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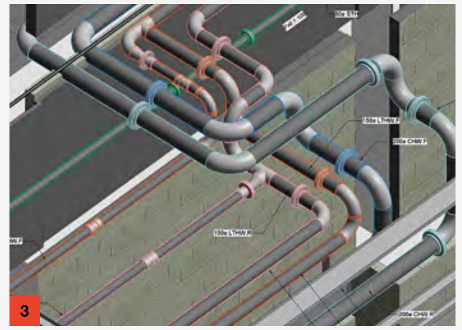

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1_Aerial view of the Francis Crick Institute, adjacent to St Pancras International Station and the British Library
2_East end of the building depicting the structure and logistics at a particular point in construction
3_Planning the Crick's north corridor main mechanical pipe run crossover in the digital environment
4_4D representation of the planned construction progress as of May 2013

The Francis Crick Institute charity was formed in 2011 as a consortium of six of the UK's leading scientific and academic organisations – the Medical Research Council, Cancer Research UK, Wellcome Trust, University College London, Imperial College London, and King's College London. It is named after the British molecular biologist, biophysicist and neuroscientist Francis Crick, co-discoverer of the structure of DNA.

The consortium has invested around £700 million to establish the new centre and ensure it is appropriately resourced in order to make the desired impact. When fully operational the centre will employ 1,500 staff including 1,200 scientists, and have an operating budget of over £150 million a year (Callaway, 2015). Its work will help to develop new treatments for illnesses such as cancer, heart disease, stroke, neurodegenerative conditions and infectious diseases, as well as being a world centre of excellence for influenza.

As construction delivery partner, Laing O'Rourke has been keen to heighten public awareness of the project and its contribution to society from the outset. The business manages an interactive visitor centre, in collaboration with the Francis Crick Institute – and has also supported numerous community initiatives such as the Prince's Trust 'Get into Construction' programme.

Building design
The vast building consists of four reinforced concrete blocks up to eight storeys high plus four basement levels. The basements were built top-down using plunge piles, while the blocks are interconnected above ground with steel-framed circulation areas and bridges.

The total internal floor area is $82,578m^2$ including $29,179m^2$ of laboratories with 4km of laboratory benching and $21,839m^2$ of associated write up space. The building design was developed with input from scientists, London Borough of Camden and community groups. The design supports the Institute's goal of 'discovery without boundaries', promoting both collaboration and public engagement.

The terracotta cladding and vaulted aluminium-louvred roof echo the 1868 Barlow train shed of the adjacent St Pancras International station. The two shells of the dramatic, curving roof conceal an extensive ventilation plant and a large array of photovoltaic panels.

Large windows and tall glass atria maintain natural light and sightlines throughout the work and public areas, encouraging researchers to interact with each other and share ideas. A third of the building is below ground to reduce its visible mass as well as to provide enhanced shielding and security for some of the more sensitive research.

1,200

Medical scientists will work in the building along with 300 ancillary staff.

33%

Of the building is below ground.

THE 'ONE-TEAM' APPROACH HAS INCLUDED DIRECT CONTROL OF THE DIGITAL ENGINEERING SOLUTIONS, MOST OF THE OFFSITE MANUFACTURING AND DELIVERY PROCESS, AND NEARLY ALL THE CONSTRUCTION AND INSTALLATION ON SITE.

The general laboratories are arranged over four floors. A typical floor consists of four interconnected working areas, helping to bring together staff from different fields. The laboratories are designed to be adaptable to change as new scientific opportunities emerge in the future. There are two laboratory floors below ground as well, mainly biohazard design facilities.

Over one-third of the building area – a total of $34,972m^2$ – is dedicated to plant rooms and services distribution, making the facility more akin to a machine than a building. The plant rooms are capable of providing conditioned air at over $400m^3/s$ – as well as differentiated ventilation, steam, chilled water and a wide range of medical gases. There is also a combined-heat-and-power plant.

The electronic monitoring and maintenance systems are also unprecedented, with 25,000 data points and 27,000 building management system points. The building is managed over a converged network with 38 VLANs located in separate satellite equipment rooms, distributed across all floors and connected via fibre optic cables to a data centre for data capture.

The potentially hazardous nature of some of the virus research means that many laboratory areas have to comply with the government's stringent biohazard containment requirements. These include interlocked air-tight doors, comprehensive decontamination facilities, back-up power sources and ultra-high security systems.

Laing O'Rourke has nevertheless been able to deliver this incredibly complex facility on time and within budget due to its strategic commitment to self-delivery, Design for Manufacture and Assembly (DfMA) and digital engineering.

