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Integrated Team Design Process – Successful Stories of Hong Kong MTR Corporation Projects

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Abstract

Achieving design quality with systematic design management is essential for any construction project. This becomes all the more important and difficult for infrastructure projects which are complex in nature and involves several disciplines and multiple stake holders. Normally, the client and the design team including the lead consultant and various specialist sub-consultants work in different places in their respective offices, which normally result in problems such as poor coordination, lack of collaboration, excessive variations, design changes, abortive reworks and unwarranted delays.

MTR Corporation sets up integrated multi-disciplinary design teams using the combined resources of MTR Corporation and the consultants working together in an Integrated Team Design Process. Such integrated design team office arrangements include advanced information and communication frameworks as well as electronic project management systems. Also, MTR Corporation through integrated team design develops the design in stages, namely feasibility study, preliminary design and detailed design; thus repeatedly reviewing and improving the design exhausts all possible options and the best and practical design emerges out.

This paper also presents some case-study based success stories of effective project management with such integrated design team process from recent MTR projects.

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Keywords: Integrated Design Team; Partnering; Design Stages; Relationship; Management.

1. Introduction

Infrastructure projects are often complex and due to several inter-related designs and multi-disciplinary requirements, design management in such projects is usually quite challenging. Normally, the client, the lead consultant, and specialist sub-consultants work in different places in their respective offices. This scattered distribution can result in problems such as poor coordination, lack of collaboration, variations, design changes, abortive rework and unwarranted delays in infrastructure developments. Coordinating

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joint design works and project communications and information management among different design teams is often great concern in multi-disciplinary project systems (Perry and Sanderson, 1998). Hence, dynamic interactions and continuous coordination among various disciplines and key stakeholders are essential for achieving success in such infrastructure projects.

In order to address this issue, MTR Corporation is committed to setting up integrated multi-disciplinary design teams using the combined resources of the client and the consultants in a fully serviced Design Team Office. Several formal and informal brainstorming sessions are held in which the exchange of ideas and information is encouraged, leading to a set of unified goals. This integrated team approach was later extended into the construction stage helping to quickly resolve design changes and contractor's queries (Ramanathan and Chin, 2009).

2. Design Team Office

In traditional design management arrangements, the design teams of different disciplines are working in their own offices at different distributed locations. Such distributed functioning might be more complicated in cases such as joint-ventures, sub-consultancies and outsourcing. The concept of team building and principles of integrated design office for collaborative engineering designs are being encouraged to achieve enhanced organizational and individual performance outcomes from various useful measures such as shared focus, synchronous team-working, dynamic interactions, efficient coordination, effective collaboration, integrated resource management, and closer physical/ virtual proximities (Palaneeswaran, Ramanathan and Tam, 2008). Such integrated design office arrangement in large/complex projects supports effective design management and best value through (i) increased informal interactions, (ii) enhanced role clarity and understanding, (iii) more frequent communications between relevant parties, (iv) development of harmonious relationships, (v) effective problem solving, (vi) quick/ timely decisions, (vi) enhanced creativity/ innovations (Monczka et al. 2000)

Normally, the lead consultant of MTR Corporation's major design consultancy projects is a civil engineering firm with experience in managing multi-disciplinary railway design. The lead consultant is supported by sub-consultants in architecture/station planning, building services and quantity surveying. Design of trackwork and system-wide E&M works is normally carried out by MTR Corporation's in-house design team. Using the resources from the MTR Corporation, lead and sub-consultants, an integrated multi-disciplinary design team is formed in a fully serviced Design Team Office (DTO).

The consultant and sub-consultants station a number of management staff, key technical staff and support staff in the DTO, full-time or part-time as required. Network facilities with CADD PC workstations are provided by MTR Corporation, whereas specialist design software workstations are brought by various consultants. All designers and draftspersons work on a consistent set of layout and background drawings through the use of controlled CADD files in the same network environment.

Working closely within the DTO is helping the designers to appreciate the requirements of other disciplines. Team members are encouraged to cross fertilize and address problems beyond their field of expertise, but everyone's role and responsibility was clearly assigned. Direct face-to-face conversations replaced the normal telephone calls, fax messages and emails. Inadequacies or designs not fitting into the requirements of other disciplines, or interfacing parties, are identified in the early stage, and such designs are immediately improved as necessary.

