THE LESSONS OF HKUST

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Summary

This paper describes the development of the campus of the Hong Kong University of Science and Technology. The project cost over HK$3,200 million. It was developed in an extraordinary short space of time and admitted its first students only 5 years after the first meeting of its Planning Committee. The project was surrounded by controversy particularly in relation to the architectural competition for its design and an alleged 'massive cost over-run'.

This paper examines what actually happened and proposes an alternative critique of the project rather than the populist version put forward at the time. It then identifies the lessons to be learned from managering this large and complex project which centre upon the realism of estimates, inflation and objectives.

- Know your objectives
  There was no clear understanding of the buildings and facilities required by a world class university of science and technology.
  The decision to advance the opening date meant that there was little time to discover exactly what was required.

- Architectural competitions take time
  The decision to hold an architectural competition was not compatible with the tight programme for designing and constructing the project.

- Don't squeeze the estimates, be realistic
  The early estimates (to the Planning Committee and to the Finance Committee) were too low both in terms of the total gross floor area to be provided and the unit cost per square meter of gross floor area. These estimates resulted from insufficient understanding of the requirements of such a university and perhaps also from the desire to keep costs as near as possible to the Jockey Club's donation.
  Subsequent estimates followed the assumptions in the earlier estimates.

- Explanations of increases in estimates needs to be disciplined and consistent
  The approach to explaining increases in estimates was not disciplined and was at times irrational when rational explanations were available.

- Inflation must be handled realistically
  The prevailing levels of inflation were not recognized and the Government was not alerted. Of course, nothing could have been done about the extremely high inflation which the project encountered but forewarning would have reduced the shock.

- The Government's cost control procedures were weak
  The Government had a commitment to carry the cost increases without effective cost control measures in place and hence without an effective cost limit. The Government did not have an effective cost managment regime in place.

In spite of these apparent flaws in the process and the manner in which they fuelled the controversies which surrounded the project, *the cost of the University campus represents reasonable value for money, that is, it did not cost more than it should have.*

The most important point to make about the development of the campus of the University of Science and Technology is that it is a great achievement and a success story.

Introduction

Buildings are formed by their context. Diverse economic, social and cultural forces create them. The process which produces them is beset by conflict arising from competing technological, economic and often political pressures. The design and construction of the campus of the Hong Kong University of Science and Technology is the product of an extreme example of such a process, one which was characterized by the conjunction of some of Hong Kong's most powerful economic, social and political forces. It is a building of today, built in today's unpredictable environment, reflecting Hong Kong's confidence in its future and designed to serve the people of Hong Kong for many, many years to come.

By any standards the University's academic building is huge and its construction must rank as one of the world's largest university projects. By their nature, universities are housed in complex buildings, and universities of science and technology are the most complex. Many other university campuses may now be larger but they were built incrementally over many years. To give some sense of the scale of the project, the academic building is over 170,000 m2 in area, and is longer than the Bank of China is high (of for that matter the Empire State Building) and is far more complex. In addition, the project includes over 2,000 student residential places, nearly 350 staff quarters and over 5 km of roads plus enormous lengths of gas, water, sewage and electricity mains. It was originated, designed and built in an extraordinary short period and was officially opened the 10 October 1991. The Chairman of the University Council, Sir Sze-Yuen Chung, summarized this remarkable achievement in his speech at the Gala Banquet:

> The opening of the Hong Kong University of Science and Technology is a proud moment not only for all those involved with this great project but, I believe, also for the people of Hong Kong. This is because Hong Kong has, once again, done what many had said was impossible or at least very difficult to do. We have planned, designed, constructed, organized and opened a technological university for the twenty-first century in exactly five years.

In common with many great architectural achievements, the University's birth was not without controversy. This paper looks at the context from which the University emerged and the controversy which surrounded its design and construction. But let it be said at the beginning that the controversy should not be allowed to overshaddow the achievement of a campus which has not received any serious criticisms but only drawn praise, and let it not overshaddow the fact that universities are about students and not about construction controversies. It is all too easy for the public to focus on what the media highlights rather than what has truly been achieved. The University of Science and Technology is set to serve Hong Kong and its students at the highest technological and scientific level for many years to come.

Following the Government's decision in March 1986 that a new university should be built, the first formal step was to establish the Planning Committee for the Third University.

