# Engineering construction management projects at Singapore Airport

Autor(en): **Lim, Boon Liang**

Objekttyp: **Article**

Zeitschrift: **IABSE congress report = Rapport du congrès AIPC = IVBH Kongressbericht**

Band (Jahr): **12 (1984)**

PDF erstellt am: **26.05.2024**

Persistenter Link: https://doi.org/10.5169/seals-12112

# Engineering Construction Management Projects at Singapore Airport

Gestion de la construction de l'aéroport de Singapour

Projekt und Management-Organisation des Flughafens in Singapore

**Boon Liang LIM**
Property Dev. Mgr.
Singapore Int. Airlines
Singapore

Boon Liang Lim, a 42 year old Singaporean, was educated locally. He worked with Bank Group: Management Services Subsidiary as a Project Executive, then a Project Supt. for the airline before becoming its Property Development Manager for almost 11 years.

**SUMMARY**
The new Changi Airport near Singapore was designed and built in four years, from 1977 till 1981. A technical description of the project and the construction management organization of the Changi Development Unit are presented.

**RESUME**
Le nouvel aéroport de Changi près de Singapour a été étudié et construit en quatre ans, de 1977 à 1981. La description technique et l'organisation de la gestion du projet de la „Changi Development Unit" sont présentés.

**ZUSAMMENFASSUNG**
Der neue Changi Flughafen bei Singapore wurde in vier Jahren, von 1977 bis 1981, projektiert und ausgeführt. Die technische Beschreibung des Projektes und die Management-Organisation der „Changi Development Unit" werden vorgestellt.

PROJECT HISTORY

The Changi before was the idyllic tropical seaside resort - rusticated in many ways shown by the kampong settlements, vegetable farms, fruit orchards and picnicker camps. The Changi now/after is the airport of the twenty-first century - a bustling terminal of 4,400 pax turnover per peak hour, 30,000 meals per day, 750 tons of freight per day and 80 aircraft movement per hour (capacity). What's How's and Why's went on behind the hectic 6-year transformation programme from May 1975 till July 1981 with the $1.500(B) total investment, including SIA Group of $0.500(B).

Buoyant air traffic forecast shown by Fig. 1 on annual air passengers, air cargo handled and aircraft movements make it extremely difficult to continue at Paya Lebar: firstly, resettlement squatter families of easily 50 times of Changi; secondly, a second runway would entail straddling over a river and the decade old MOE refuse dump; thirdly, the South flight path hovers above high density, high rise public housing and fourthly, relying on ad hoc and improvised expansion expedients is unsatisfactory. Changi offers tremendous prospects - it is a totally greenfield site. 900 hectares of land were reclaimed from the sea. The total airport area (Fig. 2) is about 2500 m x 6500 m or 1663 hectares. Each of the two parallel runways has a max. capacity of 40 movements per hour. A total of 46 passenger aircraft, 6 cargo aircraft and 3 maintenance parking positions are provided. A terminal building of 120 m x 204 m, five stores high, two finger docks each 580 m long, a hangar building and several other buildings were already realized in phase I. Air safety and noise protection are safeguarded and, above all, unencumbered expansion potential.

The project development and milestones are shown in Fig. 2. The abbreviations are explained in the index at the end of the paper.

