



Metros

Metros

Skills and services

Sector skills

Fire engineering
Human factors
Permanent way
Railway bridges and tunnels
Railway geotechnics
Rolling stock
Signalling and systems
Stations, terminals and depots

Key services

Advanced simulation
Asset management
Commissioning
Communications and systems
Cost consultancy
Design
Due diligence
Economic analysis
Electrification and traction power
Independent checking
Inspection
Mechanical and electrical
Network modelling
Operations and maintenance
Planning
Procurement and tender adjudication
Project finance
Project management
Site management
System engineering and assurance
Traction power
Tunnel ventilation and railway aerodynamics

Mott MacDonald's experience in metro projects stretches back over 130 years

The £700 million upgrade of Victoria Underground station in London involves the creation of a new ticket hall, escalators, lifts and walkways. Mott MacDonald has been appointed lead consultant for the detailed design.



A proven track record

Bangkok and Budapest, Dublin and Delhi, Seattle and Singapore – Mott MacDonald's experience in the development of metro projects stretches back over 130 years and covers the globe.

Our leading role in the implementation of major worldwide transportation projects has resulted in an unrivalled depth of knowledge and experience. This has been central to our success in the planning, design and construction of metros and mass transit railways. International metro projects over the last 25 years include Caracas, Singapore, Toronto, Los Angeles, Delhi, Kaohsiung, Porto, Hong Kong, San Francisco, Dublin, Baku and Melbourne. In London alone we have worked on London Underground's Central, Victoria and Jubilee lines, Docklands Light Railway, rail links to Heathrow Airport and Terminal 5, and Crossrail.

Mott MacDonald is very proud of its reputation for technical excellence and innovative solutions and we are continually improving our skills and services in the metros sector to better serve our clients. As a global organisation we are able to assemble multidisciplinary teams anywhere in the world to suit client requirements and any size of project. Whatever the commission we provide customers with an outstanding commitment to care and quality.

Mott MacDonald is providing design work on almost 40% of Phase II of the Delhi Metro system including a 22km stretch from the heart of Delhi to the city's south east border. We're also working on 21 of the 26 underground stations being developed over the two phases of the project.



Management and implementation



We were project manager for Bangkok's £2 billion metro system, which was the largest single consultancy contract in Thailand at the time of its award. The scheme includes a 20km section passing beneath the heavily urbanised areas of the city.

Mott MacDonald provides a fully comprehensive service for the design, development and operation of metro systems. Our extensive experience in global metro projects has given us a full understanding of how projects work from start to finish. We utilise our worldwide resources and expertise to provide the breadth of vision to plan and control every aspect of the project, from planning, designing, engineering and environmental issues to full project management services. As an independent safety assessor, independent checking engineer and notified body, we give confidence that a system will be delivered safely to the highest technical standards. Our systems ensure that our teams have the information needed and the capability to enable informed decisions to be made throughout the development process.

To maximise buildability we adopt an integrated approach to design, drawing on complementary disciplines within Mott MacDonald. Our knowledge of plant, methods and sequence adds value to projects and our approach to systems design avoids over-engineering. We streamline designs to enable easier construction and carry out requirements engineering and design reviews, and verification and validation processes. Our use of the observational method can facilitate innovative construction to eliminate heavy temporary propping and create substantial savings. Our staff maintain effective communication with design teams and as construction nears completion, arrangements are made to facilitate a smooth and efficient handover.

Our services continue through to commissioning. We undertake the independent testing of rolling stock, installations and systems, and assist in the training of operators and staff. Mott MacDonald's Railway Approvals team acts as an independent certification authority to confirm that appropriate quality management systems are in place and ensure independence with a high level of technical competence. Our core team manage all railway certification and assessment projects and draw upon the expertise of other rail professionals within Mott MacDonald as required.

Mott MacDonald is working on eight out of 24 design contracts on Crossrail, Europe's largest infrastructure project. We are bringing state-of-the-art skills to the design of tunnels, stations, signalling, traction power and rolling stock, delivering time and cost savings and improving safety.