A significant and unique feature of the development of the University was the involvement in the project of the Royal Hong Kong Jockey Club. The Jockey Club is one of the world's great philanthropic institutions. Its contribution to Hong Kong has been enormous and it initially contributed a staggering $1,500 million towards the cost of the University campus, which was later increased to $1,926 million, by far the Jockey Club's largest donation to a single project. The Jockey Club also project-managed the development of the campus. The manner by which the Government agreed to this arrangement was an aspect of the controversy which affected the project.

Following the Government's decision to establish a 'Planning Committee for the Third University', the next step was the appointment of Sir Sze-Yuen Chung as Chairman of the Planning Committee and Mr. I.F.C. Macpherson, the then Secretary for Transport, as Secretary General. These appointments were made in May 1986 with Mr. Macpherson taking up his duties in August 1986. The policy of having a planning committee of

'volunteers' supported by a full-time salaried administration (albeit numerically spartan in the early stages) was a tradition which had been established for the development of Hong Kong's two polytechnics.

The first meeting of the Planning Committee took place on the 23 and 25 September 1986 with the following terms of reference.

Having regard to the Government's intention that:

(a) the Third University should be a grouping of professional schools emphasizing science, technology, management and business studies;
(b) by 1999-2000 the University should provide degree places for 7,000 full-time and equivalent part-time students, with room for further development up to about 10,000;
(c) the University should have its first intake no later than the 1994-97 triennium;
(d) a site of about 20 hectares would be made available for the construction of the University; and
(e) the legislation, staff salary scales and conditions of service of the Third University should be drawn up with due regard to those of the University of Hong Kong and the Chinese University of Hong Kong;

The Planning Committee is invited to:

(I) tender advice to the Government on -
  (a) the name and the legislation required for the Third University;
  (b) the administrative framework for the proper function and regulation of the University;
  (c) the detailed academic profile and development plans of the University, together with the necessary resource requirements;
  (d) the capital works and programme of construction together with the necessary requirements;
  (e) staff salary scales and conditions of service;
  (f) the selection of a suitable site for the University; and
  (g) any other relevant matters; and

(II) (a) recommend for appointment the first Vice-Chancellor and other staff for the University; and
  (b) carry out any executive functions as directed by the Government.

There is no doubt that the Planning Committee had an enormous task; it was responsible for advising not only on the development of the campus, but also on the academic profile, staffing, administration, legislation and any other relevant matters. Many aspects of the terms of reference are interrelated and none more so than the definition of the academic profile of the University and the development of the campus to house the consequential academic activities.

It is clear from the terms of reference that the Government had decided to develop a university and not a polytechnic (the reason for making this distinction at this stage will become clear later) and that the academic profile of the University should emphasize science, technology, management and business studies. The implication of these decisions in terms of the type of campus required to support them are significant. One of the major requirements of effective project management is that the objectives of the project are known *and understood* by everyone who is involved in its design and implementation. Conflicting objectives or conflicting understanding of objectives are frequently a cause of dissatisfaction with the outcome of construction projects.

In the case of the University, the 'surrogate client' groups, whose perceptions of the objectives had a major influence on the outcome, were the Planning Committee, the Government, the UPGC and subsequently the Royal Hong Kong Jockey Club. Compounding the complexity of this position was the understanding of the objectives held by the architects and other professional consultants.

In academic circles there is no doubt that the perception of a new university concerned with science, technology and management would be in the tradition of Massachucetts Institute of Technology (MIT), Carnegie Mellon and Imperial College, University of London. These universities operate at the cutting edge of scientific and technological advances in both their reserach and their teaching. A high research commitment is a central part of their mission and much of their teaching is at postgraduate reserach level as well as the traditional undergraduate work. A question which emerges as the story unfolds is how well this perception was understood.

The early stage

An overview of the interrelationship and significance of the events in first year may be helpful. An early imperative of the Planning Committee was to admit student as soon as possible. The Planning Committee realized that under normal Government (and UPGC) procedures there was little hope of accelerating the opening of the new building earlier than 1992. In fact the representative of the Architectural Services Department on the Capital Works and Building Sub-committee had suggested that the design stage itself would need three years and construction four years.

