JAPANESE VISION OF COMMISSIONING PROCESS AND ASIAN VIEW

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Summary

Building Services Commissioning Association, BSCA, has been established in Japan as an NPO in order to propagate the building commissioning, especially HVAC commissioning, process among building and building services construction and maintenance society in Japan. As most engineers have not been so happy as the minimum initial cost policy used to goes first without clear definition of performance on environmental quality and energy efficiency, commissioning concept, after seven years of discussions in SHASE and IEA/ECBCS/Annex-40 shadow committee and others, has become popular and recognized as one of the most important process to be introduced, if only building owners and public sectors concerning building construction, energy conservation and environmental preservation come to understand true value of it. In Hong Kong the Commissioning Center was established in 2002 affiliated with the Hong Kong Institute of Vocational Education and with from short to long term training programs how to propagate the process and bring up commissioning engineers. In Mainland China and Korea commissioning process is not well recognized yet except in a sense of performance diagnostics and fault detections.

Keywords: HVAC, commisioning process, Japan, Asia

INTRODUCTION

In Asia, only Hong Kong has the history of commissioning recognition since 1970s, where United Kingdom's sovereignty did popularize the term commissioning into building construction world. However, as the term commissioning had been used in UK for rather testing and adjusting of the system, the energy and environmental performance stressed meaning of commissioning, not to mention the commissioning process during building production, has come to be recognized only since several years before. In mainland China there has been no idea of building performance at the life cycle point of view during communist revolution in mid twenty century, so that commissioning idea never emerged from this social system, except that few outstanding researches have been performed on fault detection and diagnosis of HVAC and district heating system in operation. Korea and Japan have had some experiences on commissioning of American and/or European sense when industries contracted building and/or process construction works, both inside and outside these countries, with overseas countries where a certain sense of commissioning applications are popular. However, in their own domestic construction works, no idea on commissioning process has ever been recognized. Typical historical events on commissioning are shown in Figure 1 with the comparison between Japan and world.

World (includes Asia)	Japan
• *1965 AABC was organized and TAB manual prepared in USA.*	
• *1966 First commissioning (testing) code was issued in UK.*	
• *1970s Commissioning (testing) activities began in HK.*	
• *1979 ASHRAE symposium on TAB*	
• 1986 ASHRAE symposium on Cx	• 1987 First introduction of Cx concept by NN
• 1989 First ASHRAE Cx Guideline was issued.	
• 1989 PECI began activities preparing Cx Guidelines/Manuals.	
• *1991 Annex 25, BOFD and real time simulation, started.*	• *1991 Participated in Annex 25*
• 1993 PECI held first National Conference on Building Cx.	
• *1995 Annex 34, BOFD Demonstration, started.*	• *1995 Participated in Annex 34*
• 1996 Second ASHRAE Guideline on Cx Process was issued.	• 1997 Cx activities began in BEMS Committee, SHASE.
	• 1998 Tentative Cx Guideline Draft was developed.
	• 1999 Cx Committee was established in SHASE .
• 1999 Building Cx Association (USA) was established.	• 2000 First formal application of Initial Cx, results publicized in 2001.
• 2000 Annex 40, HVAC Commissioning Process, started.	• *2000 Participated in Annex 40*
• 2001 USGBC LEED rating system enhanced Cx application.	• 2001-Academic as well as practical talks and papers on Cx have began to appear frequently.
• 2002 ASHRAE/NIBS Cx Process 200X-0(public review draft), Total Building Commissioning concept was defined, hereafter	• 2003.4 Annex40 Kyoto meeting w/ international symposium on Cx was held.
• 2002 Cx Center was established in HK.	
• 2003 CIBSE Cx code M (Cx Management) was issued in UK.	
• 2004 ASHRAE Cx Process 200X-0(second public review draft)	• 2004.3 Cx Guideline and Cx committee report were completed.
• 2004 CA certification program was discussed at NCBC, and BCA started Certified Cx Professionals (CCP) program.	• 2004.8 Building Services Commissioning Association (BSCA) has been established.
• 2004 Annex-40 final meeting in Paris, together w/ ICEBO2004	
• *2005~2006 First ACBC, Asian Conference on Building Cx is to be held.*	• *2005~2006 First ACBC, Asian Conference on Building Cx is to be held.*