Planning and sustainability

Mott MacDonald has undertaken studies for both public and private sector clients to assess existing and proposed transport networks, optimise route alignments and advise on feasibility and demand, revenue forecasting and economics and financing. Our access to strategic land-use/transport models allows us to advise on the effects of transport plans in terms of modal split and accessibility. We can model the operational effects and impacts of transport plans at both a network level and a wider overall transport systems level.

We proactively consider sustainability in all our projects and business activities and serve as an extensive source of knowledge on sustainability issues to our customers. We provide a complete spectrum of sustainability services, finding the best possible solution for every challenge while remaining aware of client needs, regulations, policies and public opinion.

Human factors

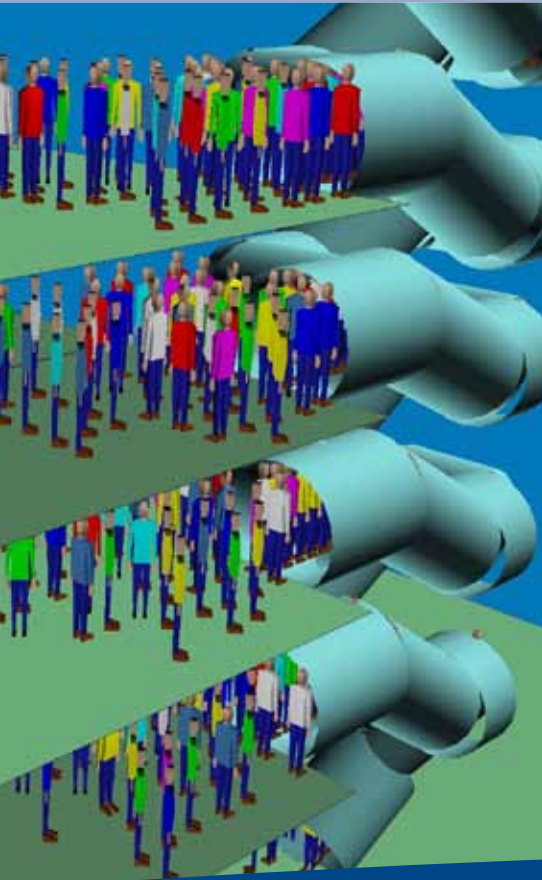
We recognise the importance of making metros as pleasant and stress-free as possible. Through human factors studies Mott MacDonald examines the many issues that can affect human performance and assesses their likely impact on human error and overall system risk.

We have a proven track record in managing human factors issues incorporating all aspects of the operator's involvement, including allocation of function between operator and equipment, display and control system design, communications facilities, workplace layout, operator workload and conditions of the working environment. Projects must also address issues such as station architecture and retail facilities, ease of ticketing and effective up-to-date communications – our expertise covers these services.

Mott MacDonald developed the surface transport master plan (STMP) 2030 for Abu Dhabi's Department of Transport. The STMP 2030 will see a comprehensive public transport network of rail, tram, metro, ferry and bus systems connect Abu Dhabi Island and Abu Dhabi International Airport with the UAE's planned new capital city, with high quality services linking the whole Emirate.



Our in-house designed STEPS program enables us to create real-time 3D studies for passenger routes, taking into consideration factors such as fire safety and the intermodal terminal movement of trains and buses.



Station design

Mott MacDonald provides a full range of structural, civil, mechanical and electrical design services for stations. Our experience covers new stations, complex interchange facilities and the upgrading and refurbishment of existing facilities. Each design presents its own set of challenges – whether co-ordinating with adjacent land owners, constructing in densely populated areas or accommodating passenger flow movement and maintaining train operations while extending or improving.

Simplicity of layout and clarity of signage provide for ease of passenger movement. We review the positioning of ticket offices and other retail outlets, staff accommodation, system facilities, stairs, escalators and ticket barriers in developing circulation routes for safe and free movement in all operating conditions.

Mott MacDonald's use of computer visualisation eases the often complex challenge of planning and designing a metro station. Incorporating project visualisations at the early planning stage enables clients to fully appreciate the form of a project and understand its impact. We also use STEPS, our state-of-the-art, in-house software tool for simulating pedestrian dynamics, to address normal and congested conditions within a station environment and provide clear evacuation routes and control systems to deliver user safety.