A SharePoint electronic project management system is used at the DTO for the workflow and communication between MTR Corporation and the consultant. The consultant uploads all correspondence and submissions using this SharePoint system. The soft copies of all submissions including documents and drawings are shared by the members. MTR Corporation's responses and comments on the consultant's submissions are also shared through this system. The system ensures all information and valuable resources are kept securely throughout the project and everyone is working on the latest and unified information.

3. Partnering

Partnering is about building cooperation and getting improvements for the benefit of all parties within a project team and is considered to be a core competency for anyone working on an MTR project. MTR Corporation, known for its proactive approach, introduced partnering with contractors in the Tseung Kwan O Extension Phase 1 project during 1999, and the results were encouraging: improved communication, cost savings, less claims, issues resolved quickly and to the satisfaction of both parties and so on (Bayliss, 2002). Even before entering into partnering with contractors, MTR Corporation has been adopting some form of partnering with consultants. The integrated design office concept was introduced by MTR Corporation for the Tseung Kwan O Line in the late nineties. As time has progressed the process of partnering has become more formalised within MTR projects. Latest MTR Partnering model is given in Table 1 (Asia Corporate Training Limited, 2010)

Table 1: “M-T-R” Partnering Model

<u>Mutual</u>	<ul style="list-style-type: none"> • Visions and Objectives • Goals • Benefits
<u>Trusted</u>	<ul style="list-style-type: none"> • Collaboration • Relationship
<u>Responsible for</u>	<ul style="list-style-type: none"> • Working with complementary competencies • Effective communication • Creating value for project success

MTR Corporation encourages partnering approach and gives preference while choosing consultants or contractors who can clearly demonstrate a willingness to work within a partnering environment with shared commitment. MTR Corporation’s Partnering approach has brought the client, the consultants and the contractors much closer together towards the goal of project delivery. As a reference, key values and behaviours identified in recent partnering workshops are listed in Table 2.

Table 2: Values & Behaviours

<p>Excellent Services</p> <ul style="list-style-type: none"> - Promoting safety - Timely decision and resources allocation - Locating teams in the same office to enable collaboration and direct communication for agreement on interfaces - Producing quality deliverables - Proactive liaison with government and public consultation 	<p>Mutual Respect</p> <ul style="list-style-type: none"> - Proactive management support - Active listening and involvement to enable understanding of others’ concerns and needs and to deliver trust - Fostering a collaborative working attitude - Collaboration and communication among stakeholders on deliverable requirements - Achieving work-life balance
<p>Value Creation</p> <ul style="list-style-type: none"> - Good optimization - Developing a partnering relationship for better coordination and interfacing - Sharing information and experience to develop standardization - Conducting workshops and peer review with the right people to improve the design - Promoting sustainability 	<p>Enterprising Spirit</p> <ul style="list-style-type: none"> - Daring to explore innovative and creative ideas - Adopting a flexible and adaptive attitude - Fostering an environment for personal and management empowerment - Challenging assumption - Sharing successes

As a result of partnering the design process has become one of collaborative working with proactive participation from team members, leading to mutual agreement. The project after project, the partnering methods are being improved, responsibilities clearly defined, and win-win attitude has taken roots among the team members.

Formal partnering workshops are held and partnering charters are signed. Recently, six leading civil engineering consultants in Hong Kong (namely AECOM, Arup, Atkins, Halcrow, Meinhardt and Scott Wilson) joined hands together in an MTR organized Partnering Management Workshop. The consultants are designing various sections of the Shatin to Central Link (SCL), which provides strategic railway corridors to serve new catchment area and connect with existing railway lines. One section will extend the existing Ma On Shan Line from Tai Wai to connect with West Rail Line via East Kowloon, and the second section will bring East Rail Line across the harbour to Hong Kong Island.

4. Design Stages

MTR Corporation develops the design in stages, namely (1) feasibility study, (2) preliminary design and (3) detailed design; thus the design is developed stage by stage. And repeatedly reviewing and improving the design exhausts all possible options and the best practical design emerges out.