However, all that changed when the Jockey Club became involved and lifted the Planning Committee off the hook of Government project management procedures. The Jockey Club was prepared to work to an October 1991 completion for Phase I of the campus. By this time the Planning Committee was committed to the architectural competition which was a hinderance to early completion, but more of that later.

The first estimate of $1,200 million for the project was made by the Architectural Services Department in January 1987 and described as a 'ballpark' figure. Nevertheless it appears to have been used by the Jockey Club without refinement as a basis for the Club's donation of $1,200 million plus $300 million for inflation. Or was this just a coincidence? The Jockey Club later confirmed that it was donating $1,500 million and the Government formally agreed to pay for any additional funding needed. Nevertheless the coincidence of figures seems to indicate that the Jocky Club originally intended to carry the full basic cost. By the time the estimate had increased a few months later to $1,900 million the Jockey Club had wisely changed its position.

The major problems associated with both the early estimates ($1,200 million and $1,467 million) were those usually associated with all early estimates, but were somewhat compounded in this case. When the first estimate was prepared there was no brief available for the project and the estimate was based, by the Architectural Services Department, on the cost per square metre for the City Polytechnic. This is not an unusual approach but the profile of the University was emerging and was to be a good deal different from the City Polytechnic. Although the brief had been developed further for the architectural competition by the time the second estimate was prepared, the estimate was still being based on the cost of the City Polytechnic.

The role of the Royal Hong Kong Jockey Club

The proposal that the Jockey Club should fund a large part of the cost of the University's campus development was raised in early 1987. By May 1987, the Stewards confirmed to the Chief Secretary that they were prepared to fund and to supervise the construction of the University. As a consequence a paper was put to and accepted by the Executive Council on 2 June 1987 which included:

RHKJC's proposal

On 14 May 1987, the Chief Executive of the RHKJC wrote to the Chief Secretary, indicating that the stewards were prepared to fund and to manage the construction of the HKUST on the basis of a turnkey project as follows -

(a) the Club's total financial commitment will be limited to a maximum of HK$1,500 million, which includes an allowance of HK$300 million for inflation;

(b) should the design requirement, when agreed by the HKUST Planning Committee, require acceptance of a tender above the Club's limit, or should that limit be exceeded for any other reason, then Government is committed to paying all additional costs;

(c) the Club will have no responsibility for financing any operating costs;

(d) the project will be run by a HKUST Planning Committee Project Sub-committee which will have full and sole responsibility for implementation of the project to an agreed design requirement. That Sub-committee will be chaired by a Steward and have as members one additional Steward, the Club's Chief Executive, two members representing the HKUST Planning Committee (one of whom should ideally be the HKUST's Vice-Chancellor) and one member representing Government. The constitution of the Sub-committee will remain the same throughout the duration of the project, and the Chairman will have a casting vote; the Chairman will also be a member of the HKUST Planning Committee itself; and

(e) all architects, contractors and consultants working on the project will be employed directly by the Club.

A number of important points arise out of this agreement:

- It was recognized that the estimate of $1,900 million for construction was a 'rough order of cost' and that it is 'difficult to provide an accurate estimate'.
- Nevertheless, the Government agreed that 'should the design requirement ... require acceptance of a tender above the Club's limit, or should that limit be exceeded for any other reason, then the Government is committed to paying all additional costs'.
- 'The project design and construction ... should conform with standards and norms acceptable to the University and Polytechnic Grants Committee and Government.'

With an estimate which is known to be unreliable, this commitment would be open-ended on the Government's part without the caveat on standards an norms acceptable to the UPGC and the Government. But this caveat is only useful if the 'unreliable estimate' is accurate and represents the project built to UPGC standards and norms. If the estimate is unreliable the caveat does not protect the Government from unexpectedly large demands for funds due to excess expenditure over the estimate.

On the assumption that the Government would wish to have early warning of the need to provide additional funding either for making budgetary provision for the additional expenditure or for making alternative proposals to reduce costs, a cost control procedure is necessary.

Fast track?

The opening of the University in 1991 was the subject of much debate by the Public Accounts Committee and in the press under the banner of the 'advancement of the opening date'. It can be seen that it was not an advancement but a decision on a specific opening date which complied with the Terms of Reference.