Figure 1 Historical development of modern commissioning process in the world and Japan (Nakahara)

In Japan, the author first introduced matters discussed on Testing, Adjusting and Balancing (TAB) and commissioning in USA during 1980s on ASHRAE literatures at a certain academic meeting in around 1986, then after joining Annex 16, 17 and 25 of IEA/ECBCS international research team for energy conservation for ten years, the author proposed to work on establishing commissioning guideline for Japan construction industries at BEMS committee, and later at Commissioning committee in SHASE, the Society of Heating, Air-conditioning and Sanitary Engineers of Japan. Before finalizing the work in March 2004, the author experienced the first initial commissioning process in Japan as a Commissioning Authority (CA) in 2000 for an office/laboratory facility; Japan joined the Annex-40 the subject of which is HVAC commissioning and which will be finalized at the present meeting in Paris; and the second initial commissioning project in Japan has just been finalized, all of which produced valuable data, tools and materials to proceed commissioning process.

Establishing commissioning association as a non-profit organization was proposed in 2003 with a close cooperation with SHASE and the Building Services Commissioning Association has been admitted as NPO by the Japanese government at the end of July, 2004. Activities will start soon. In Hong Kong, the Commissioning Center was already formed in June 2002 as a non-profit making entity and strategically affiliated with the Hong Kong Institute of Vocational Education.

LIFECYCLE VIEW OF BUILDING COMMISSIONG AND OPTIMIZATION

The term Building Optimization, Fault Detection and Diagnosis, or BOFD(D), in operation and control has come to be recognized among HVAC experts owing to the IEA Annex activities. The author defined the BOFD as follows [1] [2] and established total BOFDD structure as shown in Figure 2. The system is hierarchically composed in the maintenance stage of the figure. The higher stage BOFDD is meaningful only after the fault recovery at the lower stage. Each stage consists of three steps, from right to left, the fault detection, fault diagnosis and fault recovery. Some tools for BOFDD to be used in each stage are common with those used at the design stage, which are simulation, mathematical models, database and expert systems.

Building optimization is the process of minimizing an overall objective function that includes all cost of building operation (e.g., energy, maintenance, personnel) with the constraint of environmental condition. The building optimization can be performed with respect to both design and control variables. When the substantial object of building optimization is reflected, the measures will even include manual operation using BEMS, the retrofit of building services systems and thermal and optical performance of the building structure from the viewpoint of building management.

However, a design necessarily includes faults and unknown factors at the design stage, so that it should be inspected and modified in order to meet the client's newest need at the time of completion and the maintenance stage during operation which will be defined by the facility management. Recent computerization of design process greatly contributed to mass production of drawings and keeping beautiful appearance but the average quality of design has rather been lowered, because the expert system is not yet fully developed and the real expertise is losing its situation to introduce it into actual design. Thus, contrary to a frequent talk of the optimization, the way to the optimal design and operation is difficult to find out its way.