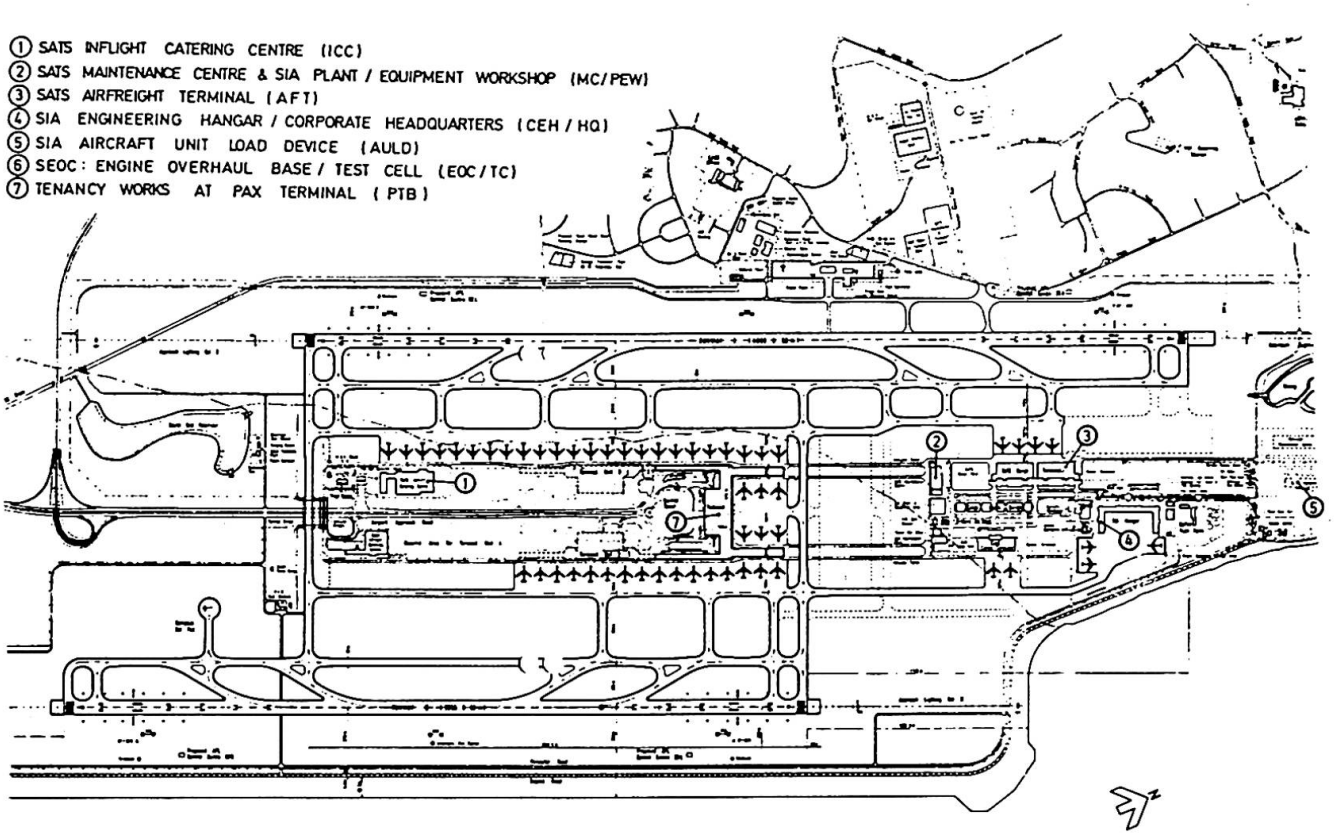


Fig.2 Masterplan Layout

| | | |
|---|---|---|
| • May 1975 | – | Cabinet decision on future airport at Changi instead of Paya Lebar |
| | – | ECAD formed to formulate/control policies for Changi Airport development programme (more details in CDU organisation chart) |
| • July 1975/ June 1976 | – | Developing/Reviewing master plan – NACO |
| | – | Block site planning through PDM with SIA Group users |
| | – | Crash programme of land reclamation, 900 hectares over 24 months |
| • January 1977 | – | Finalise selection of system consultant on ICC, AFT |
| | – | Justification for site allocation and alienation, firm up building design briefs including A&E definitives |
| | – | Commence design consultant selection – 24 teams |
| • April 1977 | – | SIA Group official decision to form CDU and three months later joined by Turner assigned managers and seconded staff from SIA/SATS |
| • February 1978 | – | Ground breaking at ICC |
| | – | Start Basement at PTB/in progress |
| | – | Soil consolidation at Hangar |
| • August 1979 | – | Award of Changi Engineering Hangar – Main Contract |
| • February 1980 | – | Award of Hangar Roof, construction sites all in full swing |
| • February 1981 | – | Arrival of first roof sub-unit (650 tonnes) by sea |
| | – | Test run of runway I, PTB, ICC, AFT |
| • July 1981 | – | Exodus Paya Lebar and Changi Airport starts |
| • September 1982 | – | SIA Corporate Headquarter starts |
| | – | Changi Hangar starts |

Table 1 Project History (Key Milestones)