Mott MacDonald provided pre-contract technical services, project design and quality and safety management for the US\$6 billion Kaohsiung Metro. The two metro lines serve the 3 million inhabitants of Kaohsiung, Taiwan's second largest city. The 14.4 km Orange Line contains 14 stations, a main depot and an operational control centre. The 28.3 km Red Line has 23 stations and two line depots.

The Budapest Metro Line 4 runs through a high density urban area with tunnels passing under four/five storey buildings more than 300 years old where settlement is no more than 4-5mm. Mott MacDonald provided detailed design for the tunnels and expert advice at sensitive sections such as the crossing of the river. The company also provided environmental monitoring for all stations.



Geotechnical and tunnelling design

Mott MacDonald's specialist services in soft ground tunnelling cover tunnel boring machine (TBM) specification, settlement analysis and response to ground movement, instrumentation and monitoring, economic assessment, cost estimating and construction supervision. We specialise in designing and specifying tunnel linings, whether segmental, sprayed concrete or cast in-situ concrete. Our participation in many of the world's most challenging projects has required us to provide innovative solutions to unique technical challenges.

Settlement control and the mitigation of ground movement effects are of prime importance in the design of an underground metro system. Mott MacDonald's skills in this area have resulted in the avoidance of expensive underpinning works and the minimisation of costs and delays to projects. Our expertise encompasses all aspects of ground characterisation. We specify, manage and interpret ground investigations, provide insight into the likely geotechnical behaviour of a wide range of environments and accurately define geological and environmental boundaries. We are at the forefront of the numerical modelling field, adopt 3D analysis utilising FLAC3D and have developed industry leading non-linear soil stiffness models to predict ground deformations around deep excavations.

We have designed viaducts extending several kilometres and developed in-house CAD methods for bridge design and drafting to enhance the efficiency of the design process. Our bridge engineers also have particular expertise in construction methods, specialist foundation techniques, earthquake analysis and design, and assessment of noise and vibration effects.



Mott MacDonald was part of the international team that undertook the planning of the initial metro system in Singapore. We have subsequently carried out numerous design and supervision roles on the Marina, Circle and Downtown lines.



Systems and assurance

Effective systems engineering is essential to the selection of appropriate processes to support client expectations for timely delivery of a cost-effective metro project. Mott MacDonald provides skills encompassing all forms of rail and communications systems necessary for the safe, successful and reliable operation of a metro scheme. We develop and design new systems and enable clients to modernise and enhance existing installations. Our engineers have extensive experience of top functional, non-functional and performance modelling, and provide support in related disciplines such as reliability, availability and maintainability (RAM) and human factors.

We consider reliability, availability and maintainability (RAM) to be fundamental characteristics of any metro project, enabling a delivered, operated and maintained system to meet its intended purpose and provide a reliable service for the travelling public.

Systems assurance is intrinsic to systems engineering, enabling a project to satisfy safety requirements. Mott MacDonald's railway systems and safety assurance engineers deliver operable and maintainable systems that meet their intended purpose. Their extensive practical experience in the preparation of safety plans means that they can identify and execute the necessary safety assurance activities for a safety case. This process must commence as early as possible to minimise unnecessary design work and costs.



Rolling stock and permanent way

Mott MacDonald undertakes the design and specification of all types of track, delivering a permanent way that is a fully integrated part of the overall system. We have developed high speed points and non-ballasted track systems for metros. We also undertake audit and inspection services, and advise clients on maintenance regimes.

We have leading edge skills in operational studies, timetabling, diagramming and train performance specifications. TRAIN – Mott MacDonald's in-house traction power simulator program – can simulate highly complex systems and all types of railway traffic, handle an unlimited number of junctions and model any number of tracks on a given route.

Mott MacDonald provides a full rolling stock service from initial outline specification to independent design reviews. Key components of our service are operations and maintenance, specialist technical support, specification and procurement, and support to the client during design and construction. We have prepared safety cases for train operating companies and advised on strategies for maintenance and overhaul.

