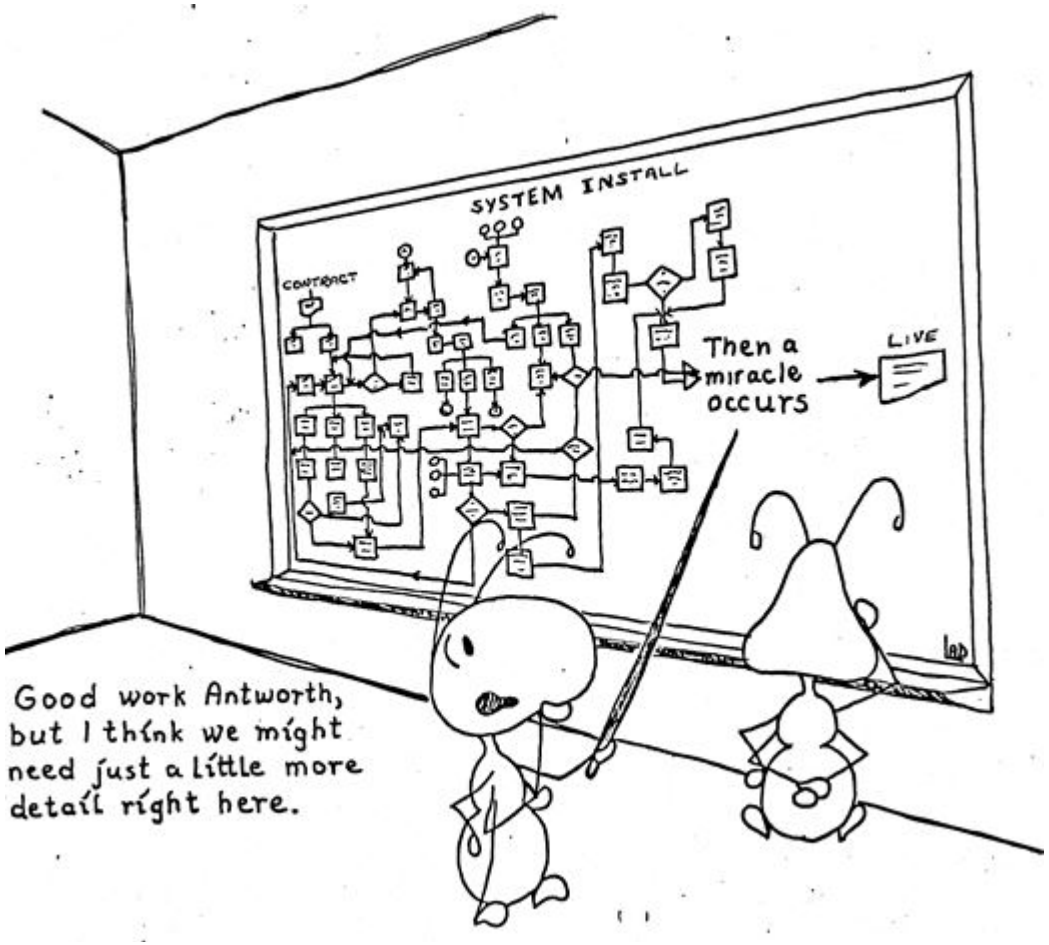
- Understand the difference between uncertainty (events) and variability
- Find out where similar projects have failed in the past
  - Reference class risk assessment helps
- Design for risk (eg, modular development)
- If its ‘bleeding edge’ expect to be ‘cut’ – allow time for repairs
- Allow people to talk about risk
  - *I’m not sure about xxxx* – Remember the Dunning-Kruger effect!
  - Every estimate is wrong!
- Constant vigilance – pick emerging problems early
- Hope for a sensible customer – they are a scarce commodity…

Lesson #3 – Keep it real

Plan sensibly (cost & time)

- The scope is a fixed constant that defines the work to be done
- You can only use the resources you have – **miracles rarely happen**
- Resources drive the cost of the project
- Resources and ***how well they are used*** determine the duration of the project
- You need contingencies

Hope is not a strategy



Lesson #4 – Small things matter

Systems integration is never easy

- It is always a major risk
- Progress is nearly impossible to measure
- Testing is incredibly complex
- Initial failure is more common than success
- Many projects ignore this ‘small task’

Lesson #5 – Technical Debt is Insidious

Don’t take the easy way……

- It is the costs of having to go back and resolve problems that arise because an earlier decision was made to take the easy route, instead of the best one

Lesson #5 – Technical Debt is Insidious

Don’t take the easy way……

- **Technical debt** is a concept that reflects the implied cost of additional rework caused by choosing an easy (limited) solution now instead of using a better approach that would take longer
- Complexity compounds the problem – the rectification takes far longer than doing it right the first time
- Plus you have the cost of the initial ‘quick fix’
- Primarily a software and ‘soft-systems’ issue – you cannot see or test for the problem