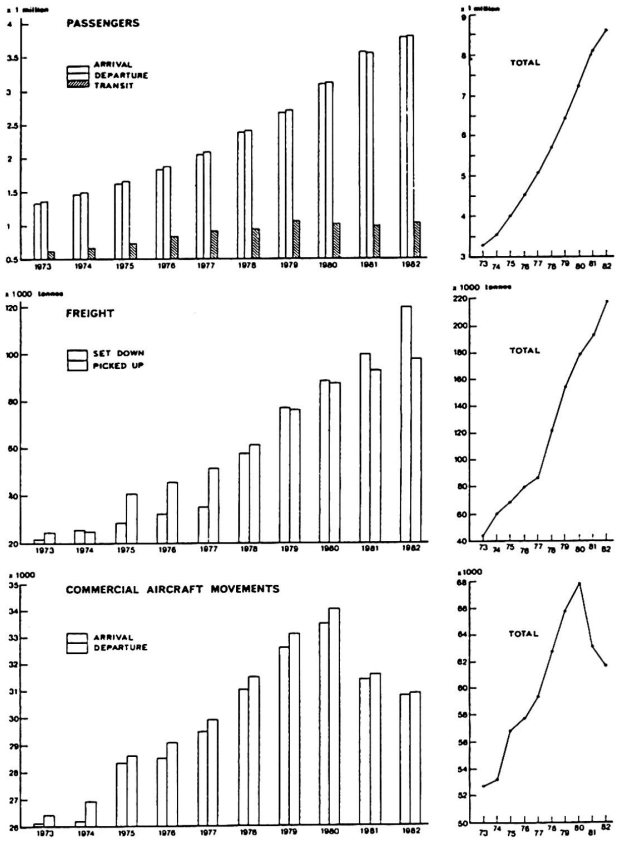


Fig. 1 Singapore Airport Statistics (1973-1982)

TECHNICAL DESCRIPTION

A few features taken from the key projects (Fig.3)

| | m2 | Cost (SIN $) |
|---|---|---|
| . SATS Airfreight Terminal (AFT) | 42,000 | 72.000 (M) |
| . SATS Inflight Catering Centre (ICC) | 50,000 | 80.000 (M) |
| . SIA Corporate Headquarters (CEH.2) | 30,000 | 225.000 (M) |
| . SIA Engineering Hangar (CEH.1) | 21,000 | |

Airfreight Terminal. Done on strictly "function first and form later" by commissioning BNP to do all economic studies/review, system engineering and only after completion of system flow and layout and the Building Design Brief, the Building Consultant got on board to wrap around the process flow layout. The first phase comprises symmetrically placed site, modules 2 and 3 capable of expanding to M1 and M4 to double up the initial capacity of 300,000 thru-put freight tonnes to 600,000 FT. The internal features show the modern methods of material handling system by elevated transfer vehicle (ETV) and high level storage racks through use of retrieval cranes.

Inflight Catering Centre.Similarly done as for AFT. System experts on mass meal production were appointed to carry out a thorough review of traffic analysis (by computer model simulation). A system of layout flow processers, storage support sub systems, wash-up subsystem was developed on a participatory approach with all related users. A building design brief containing the "A&E Definitives" was jointly developed with CDU before the Building Design Consultants were selected. The design development was exhaustive capitalising on the confluence of expertise from 4 sources: the System Experts, Inhouse Catering, Management Know-how, CDU Project Management and the long standing and eminent Architects, Engineers and Quantity Surveyors. Planned on modular grids the present capability of 30,000 meals per day can be easily expanded to 50,000 per day in the 1990's.

SIA Corporate Headquarters. Located at the upper 5 floors of the U-shape on plan, 10-storey annexe, SIA Head Office shows a modern office system approach. In conjunction with the Accoustic Consultants, the Architects and Engineers, CDU's inhouse landscape open plan unit (LMU) in consultation with a German team (QBT) implemented the first open plan office of the 30,000 m2 scale at the annexe. The physical results are achieved through fine tuned co-ordination efforts - LMU, Design Consultants, Contractors, the end users and the specialist open plan furniture vendors.

Changi Engineering Hangar (CEH). Again, the successful completion is accomplished through collaborative efforts of design consultants, specialist contractors and in the case of the tubular diagrid roof the unstinted contribution of the Checking Consultant Engineer. The Tubular Space Frame Diagrid Roof solution was the combined result of poor site condition and height constraint. However, the design, services co-ordination, fabrication and final site erection and lifting of the 2,500 tonnes of the 218(L) x 92(D) x 8(H) columnfree roof structure is a construction planning and management operation worth of attention to future practitioners or clients facing the same problem. Even the last expected activity could go wrong, if no advanced preparing as well as corrective action planning to face up situation had been provided. The case of protective coating is a classic example.