Following the architectural competition there was no more than 18 months for the design of Phase I, with a large part of the design of Phase II having to be carried out at the same time due to their interdependence. The Phase I construction programme was an amazing 22 months for a contract of about $1,000 million. For Phase II it was a little longer - 27 months, still impressive for a contract of about the same size. Both contracts were completed more or less on time. Phase I was under great pressure to complete as students were due to be admitted and was marginally late. Phase II was not under quite such pressure and was about one month late. Not many other countries could produce contractors which could build at this pace.

Much has been said about this being a 'fast track' project and that this approach was one of the reasons for the additional costs. Apart from the argument that such costs should have been included in the estimates to begin with as the speed of the project was known (which is dealt with later), the University project is not a fast track project in the accepted construction management definition. It is a conventionally organized project with an extremely compressed time scale from which arose additional costs due to the risk of abortive and inefficient working perceived by the contractors.

The architecture competition

The Planning Commitee decided that the best way to select an architect to design the campus and its buildings was by means of an architectural competition. As the University was an important public project the Planning Committee selected this method in order to broaden the field of participants and the range of proposals. It also reflected the experience of the Chairman of the Planning Committee in the development of City Polytechnic.

This decision generated a major controversy at the time of the declaration of the result, as the commission to design the campus was not awarded to the winner of the competition - Design Consultants and Lotus in association with Wong and Ouyang Ltd. Later, the controversy surfaced again when the Public Accounts Committee (PAC) spent a great deal of time examining the circumstances leading to the appointment of the project architect - Simon Kwan and Associates in association with Percy Thomas Partnership (HK). This paper

does not dwell on the events which lead to the choice of the 'runner-up' in the competition as project architects, except to say that the Planning Committee were within their rights not to appoint the winner of the competition as project architect as at no time did they guarantee the winner the commission. The focus here is on the project management implications of holding a competition.

The Jockey Club's project management team quickly recognized that the architectural competition would slow down the design process. At its early meetings, the Campus Project Management Sub-committee 'reluctantly accepted that the Planning Committee were committed to proceeding with the architectural competition', The Sub-committee 'noted that adhering to the planned competition dates inevitably jeopardized the proposed opening date of September/October 1991'. In essence, the competition took eight months when the competitors developed their designs. During this time the Jockey Club could not afford to devote substantial resources to the task. Therefore the submissions, though satisfactory for a competition, were still in need of substantial development. Had a single architectural practice been selected in April on a normal fee basis together with all the other consultants, enormous design resources could have been devoted to the project so that by November 1988 the detailed design development would have been well advanced, taking pressure off the remaining design period and the construction period. The construction period could have been longer and the contractors would have been provided with more complete drawings to a more effective schedule, thus allowing a smoother construction process.

Looking back it could be said that the architectural competition was not a good idea except that it produced a building which matches the grandeur of the site and enjoys much critical acclaim.

Key dates

1986	
September	First meeting of Planning Committee
1987	
January	Decision to hold an architectural competition. Commencement of brief preparation for competition.
March	Architectural competition brief for the first stage issued.
June	Polkinghorne and Redstall appointed by the Jockey Club to develop a detailed brief.
July	Architectural competition brief for the second stage issued (not incorporating Polkinghorne's work).
November	Winner of architectural competition announced (initial design available).
November	Vice-Chancellor and President appointed (not to take up appointment until late 1988).
1988	
January	Polkinghorne and Redstall's brief completed.
March	Design Review Committee's first meeting.
October	Advance construction contract commences.
1989	
May	Tender documents sent to contractors bidding for Phase I (design sufficient for this but not completed).
September	Phase I construction commences.
1990	
September	Phase II construction commences.
1991	
July	Phase I completed.
September	First intake of students
1993	
January	Phase II completed.

The cost

The cost of constructing the University campus was probably the most controversial aspect of the project. The increase in the estimated cost was the focus of the Report of the Director of Audit, and the Public Accounts Committee (PAC) picked up the issue, as did the press. The estimates of the cost of the project evolved and changed over time in parallel with the realization of the meaning of a world-class university of science and technology and the consequential development of its design. The following schedule notes the periods during which estimates were prepared as a framework for understanding how they progressed.