Self-delivery
Laing O'Rourke has provided the client, UKCMRI Construction Limited, with complete end-to-end delivery of the Francis Crick Institute building. The 'one-team' approach has included direct control of the digital engineering solutions, most of the offsite manufacturing and delivery process, and nearly all the construction and installation on site.

By self-delivering around 60 per cent of the work, Laing O'Rourke has been able to ensure the quality and value of this remarkable project for the client. The one-team ethos motivated the project team to conclude all preconstruction activities before work started on site, ensuring that construction and commissioning will also progress to a successful conclusion.

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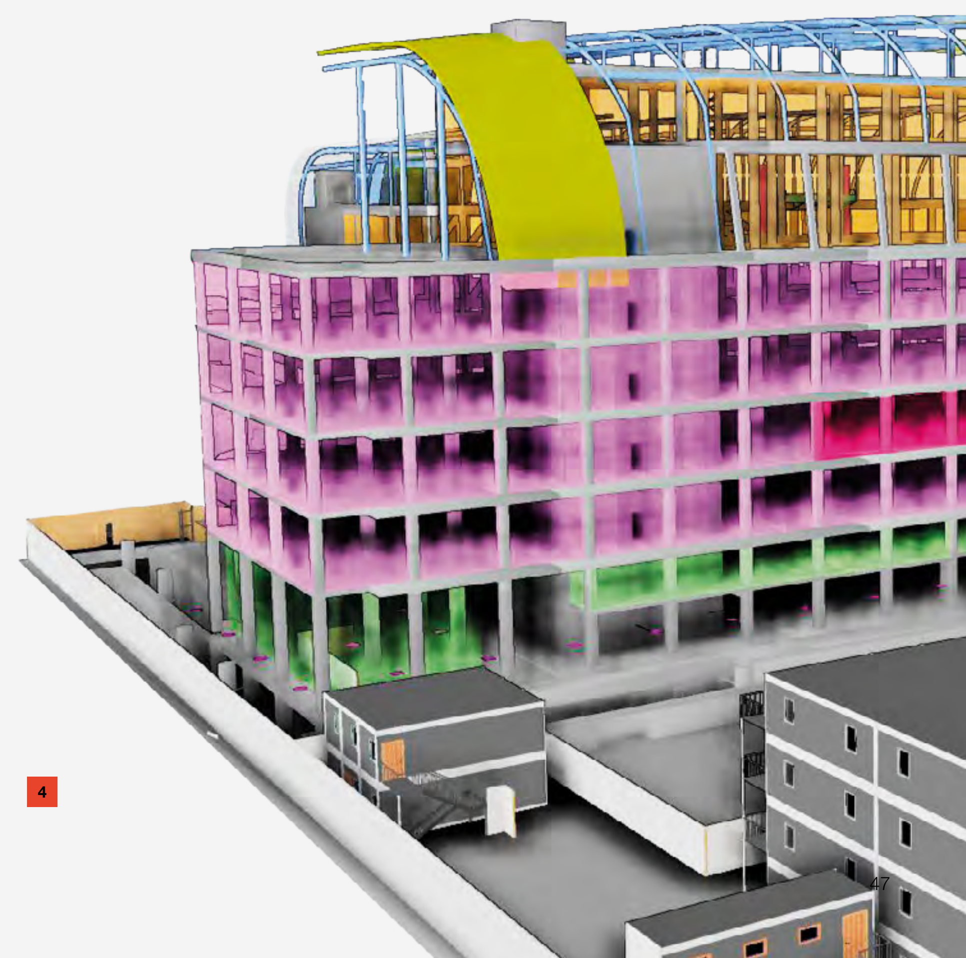


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One of the biggest potential programme risks was the testing, commissioning and validation required for the laboratory facilities, particularly those with biohazard containment levels of three and above. This focused the whole team on delivering engineering excellence throughout, ensuring the necessary validations were received at first inspection and with no resulting hold points.

Collaboration with the client has also been critical to success, helped by co-locating the Laing O'Rourke and client teams in the same site offices. It engendered a common desire to succeed among the 200 office staff and up to 1,000 site operatives, with everybody wanting to play their part in delivering this life-changing facility to the best of their ability.

Laing O'Rourke has also trained numerous apprentices over the four-year building programme, providing them with an excellent basis for future careers with the firm. This included 40 apprenticeship positions provided for local people from the London Borough of Camden.

MUCH OF THE £240 MILLION OF SERVICES FOR THE PROJECT WAS DELIVERED TO SITE AS FULLY ASSEMBLED MODULES.