Lesson #5 – Technical Debt is Insidious

Do the work right the first time

- Stress kills quality – focus on results not deadlines
- Tired people make mistakes – look after your team
- Take the time needed to set up the job properly – it saves time in the long run
- Everyone makes mistakes – help people learn and recover
- Your project is only successful at the end – cutting corners to stay ‘on-time & on-budget’ in the early stages leads to the next ‘Crossrail’

Lesson #5 – Technical Debt is Insidious

Testing is supposed to find problems

- Cutting down on testing leads to disasters – allow the time needed
  - Most IT development this is 25% to 30% of the project time
- Organize to do the work perfectly – it's the cheapest option
- Plan to deal with reality:
  - Design testing into the development
  - Design the testing thoroughly
  - Test for the 'worst case' – remember the last Australian census
- Don't just fix problems – they are rarely a one-off unique problem
- Look for causes (root cause) and implement preventative actions

Lesson #5 – Technical Debt is Insidious

- **Be prepared to look for problems**
- Crossrail went from:
  - We will be finished in 4 months to
  - Over ¼ million activities needed to allow full operation
- Some work was blindingly obvious (eg Bond St Station)
  - A culture of ‘she’ll be right’?
  - Refusing to look?
  - Deliberate lying to the community?
- Assurance is a vital component of complex projects!

Lesson #5 – Technical Debt is Insidious

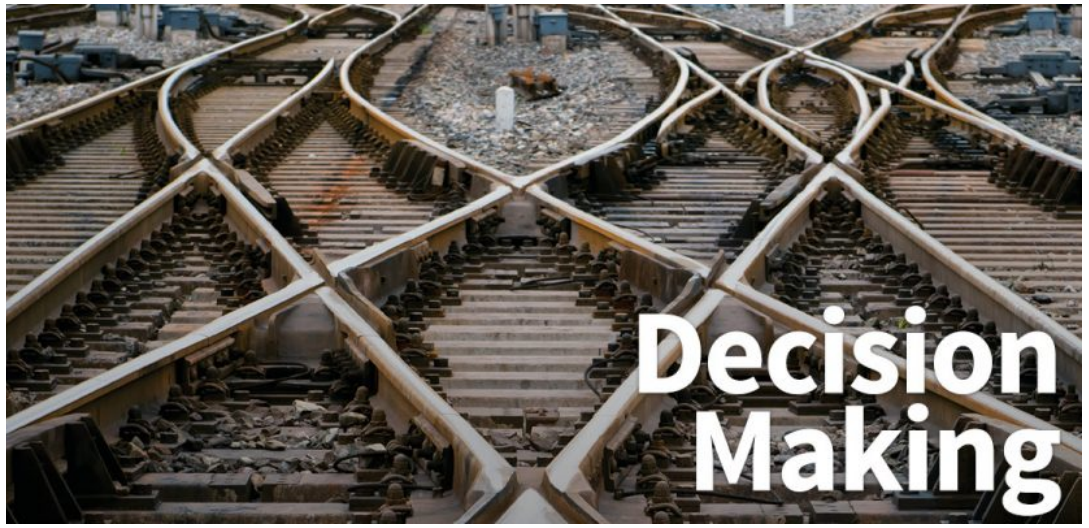
- **Be prepared to look for problems**
- Technical debt is more insidious:
  - The ‘quick fix’ may hid problems until stressed (eg, the last census)
  - The cost of rectification can be massively more than just doing the work - but you cannot foresee this
  - Systems of systems are complex (as well as complicated)
- Complexity means
  - Emergence of bigger problems driven by interconnectivity
  - Tipping points into chaos
  - Non-linear escalation of problems

Lesson #5 – Technical Debt is Insidious

- **Be prepared to take the hit early**
- Plans are always wrong (you don't know how wrong until later)
- Estimates are simply a prediction about the future
- Change is inevitable
- **Doing the job right the first time is still the cheapest and quickest option**

Conclusions

- Good project management processes provide reasonably useful information on:
  - Time and cost
  - Scope definition and accomplishment
  - The effect of risk
  - The achievement of quality
  - Predictions on the future performance of the work
- Good project managers use this information:
  - They make decisions and are proactive
  - They communicate for effect



Conclusions

- Success is ephemeral:
  - On-time and on-budget is less important than useful and wanted
  - Quality is vital – it will be experienced long after the other factors are forgotten
- Crossrail is not so bad – time and cost overruns are typical, not exceptional
- The ‘disaster’ was caused by management ignoring emerging problems and misinforming just about everyone
- The costs and consequences are magnified by the consequences of technical debt – this could have been avoided

Conclusions

- Unfortunately most benefits realization and value creation occur after the project is finished
- Good project managers keep focused on these outcomes and manage to maximize value
- But they need the support of good senior managers and sensible clients – both are very rare commodities

Sydney Opera House,
Australia's most successful failure!

mosaic

Who's cross about Crossrail

Millions of London commuters,
the UK Government, the Lord Mayor of London
and a very, very long list of stakeholders…

Questions??