The initial estimates (January - July 1987)
The initial estimates, of which there were probably four, culminated in an estimate of $1,500 million plus on allowance for inflation of $400 million. This estimate was accepted by Exco in June 1987 and also formed the basis of the estimate of $1,467 million included in the First Report of the Planning Committee in September 1987. For comparison with other estimates, this estimate should be reduced to $1,352 million by deducting $115 million for furniture which was subsequently transferred to another funding catgegory.

The second estimate (March - May 1988)
This estimate of $1,620 million was a result of the development of the design and further understanding of what was required. It was accepted by the Finance Branch in May 1988.

The third estimate (September 1988 - April 1989)
This estimate of $2,007 million was the consequence of further revisions of the design following input from the academic advisors and further realization of what was necessary in a university of this kind. This estimate and a request for additional funding was *not* put to the Finance Committee.

The fourth estimate (August 1989 - June 1990)
A series of new estimates were prepared over this period as a result of the acceptance of the first tenders which were much higher than expected. After a number of detailed explanations of the additional costs and negotiations between the Jockey Club and the Government, a final budget of $2,340 million excluding inflation was agreed. With inflation, the estimated cost was $3,548 million at Tender Price Index (TPI) 590. The Finance Committee agreed to these figures on 1st June 1990.

The final cost
The final cost of the project was just over $3,200 million due in large part to a reduction in tender price indices after preparation of the final estimate.

A critique

Hindsight is a wonderful perspective, if a somewhat unfair advantage. Even so, retrospectives can be valuable and provide useful lessons for the future.

The estimates prepared for this project suffered from a psychological phenomenon which is not uncommon to large scale construction projects. It is that 'our project can buck the trend and cost less than everyone else's'. As a result, estimates tend to be squeezed and hence too optimistic as the realistic estimates of professional consultants are trimmed. Consultants' estimates are seen to somehow benefit the consultants. It is as though there is an inability to distinguish between consultants' estimates and contractors' bids. Consultants' estimates are estimates of what contractors will charge and contractors bids are what they will actually charge. To reduce the latter saves money; to reduce the former produces inaccurate budgets.

This attitude was present from the beginning of this project. Shortly after being reported to the Planning Committee, the original $1,500 million estimate was revised upwards but it was nevertheless set at $1,500 million for submission to the Finance Committee and the paring of the estimate had begun.

A further problem generated at this time was that inflation was not dealt with the effectively. Although the major additional cost of the University was the increase in base cost, the additional cost due to inflation contributed enormously to the public (and the politicians') perception of the size of the increase. If the reporting

of inflation had been handled carefully during the development of the project, the shock at the increase would not have been so great.

The increase in the estimate from $1,500 (actually $1,352) to $1,620 million was claimed to be due to a whole host of relatively small items. These items were identified by the professional consultants and estimated by them. The estimate was then reduced by the project management team again to below a realistic figure. A particular example was the omission of $40 million of extra preliminaries due to the accelerated construction programme, which was later used by the project team as a reason for estimates being low. Inflation continued to be unrealistically addressed. At the time inflation was still running at about 12% per annum, yet only 7% was allowed. Conditions for a shock at the final outcome were already laid. The effect of the squeeze and inflation was that the $1,620 million revised estimate was unsound and probably a reduction in real terms on the $1,500 million estimate, which had itself been squeezed.

The increase from $1,620 to $2,007 million was again claimed to be caused by a large number of relatively small items as a result of the developing design plus extra for a reappraisal of housing provision and for a further increase in gross floor area which was not recognized explicitly. If earlier estimates had not been squeezed and appropriate unit costs used, the likelihood is that these increases could have been largely convered and the increase to $2,007 million would not have been so dramatic. In this round, the estimate reflected the total of the cost plan prepared by the quantity surveying consultants but once again inflation was underestimated.

If earlier estimated had been more realistic and reported to the Finance Committee, then in the final round of estimates the apparently dramatic increase from $1,620 to $2,340 million reported in June 1991 would have been much less or could have been explained away much more easily. What happened was that attempts were made to identify specific items of extra cost whereas the additional cost was not due to specific items but due to too low a level of overall pricing. The total estimate of $3,548 million appeared huge relative to the earlier estimates due, in no small part, to the $1,208 million for inflation. Again, if inflation had been estimated realistically and reported, the reaction generated by the total sum would have been lessened.