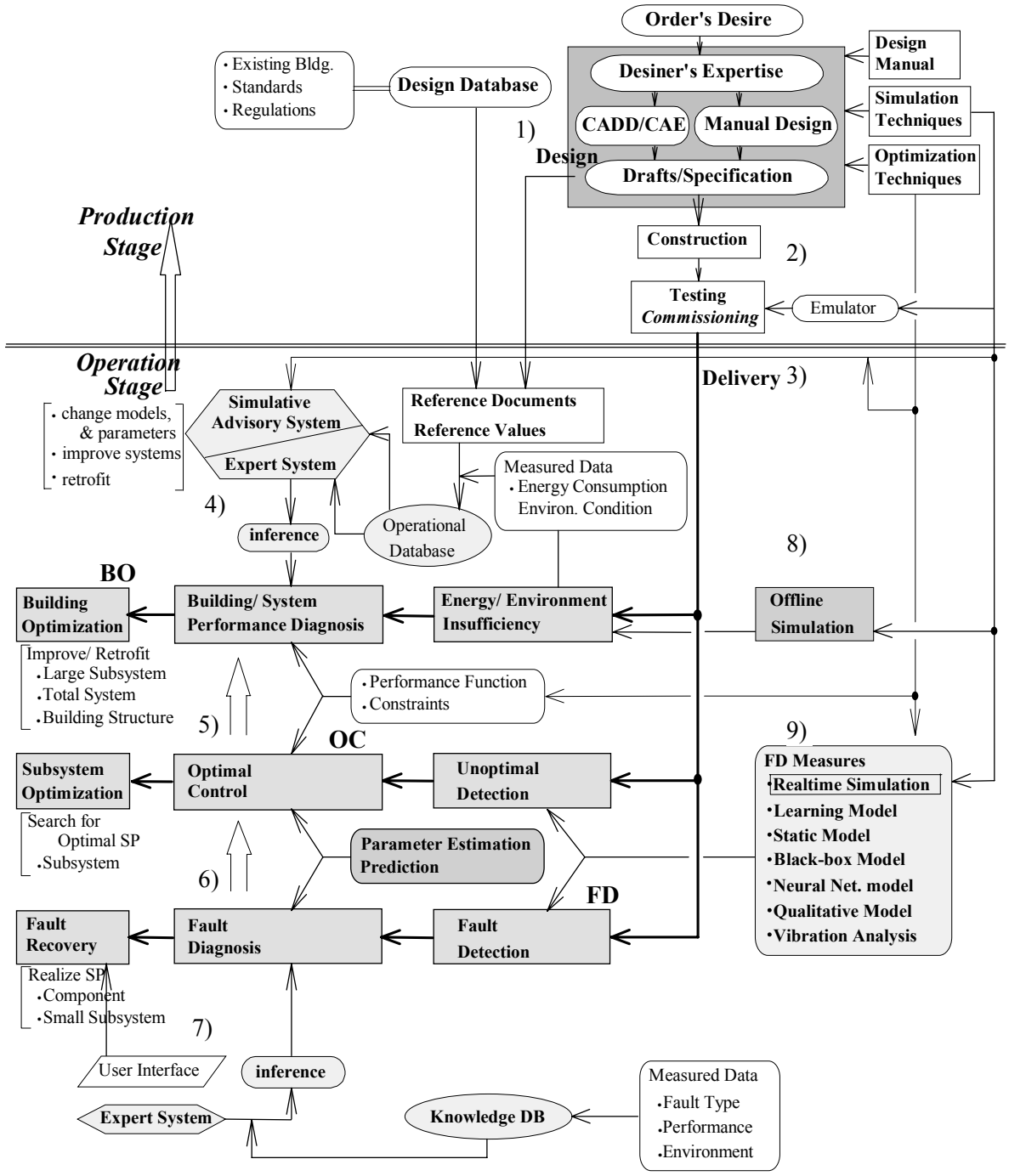
Thus, Figure 2 also shows the process of the life cycle building optimization in which the production stage as well as the operation stage is closely related through simulation techniques, fault detection and diagnosis by mathematical model, existing data base, statistical analysis, control strategy and commissioning. The design without narration of control strategy is ultimately defective. The control strategy at the design phase, which should be simulated beforehand to assure the effect, must have the same kind of performance function and constraints which will be followed at the operation stage. Commissioning has thus become an important keyword of optimization for realizing optimal building environmental system with the indoor air quality as the constraint and the energy consumption as the performance function from the life cycle point of view. This kind of commissioning system has gradually been recognized in the construction community, which, especially in the USA, leads to total building commissioning concept.

Thus, the ideal commissioning process should begin just after the schematic project plan is established by the owner. The commissioning authority is responsible for finding out any faults within design, the process and content, and acting as an intermediary among the designer, constructor and the client in case any change is needed. He should also be responsible for making sure that the system as well as the building can be operated as the predicted performance from the energy, environment and facility management viewpoint for at least two years. This will make lifecycle optimization possible as shown in the figure.