Soil Consolidation. Because of an underlying lens-shape section structure of thick marine clay, the site had to be subject to 14 months surcharge varying 6-8 meters high plus stitched down castle board drain at approximately 2.00 m centres at a total costs of $5.00(M).

Flying Table Forms. Owing to slow start-up due to site conditions and another reason, the Construction Team collaborated with the Contractor to use this system of formwork. Productivity rose from 31 days per floor to an all-time high of 18 days per floor at the 9th and 10th floor slab. Records confirm a time saving of 25% over the conventional formwork method.

## EXECUTIVE PROJECT MANAGEMENT ORGANISATION

Ideals shown in our objective on design/approaches are one thing but follow-up action is another. There was the large scale of some 304,000 m2 of total gross built-up area scattered over six far flung sites. Another couple of worrysome features were the near $500.00(M) budget and the very tight time frame of 4 years for design and construction, discounting 1½ years for masterplanning of the total project duration.

While mobilising inhouse development expertise and user departments for master-planning and building design briefs went underway it was at the 2nd quarter of 1977 when the Changi Development Unit (CDU) was set up and put into operation.

It was intended to be the pure type of project or indeed a construction management organisation to be run independently with minimum interference and maximum support from SIA/SATS top management. The organisation is accountable to both SIA/SATS management separately - implemented by monthly series of high level project management meetings (Fig. 3).

The Property Development Manager (Changi Projects) is represented in the Executive Committee on Airport Development (ECAD) to provide the organisation links (Fig.4). He also submitted monthly status as well as financial management report to the Group Chairman.

CDU's mission was to ensure effective project funds control, time schedule and quality of the works. All the three (3) wings, namely, Project Engineering, Construction Control and General & Administration are mutually supportive to carry out its mission during 4-5 years. Its own facilities included a 1.000 m2 two-storey CDU rented building, photostat and blue print equipment, word processor, 2 landover vehicles and some other sundry equipments/site facilities.

Some matrix relationship lines were inevitable as eventually the project engineers, construction superintendents had to work closely with end users, airport building authorities, innumerable consultant staff, contractors supervisory and management personnel.

In view of the different form of employment contracts, man-management grew sometimes to awkward proportions. The composition of the CDU at peak is:

| | | | |
|---|---|---|---|
| (a) | second SIA/SATS | 44 | |
| (b) | contract personnel | 52 | |
| (c) | assigned TEA | 6 | 102 |

TEA personnel enjoyed relatively generous compensation being assigned through the project management contract, contract staff receive very high salary but reduced