Mott MacDonald was technical advisor for the 'transformational' first section of London Overground's £1 billion East London Line extension project, which opened in April 2010 – two months ahead of schedule. We are providing technical services on the next phases of the extension, which will complete the London orbital rail network.

Mott MacDonald's experienced tunnel ventilation and rail aerodynamics engineers, designers and simulation specialists cover a broad base of disciplines. The simulation software we use to analyse and design tunnel ventilation systems was created for the Channel Tunnel. Since then it has been enhanced to meet the particular requirements of many projects and is now the most proficient of its type.



Our safety assurance professionals have passed the Rail Safety and Standards Board (RSSB) engineering safety management course (Yellow Book), which confirms their ability to deliver best practice. Our extensive experience in the preparation of safety plans means that we can identify and execute the necessary safety assurance activities for the successful development of a safety case.

Safety and risk management

Maintaining the safety and reliability of systems throughout the lifetime of a metro is a fundamental requirement of the owner and operator.

Safety is of paramount importance in Mott MacDonald's design culture, which seeks to eliminate or mitigate the risks and hazards. We identify at the outset the potential risks – and opportunities – that could occur on a metro project from initial concept and planning to construction and operation. We are expert in the use of both analytical and computer based tools for risk assessment and our experience includes hazard identification and assessment, HAZOPs, fault and event tree analyses, risk studies, safety cases and reliability and consequence evaluations. We carry out assessments to identify operator training needs, define core competence requirements for safety-critical activities and determine staffing requirements.

We are a world leader in the fields of tunnel ventilation and fire safety. Our skills in aerodynamic and thermodynamic analysis address issues relevant to both new systems and the refurbishment of existing systems in normal, congested and emergency modes. We have pioneered computer technology to provide state-of-the-art simulation, animation and virtual reality depictions of metro-related safety issues. Using computational fluid dynamics (CFD) we simulate fire and smoke movements and the interface between tunnels, stations and terminal facilities to develop emergency egress analyses.

Our knowledge of metro construction and operation enables optimum safety solutions to be developed using an approach that involves the whole team – client, designer and contractor – identifying risks and the actions required to eliminate them.

Asset management



We have undertaken numerous projects for the assessment and repair of existing railway and station tunnels, the improvement of trackbed and the management of embankment maintenance and renewal for surface lines.

Refurbishment and repair of a metro is often a cost-effective alternative to replacement. Mott MacDonald provides comprehensive services in the inspection, assessment and rehabilitation of tunnels, bridges and buildings and has considerable experience in the assessment, maintenance and design of remedial works for rail schemes.

Integral to the success of any inspection or refurbishment scheme is a thorough understanding of day-to-day operational issues. Our experience in the design of tunnel systems and our role in the compilation of operations and maintenance (O&M) manuals for completed works mean our engineers fully appreciate clients' needs during maintenance periods. We can tailor our services and staffing to meet each client's individual asset management requirements.

Our expertise in this area covers:

- Preparation of inspection and maintenance plans and strategies
- Preparation of O&M manuals
- Technical input to long-term asset management contracts
- Design of structural health monitoring systems
- Development of graphical interface system for lifetime records
- Inspection and maintenance advice for existing structures
- Feasibility studies, concept and detailed design of maintenance works
- Contract documentation relating to all forms of procurement
- Value engineering and risk management
- Construction advice and problem solving

San Francisco's US\$4.2 billion Transbay Transit Centre Development will be the USA's largest intermodal transit centre west of New York City. A critical element within the programme is the extension of the Caltrain rail service, incorporating a 2km tunnel and new subsurface station, improvements to existing surface stations and reconfiguration of the Caltrain yard. We're providing programme management including overseeing design, monitoring budget and schedule, and advising on procurement.



Mott MacDonald – multisector, multiskilled, multinational

Buildings

Communications

Construction economics

Education

Water

Environment

Health

Industry

Management consultancy

Planning

Project finance

Project management

Transport

Urban regeneration

Energy

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