The concern expressed by the Government on receiving the final uninflated estimate of $2,340 million, and the concern subsequently expressed by the Auditor and the Public Accounts Commitee, would have been tempered had a more structured and rational approach to explaining the increases been adopted. What actually happened was that a whole range of reasons for the additional cost were generated and reported at some stage, some of which were entirely acceptable and some of which could not be justified.

The approach to presenting the increases in estimates would have been more acceptable if it had been consistently argued without introducing extraneous and unjustifiable topics.

The $2,007 million estimate (or an adjustment of it) should have been put forward to the Finance Committee as the first confident estimate. Much of the difference between it and the $1,620 million estimate would not have needed explaining if the $1,620 million estimate had not been squeezed. That which did need explaining could have been argued on the basis of the clarification of the brief (at this early stage but only at this stage) and the need to apply an overall increase in pricing.

Any further explanation needed could largely have been readily provided for by the uncertainty of predicting inflation. It could be clearly shown (but the Government may not have accepted) that for a fixed price contract such as this, private sector indices are more appropriate and could have resulted in up to $150 million dollars more for inflation. By allowing for this additional inflation, the base estimate would have been reduced by $150 million from $2,340 million to $2,190 million.

Inflation should have been handled more positively all the way through the project. There is no point in making assumptions about inflation which are unlikely to occur. All that results is shock at the eventual cost even though it is a result of ligitimate inflation. A much better approach is to report inflation at regular intervals as the forecasts predict so that it is expected and thereby more acceptable.

Presentation of a sensible estimate at an early stage which is not cut to the bone (and beyond), a sensible treatment of inflation, inclusion of the costs of the additional floor area and consistent arguments for the only major acceptable items of additional cost would have the benefit of keeping the process simple and persuasive.

A clear picture would have been given of the acceptable cost of the University rather than the confusion of relevant and irrelevant, large and small and often invalid items which were used at various times to try to justify the increase.

Value for money?

Assessing value for money in construction is notoriously difficult. Detailed and intricate cost-benefit assessments are required using value engineering techniques. Few clients are prepared to pay for the assessments and time is often not available. This was certainly the case for the University project. Instead, reliance is placed on the experience of the project team and a clear understanding by the client, and all others concerned, of the objectives of the project. The project team must be able to transform the objectives into a building which represents value for money. This is not the palce for a discourse on value for money in construction, save to say that value for money does not mean cheapest. Put simply, it means the best design for the prupose taking into account initial and future costs and benefits.

The cost per square metre of gross floor area for the Univeersity of Science and Technology does not seem unreasonable in the light of the level of costs for various types of buildings at the time it was built. Below were specific factors which pushed up the cost of the University relative to other buildings, particularly the City Polytechnic, and to a certain extent buildings at the University of Hong Kong.

The speed and uncertainty of design and construction would have added substantially to the cost. Contractors would include in their tenders for uneconomic working as a result of congestion and idle time as workers waited for others to complete their work. Contractors would also include in their tenders for the risk associated with waiting for drawings from the consultants or carrying out work from incomplete drawings which may be abrortive. A project with such a tight programme would require a much greater than usual management input.

- All utilities and services within the academic buildings were comprehensive and flexible to respond to changing technological needs. For example, the services costs for the City Polytechnic were 35.5% of the total for Phas II Academic Building, 35.1% for the University of Hong Kong's computer science and electronics building but were 41.1% of the University of Science and Technology's Phase II Academic Building.
- The University has a high proportion of sophisticated reserach laboratories, some of which, particularly those in engineering disciplines, required special structural provision.
- Major underground utility installations were required to connect the campus to the adjacent services. Environmental considerations resulted in the construction of a major sewage tunnel to Junk Bay.

Neither the UPGC nor the Government set any pre-determined unit cost (per m2 GFA) limits for academic and associated buildings. Each case is decided on its merits. Even though normal routines were bypassed to speed up the construction of the University, there is nothing to suggest that its cost was unreasonably high for the facilities and standards provided. In comparison with the City Polytechnic and the Polytechnic's comparison with other buildings, it may well be that the Polytechnic was set at too low a standard. Nevertheless, a university of science and technology has distinctly different needs from a polytechnic and as a result is more expensive. Cheap buildings do not represent good value if the use of materials and construction techniques incur high future miantenance costs and inhibit flexibility to adapt to future technological demands.