Benefits and outcomes

Our research has led to benefits for our industry collaborators, as well as for other research stakeholders, such as policy-makers and professional institutions. It has also increased the level of expertise in the sector, through training and education, providing long-term benefits to our members and partners, and to the sector as a whole.

Benefits and outcomes

Laing O'Rourke: A 10-year celebration of collaboration and innovation

Image
Grange University Hospital, Cymbran Wales, an example of full DfMA

Systems Engineering — fundamental to delivering our most complex projects

The pioneering application of Systems Engineering, on projects such as Heathrow's Terminal 5, is just one example of Laing O'Rourke (LOR) embracing best practice principles and innovation, throughout our ten-year relationship with Imperial College London.

What began as Design for Manufacture and Assembly (DfMA 70:60:30), has continued to develop our Modern Methods of Construction (MMC) approach and delivery model.

This has been built on for over a decade, delivering against two key objectives:

- Continual investment in a specialist engineering function
- Development and improvement of a leading-edge engineering skills base, through the sponsorship of PhD students, funded research and skills training.

Continued focus on R&D to transform the construction industry

By continuing to focus on research and development, Laing O'Rourke's approach always starts with an objective look at the business requirements of a project or technology opportunity. Only then can the key objectives and outcomes be developed, followed by the technical detail that is required. This ensures systematic project delivery that meets requirements and delivers quality commercial outcomes.

Top
Leadership CPD at Imperial

Right
Crossrail Train

Laing O'Rourke develops new business models to transform construction, with digital systems integration now fully part of their DNA. A commitment to MMC encompasses both digital and technological innovation, and this runs directly in parallel to the practical advice given to project leaders, to ensure continuity and consistency between project set-up and the subsequent operational delivery.

Following Laing O'Rourke's contribution to the birth of Systems Engineering in infrastructure in the Terminal 5 programme at Heathrow Airport, the company has continued to invest in systems engineering and digital capability, leading development across key infrastructure projects — the London 2012 Olympics, Crossrail and now High Speed 2. These are all projects that have played a key part in the development of BIM standards, and supported key government initiatives — including the Avanti Programme, the UK BIM Task Group and the Centre for Digital Built Britain.

Our partnership with the Imperial Centre for Systems Engineering and Innovation is a striking example of continued commitment to digital innovation. It provided emerging insights on design changes using BIM data, network analyses and co-modelling approaches. Other new methods included: addressing productivity in construction; construction progress monitoring and tracking; and, practical advice on how to use shared visualization of data, often across different disciplines.

New knowledge: unlocking future opportunities

With access to the Centre's latest research and thinking, this knowledge has influenced Laing O'Rourke's strategy and approach, with new skill sets being developed within the company.

These have been applied to improve our delivery programmes, and support our projects, which are the beating heart of the business. As we have further extended and developed our expertise within Laing O'Rourke, we have applied these new techniques and skills in various other areas. This has unlocked a series of opportunities.

New nuclear: using Modern Methods of Construction

The centre supported Laing O'Rourke's research to extend MMC principles into Nuclear New Build inspired through our involvement in the Hinkley Point C nuclear power station project, and other programmes such as the Rolls-Royce led Low Cost Nuclear Small Modular Reactor LOR engaged PhD researcher Dr Jean Paul Vella - through its connections to the Centre - to develop connection methods which would extend our 'kit of parts' approach, and unlock increased productivity in seismically qualified Nuclear construction.

This project had three key objectives:

- Reduce the width of joint connections between precast concrete slab panels, to reduce the time and cost onsite.
- Reduce the need for the conventional formwork and propping, to temporarily support the structure while the joint develops the specified strength.
- Validate the structural reliability of the off-site MMC modular approach in the nuclear environment.

Designs produced from the research have been adopted across a broad range of products and solutions - manufactured offsite for construction and infrastructure projects at LOR's modern centre of construction excellence at Explore Industrial Park,. Jean -Paul Vella has joined the Laing O'Rouke team to help transfer this learning directly into practical application.

Planning and logistics research benefitting Hinkley Point C

Working closely with the Centre's Professor Washington Ochieng and Dr Panagiotis Angeloudis, construction planning and logistics research has benefitted and aided the construction of the Hinkley Point C nuclear project, and, their operations in the Precast Yard.

The first research project resulted in the development of a microsimulation model, which focused on the multimodal logistics of urban construction projects. The model had the ability to plot a route for prefabricated component shipments through rivers and waterways, to meet construction sustainability goals set by the UK Government. This model served as the foundation of the Delos simulation engine, which has been in continued development since then, and has since been used by more than 10 researchers as their primary 'experimentation sandbox' for logistics and mobility studies.

The second of Professor Washington Ochieng and Dr Panagiotis Angeloudis' research projects, developed an automated layout planning tool which has been deployed on the Hinkley Point C construction site. It is also used to coordinate the casting of building components, considering the lifting equipment available, construction schedules and safety restrictions.

Other projects have created simulation models to support tower crane performance and improve efficiencies across the vast site in Somerset.