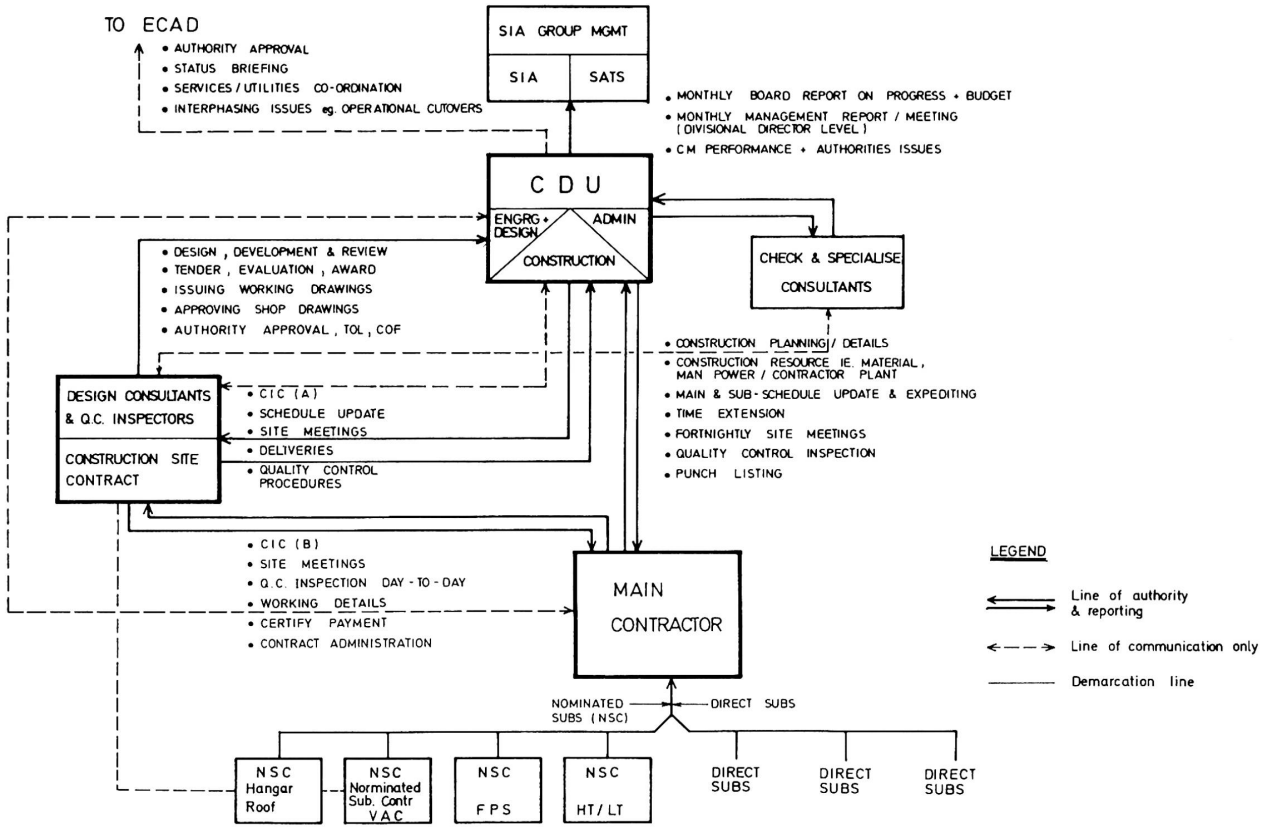


Fig. 3 Construction Management Chart for US$ 100M SQ Hangar & HQ at Changi Airport

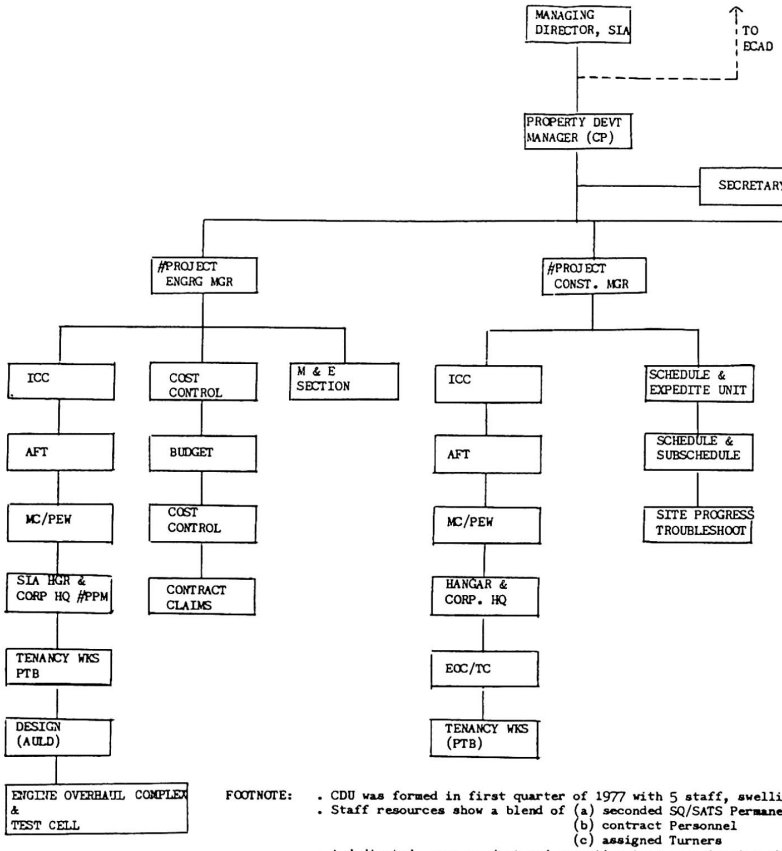


Fig. 4 Organization Chart of CDU

FOOTNOTE:
- CDU was formed in first quarter of 1977 with 5 staff, swelling to 102 in 1980 but now reduced to 6
- Staff resources show a blend of (a) seconded SQ/SATS Permanent staff – 44
  (b) contract Personnel – 52
  (c) assigned Turners – 6 102
- A dedicated, pure project and executive type organisation which is almost autonomous yet having a lot of matrix links with Users/Authorities
- Most contracts are done "design and build" basis

fringe benefits compared with the seconded permanent staff. All the conflicts were resolved after a series of meetings and compromises as the threat of quitting their jobs to disrupt the project was more real than imagined.