4.1. Feasibility Study

In this stage, the consultant will concentrate on transport planning, patronage and revenue forecasts, cost estimates, economic benefits, evaluation of options, and environmental, technical and operational requirements, leading to a preliminary recommendation on the Project.

4.2. Preliminary Design

The consultant will review the Feasibility Study and organize Value Engineering (VE) sessions to explore all possible options and to identify innovative ideas on design, construction and operation with an aim to improve the operational efficiency, reduce costs, increase patronage, enhance accessibility and the financial viability without sacrificing safety and reliability. The consultant at this stage will carry out a detailed technical study to confirm the railway scheme and will facilitate preparation of land requirement plans, gazettal plans, and associated statutory process. The reports and drawings will be of sufficient details and dimensioned to show the full scope of the works and to enable a robust cost estimate to be prepared.

4.3. Detailed Design

The consultant will review the Preliminary Design identifying any previous design deficiencies, defects and incompleteness and take up the total design responsibility to modify, re-engineer and provide MTR Corporation an effective scheme and complete the Detailed Design. The consultant will address all interface issues with government departments and utility companies and their consultants and agents. The consultant will develop a Scheme Design to produce a design in which all components of the Works are fully compatible, integrated, complete and coordinated.

The consultant will further develop the Scheme Design and prepare Tender Drawings and documents. The Tender Drawings should be fully detailed and contain sufficient information such that no further clarification is required prior to construction. The Consultant shall also carry out all statutory and utility submissions to ensure that all necessary approvals or consents are obtained from various government departments prior to the award of the Works Contracts.

Value Engineering workshop are held at appropriate stage of the design to explore viable options and to confirm the optimum scheme. The workshops are attended by senior management of MTR Corporation and the consultant as well as key technical staff.

Escalation of construction cost has been a key concern for major infrastructure projects in Hong Kong. MTR Corporation adopts a systematic and coordinated approach to monitor and control project cost. Potential changes in design which affects cost have to be reported to MTR Corporation's senior management and will only be incorporated into the design after approval has been granted.

5. Case Studies

Here are two examples to illustrate how some of the design issues were resolved, and how the integrated design team attained optimum design solutions.

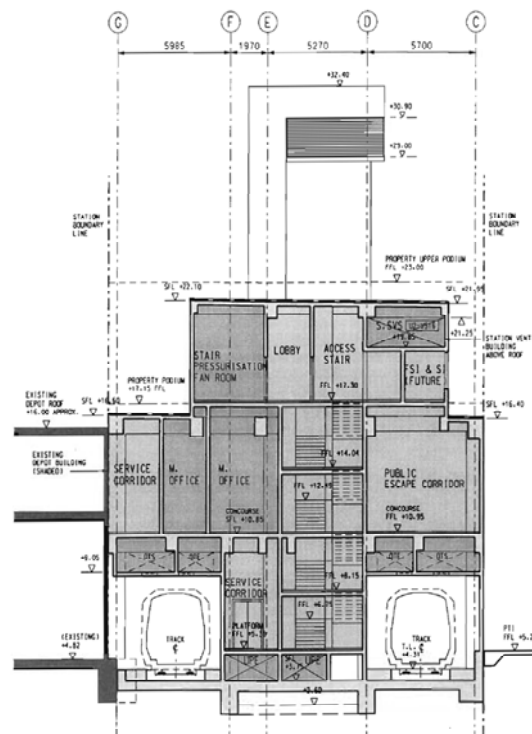


Figure 1: Typical Cross Section of LHR Station – Volume Optimisation

5.1. Optimisation of LOHAS Park Station Box Design

The initial planning and design for LOHAS Park (LHP) Station was completed in 2000. However, the master layout plan (MLP) of the vicinity, namely Area 86 was subsequently modified to a great extent. AECOM Asia Co. Ltd. was nominated in 2005 as the detailed design consultant for the LHP Station project, and the station design needed to be revised to integrate with the revised MLP. Operational enhancements implemented by MTR Corporation in the intervening years were also taken into account.