However, who on earth can fairly advise the client through the life of the building? The architect has never reflected the maintenance stage, neither does the HVAC designer, for only designing is their profession. Urgent needs exist to educate and certify those who can be responsible as the manager, professional expert, or professional technician in order to meet the market demand for commissioning professionals, number of which is expected to increase rapidly. The discussion on certification of commissioning professionals at NCBC 2004 meeting, as shown in Figure 1, was fairly timely subject and even in the USA the newest kinds of certification programs based on total building commissioning concept have come available since 2003.[3][4]

MQC AS A COMMISSIONING PROCESS CONTROL TOOL

During Annex 40 study, Japanese Shadow research group was interested in Model Quality Control matrix that was introduced by Op'tVeld, a Dutch delegate [5], and made efforts to modify it into practical commissioning process control tool as well as database. It also, as it has been responsible for drafting the commissioning terminology and to prepare SMCP, Standard Model Commissioning Process, for large and complex buildings, modified classification of column, the commissioning phase, and lines, the commissioning aspects, to meet total figure of the Annex work and for practical commissioning business. It leads us to use most popular spread sheet table tool, Microsoft Excel, in order for users to customize as they like for their specific project. Figure 3 shows the matrix as index for selecting specific cells on demand to refer for relevant definition, activity, detailed information and any other database and linked files. Details are discussed elsewhere. [6]



1) Design professionals complete design documents to meet Owner's Project Requirements with their professional knowledge and database from the technical, social and legal points of view.
2) Construction team control the time and quality of the product, the building and building systems, and test them as to meet the design documents, for which commissioning team verifies at each step and perform functional test before hand-over
3) The system such as HVAC that need seasonal testing shall be continued commissioning until one year after completion.
4) Whoever responsible for commissioning will evaluate the macroscopic building performance on energy and environment with the reference data from database, statistical data of existing buildings and legal restriction, on energy budget and troubles.
5) Optimal controls are performed under the performance function, the energy consumption, and constraints, the comfort criteria. Design and component equipments also comprise constraints for optimal controls.
6) Either manually or automatically the fault detection and diagnosis are executed if the total system, subsystems and components are working in the predefined performances.
7) Maintenance engineers use to expert systems to operate and evaluate if the system is working in proper condition. Consulting engineers, sometimes during continuous commissioning, assist them to keep the expert system most appropriate condition.
8) Commissioning professionals survey and evaluate the existing system referring to the design documents, as-built documents and commissioning reports, if any; that is, re-commissioning or retro-commissioning.
9) Tools mostly common both to design process, optimal control and BOFD process.

Figure 2 Life cycle commissioning and optimization (Nakahara)

Commissioning Matrix		Production Stage							Operation & Maintenance Stage	
Instructions		Program Phase (Pre-Design Phase)		Design Phase		Elaboration Phase	Construction Phase		Operation Phase (Occupancy and Operations Phase)	
TYPE IV - V Non-Residential Building		Program Step	Planning Step	Preliminary Design Step	Working Design Step	Elaboration Step	Construction Step	Acceptance Step	Post-Acceptance Step	Post-Post-Acceptance Step
aspect	Phase Keyword									
	Definition: Phase Definition									
	Definition: Step Definition									
	Definition: CA's Role									
	Actions									
	Organization									
	Requirements: Standards/Regulation									
	Requirements: Performance/Criteria									
	Commissioning Tools: Documentation Tools									
	Commissioning Tools: Technical Tools									
	Commissioning Tools: Communication									
	Purchase/Finance: Purchase (outsourcing,hiring)									
	Purchase/Finance: Funding									
	Outcome/Documentation									
	Others									

Detail Preview

TYPE IV - Non-Residential Buildi...

Preliminary Design Step

Cx Checklist
Design checklists
Cx Guidelines and Formats

Documentation Tools

cell contents	specification	specification(2)	URL	MAIL	Other Files
Guideline	ASHRAE(USA)	1996 version			
		200x version			
	SHASE (Japan)	2003 draft version			
	NEBB (USA)				
	CIBSE (UK)	air and piping systems			
		equipments			
		BEMS and contyrol systems			
Model plan documents and formats	PECI(USA) MCP&GS (Model Commissioning Plan ans Guyde Specifications)				
	Annex documents SHASE Cx Guideline				
	Typical actual example plans	YBS Initial Cx example (Japan)			
		TepcoT Initial Cx example (Japan)			
SMCP (Standard Model Commissioning Plan)	Annex 40 models	Building Types 1~5			

Figure 3 Commissioning phases and aspects; MQC index sheet (Nakahara, et. al)

JAPAN VISION OF COMMISSIONING PROCESS

ACADEMIC ACTIVITY FOR COMMISSIONING GUIDELINE

As frequently described before reaching here, only academic activity has been done in SHASE committee about commissioning process. The author as the promoter of it submitted papers to AIJ, Architectural institute of Japan, as well as SHASE and contributed papers to many kinds of academic and commercial magazines, and made lots of presentations at various kinds of meetings corresponding to requests. This means how people think this kind of quality control process is necessary among the practical field. To the contrary, actual application of authorized commissioning process as a pure business is none yet, but there are two directly-paid-by-the-owner cases for initial commissioning even though just after the construction phase.