DfMA

Much of the £240 million of services for the project was delivered to site as fully assembled, tested and commissioned modules manufactured at Laing O'Rourke's Crown House Technologies factory in Oldbury, West Midlands. A total of 15km of modules have been successfully delivered and installed, backed by 1,900 factory tests.

Also provided by Laing O'Rourke's Explore Manufacturing factory in Nottinghamshire were 15,465m² of twinwall precast structural wall panels and 41,282m² of lattice plank precast concrete floor system. The building envelope incorporates 22,000m² of precast terracotta cladding panels. Offsite solutions were investigated and, where possible, implemented for all elements on the critical path.

A collaboration between the Engineering Excellence Group and Cambridge University also resulted in an innovative piling technique, involving fibre-optic cables to measure the strain distribution and temperature of 260 piles. The fibre optic cables continually measure the strain distribution and temperature of the main support piles, enabling the slightest foundation movements or changes to be isolated and rectified immediately. This system instantly shows actual performance of the piles during operation and will also help to optimise pile designs in the future.

A further challenge was to devise a non-ferrous construction solution for the basement laboratories, which will house highly sensitive scientific equipment, such as nuclear magnetic resonance spectrometers, electron microscopes and super-resolution microscopes.

15km
Of plant modules delivered and installed.

40
Apprentices recruited from the local area.

The structural solution was to use stainless steel reinforcement in the precast concrete plunge columns. The 14m long, 15t columns were the largest ever manufactured off site. The room fit-out includes timber glulam beams.

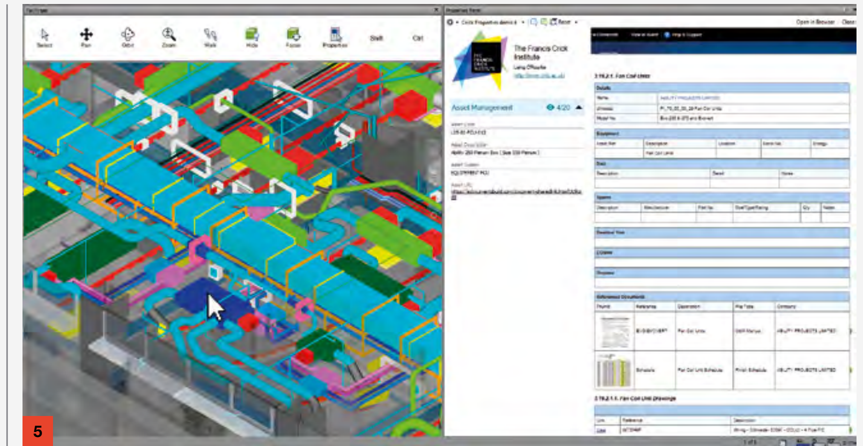
Digital engineering

Maintenance of such a sophisticated facility is critical, requiring a clearly defined servicing and replacement strategy. Laing O'Rourke's digital engineering team will deliver an as-built model at handover that will contain all major assets, tagged with a specific code for use in a computer-aided asset management system.

Starting with a coordinated master file in Autodesk Navisworks, and the original authoring models in Autodesk Revit, Laing O'Rourke has incorporated all subsequent design and construction changes and added more building information models as suppliers have made them available.

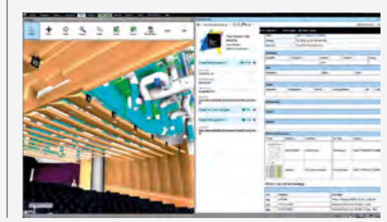
Each asset in the model is linked to its respective specification sheet within the online operation and maintenance manual provided by Edocuments. This minimises the need to update the model as changes to asset information – be it servicing, warranty, spares or even changing the asset entirely – can be done without having to re-author and re-export the model.