Images
Hinkley Point C, EDF Group

Super yacht technology meets the architectural challenge at Bishopsgate Unique Structural Solutions

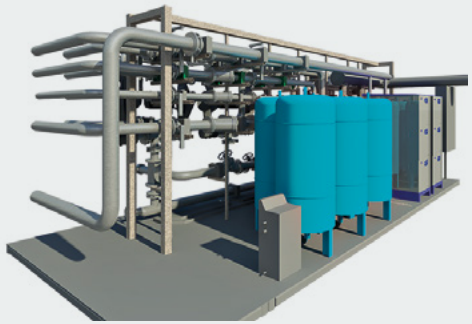
Systems Engineering principles were the key to addressing a complex engineering and supply chain challenge on 150 Bishopsgate. The project, to construct a central London tower, was fulfilled by Laing O'Rourke's concrete structure specialists in Expanded. The architectural requirement was to support the corners of each floor plate all the way up the tower, which has a bold stainless steel 'exoskeleton' similar to a tall ship rigging system. By having rigorous systems engineering principles in place, it ensured that detailed requirements and explicit verification and validation methodologies were used to develop the design.

The rigour in LORs approach also fully supported the manufacturing, supply chain and site assembly processes. The resulting solution brought leading-edge technologies from the worlds most advanced super yachts, safely into the construction environment.

Advancing MMC modular solutions for new Schools

Systems Engineering principles are central to Laing O'Rourke's R&D strategy, along with the continued development of modular building products and solutions. Laing O'Rourke has collaborated with the Centre on some of the key MMC innovations on recent schools' projects. Laing O'Rourke scholars from the Centre conducted research, and developed solutions to aid the design process.

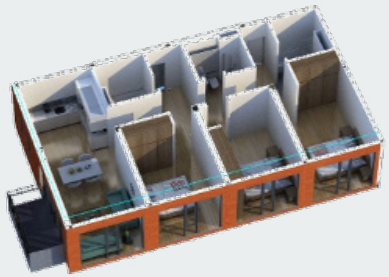
One example was Irek Starzk, a graduate of the Masters in Systems Engineering and Innovation programme, who developed an approach that utilised digital technology to visualise the plant room assembly process. This led to a series of 'packaged plantroom' solutions, that have improved productivity by 50%, and established a platform system for LORs new school development projects.

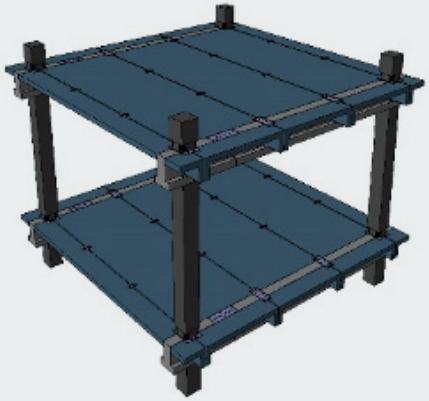


Left
Parametric tool for the design of modular plant-rooms. Delivery will requite a step change in parts of its supply chain

Right
150 Bishopsgate

Modular construction
Laing O'Rourke is a leader in offsite modular production methods





Prefabricated concrete frames
Prefabricated concrete frames - Laing O'Rourke has worked with Imperial College London on innovative jointing methods

Advancing MMC modular solutions for housing

Laing O'Rourke has developed an advanced manufactured housing solution which will transform the sector. Steel framed housing modules will be precision-manufactured in a highly automated facility, resulting in residential apartment buildings which will be 95% complete within the factory environment, with a 95% reduction in terms of labour costs and on-site construction time.

Laing O'Rourke's Advanced Manufacturing Facility (AMF) relies on the application of Systems Engineering to create configurable products and provides the essential technical integrity required. The AMF has enough system flexibility to meet a wide range of client requirements, and with highly automated manufacturing processes which operate to the highest standards, the beneficiaries will be future residents. The design and engineering programme has been led by Doug Baldock, a Masters graduate from the Centre, who joined Laing O'Rourke to deliver the project.

Advancing re-usable structural solutions for ultra-fast construction.

Laing O'Rourke has developed a new, patented structural system that can be built up to 4 times faster and saves up to 70% of embodied CO_2 when compared to a traditional structural system.

A key feature of this 'D-Frame' system is the connection development and testing which was completed following a systems engineering methodology with the Imperial College Civil Engineering department. This enables the structure to be simply 'deconstructed' and re-used or re-configured supporting the principles of the circular carbon economy.

Executive level education to advance the industry

Not only has Laing O'Rourke supported t he Centre by developing engineering skills throughout the industry, via the Laing O'Rourke Scholarship Programme, a Systems Engineering Leadership Programme has also been developed.

The latter programme is designed to develop systems engineering leadership in the delivery of built infrastructure. The programme covers:

- The fundamentals of systems thinking and systems engineering
- The role and contribution of systems engineering — to address the challenges required to transform the construction industry, while creating safe places for users of the built environment
- Technical leadership skills — for using systems engineering in the delivery of the built infrastructure

This development programme has already benefited both Laing O'Rourke staff and over 200 other industry Professoressionals.

In conclusion: 10 years of the construction value-chain

Throughout the 10 years of support — via the complete end to end construction value chain we've undertaken — Laing O'Rourke has provided both fertile research (and reference territory) for the Centre's team, as they developed their leading-edge capabilities.

Laing O'Rourke will continue to support the Centre as it evolves to address the challenges of the next 10 years.

By supporting the application of Systems Engineering and Innovation, throughout the construction sector, we hope to continue enabling successful delivery of the most complex projects in the future.