In the revised design, the station plan and volume were optimised, access from the LOHAS Park was improved, flow of passengers at different phases of the property development were planned to be evenly distributed. The size of the station, including its services and ventilation shafts, were designed to the minimum required size while satisfying the anticipated usage (Figure 1). Extensive coordination amongst

the design disciplines took place. A brief comparison of the station size in the previous proposal and the current scheme is given below:

Size of Station Box	Proposal in 2000	Current Scheme
Length (including overrun tracks)	355m average	360m
Width	23.2m	20.5m average
Height (measured from track level)	14.3m average	12.3m average

The overall volume of the Station box is reduced by 23%, which has not only reduced the cost of construction and maintenance, but will also reduce the operating costs due to the smaller air-conditioned space. The economical and environmentally friendly scheme was devised in the scheme design stage of the Detailed Design Consultancy with the help of the integrated design process and the cooperative team spirit.

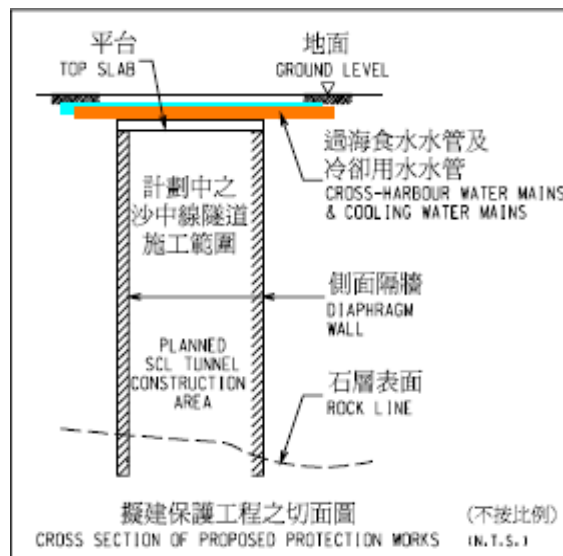


Figure 2: Proposed Protection Works

5.2. SCL Protection Works

The SCL alignment will run underneath the reclamation in North Wan Chai of Hong Kong Island, which is being implemented under the Wan Chai Development Phase II project (WDII).

During the SCL preliminary design study in 2009, it was identified that a section of the SCL tunnels would run underneath a number of major cooling water mains and cross-harbour fresh water mains which would be installed by WDII project, prior to commencement of construction of SCL tunnels. The preliminary design consultant was requested by MTR Corporation to identify solution to address this issue.

The preliminary design consultant, working in the DTO together with MTR Corporation's project management team, conducted a detailed investigation of the options and proposed to construct protection works for SCL under the WDII project (Figure 2). A quick decision was made by MTR Corporation to adopt the consultant's proposal.

Following this, MTR Corporation requested the consultant to complete detailed design of the SCL protection works within a tight timeframe. Adopting the partnering approach, the consultant mobilized a multi-disciplinary team to work in the DTO and maintained close liaison with MTR Corporation.

MTR Corporation's project management team provide clear direction to the consultant and conducted a number of design review workshops with the consultant to enhance communication on key design issues and to fast track the approval process. Day-to-day liaison was maintained amongst the design team members.

The design was successfully completed within the tight design programme. This was achieved because both MTR Corporation and the consultant were fully committed to tackle the challenge and worked as a team in the DTO under the spirit of partnering.

6. Conclusions

The integrated team design process in MTR projects has established its merits including effective design development, efficient management of time and costs, increased flexibilities, improved design quality, enhanced constructability potentials, reduced rework and wastages, lesser conflicts and changes, and optimal project costs. The integrated team design process has also helped in building a cohesive team with a unified goal, and MTR Corporation's partnering model has enhanced mutuality, trust and responsibility. Benefits such as improved efficiency, increased opportunity for innovation, and the continuous improvement of a quality product are achieved. MTR Corporation's well documented design development in stages enables members of DTO to repeatedly review and improve the design. Public and private sector clients should try to take advantage of these findings from MTR projects to improve the efficiency and effectiveness of their project teams on future infrastructure projects with similar complicated multidiscipline interfaces.

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