Imbued with humanist school of thinking, CDU Admin actively promoted several programmes to forge close knit team spirit i.e.

(a) Inter site sports competition and cross country run
(b) CDU Annual Dinner & Dance and X'mas Do's
(c) Visits to Homes of Handicaps, Aged, Salvation Army, etc

Quality Control Circles (QCC) and Open Appraisal Interviews were extensively used.

It is to be noted that all contracts were carried out on a "design and build" basis except the 747 Test Cell which was one on turnkey. Budget and schedule control were practised by means of cost commitment and payment reports, variance procedures, milestone/stage programme tracking and updating.

## CONCLUSIONS

Experience is the greatest teacher of all lessons. Having lived through all the difficult phases of the projects, we realise that short lead times have to be treated seriously. Advanced preparation is the safeguard. Diligence and dedication cannot find substitutes in whatever project tools or systems.

In general appraisal, we have fared fairly well. The benefits of a well structured project management system are vivid. It represents results achieved through co-operative endeavours which are certainly greater than the total sum of the component parts. For the skeptics and followers alike, Changi Airport provides a living model of the synergistic efforts of international expertise, technological advancements and the local resources of people and marginal land availability.

LIST OF ABBREVIATIONS/ACRONYMS

| | | |
|---|---|---|
| ECAD | : | Executive Committee on Airport Development (headed by the Chief Permanent Secretary Singapore Government after being formed by Cabinet Decision in May 1975). |
| DCA | : | Department of Civil Aviation which is part of the Ministry of Communication. |
| CADD | : | Changi Airport Development Division i.e. specially formed by Public Works Department to do all Master Planning, Infrastructure, Pax Terminal and other services buildings. |
| CDU | : | Changi Development Unit formed by SIA Group Management to handle the Group's major projects worth over (B)0.500 Singapore Dollars. |
| MOE | : | Ministry of Environment |
| NACO | : | Netherland Airport Consultancy |
| A & E | : | Architectural and Engineering |
| M & E | : | Mechanical and Electrical |
| ATC | : | Air Traffic Control (Tower) |
| SATS | : | Singapore Airport Terminal Services |
| SADE | : | Singapore Airport Duty-Free Emporium |
| SEOC | : | Singapore Engine Overhaul Centre |
| TEA | : | Turner East Asia |
| CEH | : | SIA Changi Engineering Hangar |
| ICC | : | Inflight Catering Centre |
| AFT | : | Airfreight Terminal |
| MC | : | Maintenance Centre for apron handling equipment |
| PEW | : | Plant & Equipment for engineering ground equipment |
| AULD | : | Aircraft Unit Load Device i.e. aircraft container |
| PTB | : | Passenger Terminal Building |
| ETV | : | Elevated Transfer Vehicle |

| REFERENCE MATERIALS | | SECTION |
|---|---|---|
| 1. | Airport Forum 4/81 | Background Data |
| 2. | Proceedings of Airport Planning and Development Symposium - 1982 | Background Data |
| 3. | Department of Civil Aviation: Annual Report 1977 till 1982 | Growth Statistics Background |
| 4. | Implementation of Project Management by Project Management Institute, California USA | Executive and Autonomous Project Management Organisation and Organisation Styles |
| 5. | Selected Readings of Human Resources Managment and Productivity by Bill Reddin | Humanist Approach and QCC's |
| 6. | Managing Human Resources by Sayles and Straus | Humanist Style and Open Appraisal |
| 7. | Project Manual on Financial Controls and PMIS by Arthur Anderson | Financial Controls |
| 8. | Programming Method - HM SO | Scheduling Controls |
| 9. | Management Techniques - by Oxley and Posket | Scheduling Controls |
| 10. | Principles of Construction Management by Roy Pilcher | Programming and General Interest |
| 11. | Management of Engineering Projects by Maurice Snowdon | General Interest |
| 12. | Straits Times Commemorative Feature on SIA Group Projects - 1979 | Background Materials |