ACTIVITIES ON ACTUAL COMMISSIONING PROJECTS

The first actual project described before, HVAC system of Y building, is rather commercial one that was conducted by the author himself as the CA. However, the reason that the author do not call it a pure business sense is that CA as well as the owner, which is a control manufacturer and contractor, and contractors had the mind to contribute establishing commissioning process in Japan and produce as much fruits of standard model documents, templates, contents, etc. as possible in order to reflect them to formal commissioning guideline that had been developed in a SHASE committee work, for which the author was responsible. Therefore, contractors, design professionals and owner itself volunteered for additional commissioning works without any payment and in addition they provided assistants for managing commissioning process with the independent personality apart from the on-going contracted work. Of course it must be considered that they viewed a new business model available in the future behind that contribution. Detailed report is seen elsewhere. [7] The project is now under continuous commissioning stage with joint works of in-house researchers / engineers and the author as an adviser.

Another case is for a certain power company's new building, a part of the HVAC systems of T building, for establishing

standard commissioning process either to bid it outsiders or to do it by in-house engineers. [8] The CA, or rather to be called as chairman, was the director of the design professional office who had contributed to the formerly mentioned Y commissioning project. He also attended the NCBC 2001 meeting together with the author and other delegates, which was the first participation to the conference from Japan. He organized commissioning / research team for T building consisting from NCBC-visit members including the author as the advisor and the owner, contractors and HVAC designer as observers. The sponsor, or the owner, is willing to reflect standard documents brought up from this research-like commissioning project to commissioning manuals that might be further developed to be included into SHASE and/or NPO materials.

ACTIVITIES IN CONTRACTORS

As described before, one of the reason that commissioning talks drew attention in Japan, just as in every country I suppose, is on the doubt how building performance might be insufficient, how testing and adjusting was left vague because of the lack of time and money and how come the construction business in the future in this too hard a competitive state that has resulted in low-cost contracting, which everyone can understand must result in low quality to produce as much profit as possible, or as less deficit as possible. No engineer favors this state and commissioning process must be only a solution for it. How come owners never want to pay additional money? That's right and yet engineers cannot admit low quality buildings are piled up in the world.

Typical activity done by contractors for commissioning study is that of Building Constructors Society, BCS, which aims at rather upgrading quality control measures of general contractor's business in order to appeal owners reliability of general contracting than establishing commissioning business model that might become, they think, competitors. Apart from the motives it is good to learn advantage of commissioning process and introduce it to their own business to increase social welfare and heighten social fairness. Building services engineering section of BCS organized a commissioning committee and made survey on actual status of commissioning business and technology from several standpoints. Some of them have joined the Annex-40 shadow committee of Japan, too. It will be very happy if their conclusion would realize raising high level of quality control in their own companies and resist the cheap-but--- bidding and persuade owners how important it is to keep reasonable cost and time, and further, the necessity of independent commissioning team working all through the production stage of buildings.

ACTIVITIES ON TECHICAL TOOLS FOR COMMISSIONING

Formal activities, in which commissioning is recognized as a process but never limited to TAB and/or system diagnosis, may be limited within the Annex-40 shadow committee members. Japan activities on commissioning tool development are classified as follows.

Technical Tools for Commissioning:

Technical tools herein defined include mathematical tools and measure/analysis tools. Objectives and advantage of commissioning tools are listed in Table 1. Commissioning tools may be either manual or automatic. Several results performed by Japanese researches are to be reported at this meeting, ICEBO 2004, and to be included within Annex 40 final report together with those already presented past Annex 40 meetings.