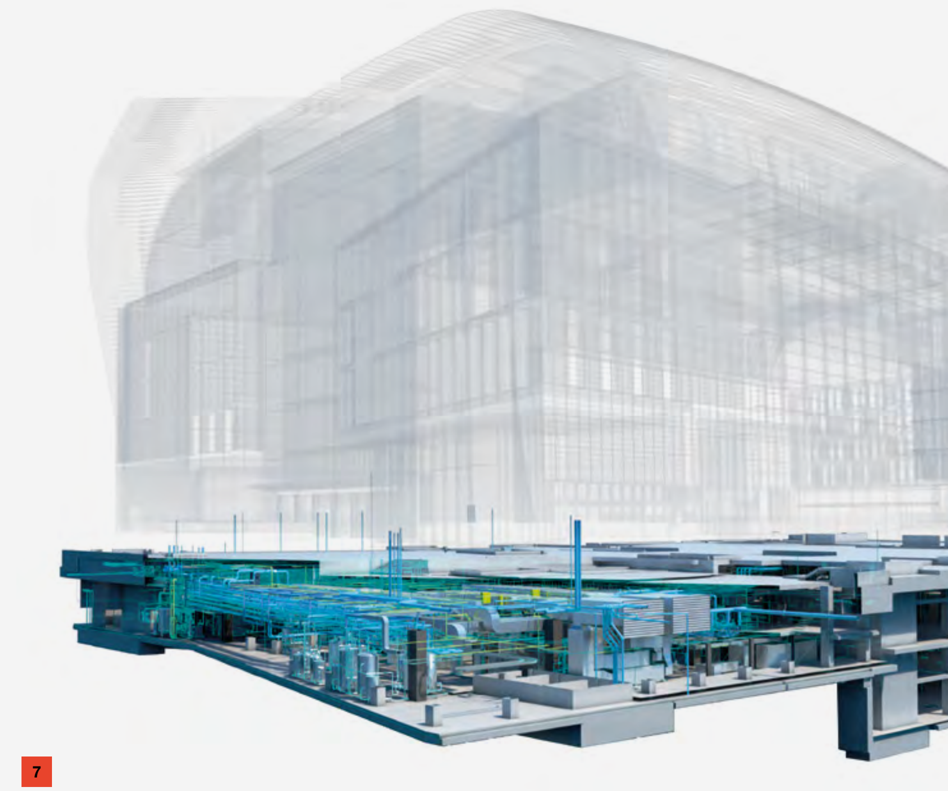
The model handed to the client will be in Navisworks format, with the building separated floor by floor. By linking the model to the operation and maintenance, the client and facilities manager can readily inspect assets that are in hard-to-reach or inaccessible areas.



To overcome the overwhelming amount of data associated with combining hundreds of models from six different building information modelling authoring platforms, the digital engineering team commissioned a bespoke add-in to Navisworks that unifies the display of data, ensuring clarity and consistency for users. When selecting an asset that is part of a system, the user can highlight that system and trace it to all areas of the building.

The key to Laing O'Rourke's successful delivery of the Francis Crick Institute is making sure it understands how the client will use the information. This has involved a much wider stakeholder engagement exercise and will result in a set of information that has an operational context far beyond a useful wayfinding tool.





5_Fan coil unit O&M information being accessed directly from the digital model within the laboratory ceiling space

6_Interface of O&M information being accessed directly from the digital model within the auditorium, accessed via a tablet device

7_Cutaway view showing the energy centre in the basement

THE FRANCIS CRICK INSTITUTE IS A PERFECT EXAMPLE OF THE UNPARALLELED CERTAINTY AND VALUE THAT CAN BE ACHIEVED THROUGH LAING O'ROURKE'S SMARTER, DIRECT DELIVERY APPROACH.

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Conclusions

The Francis Crick Institute is a perfect example of the unparalleled certainty and value that can be achieved through Laing O'Rourke's smarter, direct delivery approach.

The hugely complex, highly technical building has been delivered to the client's and regulators' exacting specifications thanks to the company's ability to directly deliver over 60 per cent of the design, engineering and construction work.

The one-team approach has supported exceptional levels of coordination and collaboration within the project team, reflecting the collaborative research this extraordinary building is designed to achieve.

Reference

Callaway E (2015) Europe's superlab: Sir Paul's cathedral. Nature 522, 406–408 (25 June 2015) doi: 10.1038/522406a

Main contributor

Jonathan Abbott is the Laing O'Rourke Project Executive on the Francis Crick Institute. He joined the Group in 2007 to lead the delivery of the £250 million Tunbridge Wells Hospital in Kent, UK. Jonathan has a wealth of engineering expertise gained during a career spanning nearly 40 years. He has held a number of senior project and operational management roles with some of the UK's best known construction companies and engineering consultancies.

Case study: New Generation Rollingstock

DELIVERING A STATE-OF-THE-ART RAIL MAINTENANCE CENTRE ON A CONSTRAINED SITE WHERE 30KM OF IN-GROUND SERVICES AND TEN RAILROADS CONVERGE IS NOTHING IF NOT COMPLEX. BUT, AS PART OF THE QUEENSLAND STATE GOVERNMENT'S LARGEST EVER SINGLE INVESTMENT IN RAIL INFRASTRUCTURE, THERE CAN BE NO ROOM FOR ERROR.