Table 1 Objectives and advantage of Commissioning tools

Objectives of commissioning tools	The merits of automatic commissioning tools
a) checking of the performance at the design phase b) performance test c) functional test d) FDD of HVAC components and systems e) FDD of logical/ system/ components of BEMS f) detecting faulty design or specification g) detecting faulty installation of components h) checking completeness of TAB work and i) training of building owner and maintenance personnel	a) reducing time for commissioning b) reducing cost for commissioning c) preventing mistakes in commissioning d) reducing the required number of commissioning experts e) performing commissioning under the design condition by using modeling technology

Questionnaire Survey:

Questionnaire survey on recognition and expectation by Japanese HVAC engineers was made in order to identify potential research subject to develop during Annex 40 study in 2001-2002. Question was as follows. Results was reported in Annex 40 meeting [9].

System Simulation:

HVAC System simulation programs were used for comparative study of energy effectiveness of various HVAC systems. Some programs aims at analyzing control behavior and/or room environment. Most of their target phases are design phases for the sake of HVAC designers. Actually, however, lack of time for design, lack of skill for program handling, lack of credibility for total system simulation results and many other reasons caused rare application to actual HVAC design except in the case that any law regulates to use them for, e.g., energy conservation and sustainable building design. However, several reasons may urge HVAC designers and engineers to use simulation programs in the future as follows.

1) User interface to input data and select proper items among options has become very friendly and simple through inter active operations with the use of *Windows*.

2) Energy efficient and/or green building design has become more and more socially requested aiming at fulfilling Kyoto protocol on global environmental issue.
3) Needs for fault detection/diagnosis and commissioning and for verifying system performance for performance contract request more precise, verified and multi-functional simulation programs such as HVACSIM$^+$ and EnergyPlus.

Then, simulation programs as the commissioning tools are classified as Table 2. Programs for comparison were selected from Japan-, USA- and China- developed as shown shaded in Table 2. Availability of them was intensely studied in SHASE commissioning tool subcommittee. The result of the study performed was reported in the past paper [7] as well as at the present meeting. [10].

Table 2 Simulation programs as commissioning tools

classification		examples
Heating/cooling load calculations	Peak load	Micro/Peak (Japan)
	Annual load	Hasp/ACLD (Japan)
Total HVAC system simulations Energy performance simulations	Static simulations	Hasp/ACSS, BECS/CEC (Japan) DOE2, BLAST, EnergyPlus (USA), ESP-r (UK) Dest (Tsinghua, China)
	Dynamic simulations	HVACSIM$^+$, [TRNSYS], [EnergyPlus]
Simulations for specific sub-systems		Thermal storage system: TESEP-W (Japan) Solar system: TRNSYS
Room air distribution and environmental distribution	Macro-model	Block-model, R-model (combined complete mix. and piston flow model) (Japan)
	Micro-model	CFD programs, such as *STREAM*
Control system simulations		MATLAB, LABVIEW, HVACSIM$^+$

HVAC COMMISSIONING ASSOCIATION, NPO

In August 2004, BSCA, the Building Services Commissioning Association, was given birth as NPO. This is purely private organization, but has corporative relation with SHASE in their educational and academic activities on commissioning, defining work sharing between them. The BSCA is viewing to take the role of

1) preparing practical manuals, standard documents and templates for CA to manage commissioning process,
2) educating and training of how to manage and proceed the commissioning process to bring up CAs,
3) holding seminars on commissioning process guideline co-sponsoring with SHASE,
4) developing certification program for commissioning providers, engineers and CA,
5) enlightening social recognition on the role and value of commissioning, targeting especially government and utility sectors, and building owners' and maintenance sectors, as well,
6) international communication and collaboration by exchanging information and technologies, possibly holding international conferences on building commissioning,

while it has no back-up organization yet from the financial point of view except for regular members and supporting members. However, the author is optimistic of its future, because needs for commissioning will never cease in the present society where needs for energy conservation, global environment preservation, human comfort and life safety, request for long life and sustainable building will be heightened more and more. The character and activities of the NPO refer to those of Portland Energy Conservation Inc. (PECI) and Building Commissioning Association (BCA) in the USA, which the author views and most members support, though the scale and financial background can not be compared at all.

ASIAN VIEW FOR COMMISSIONING PROCESS

HONG KONG[1] [11]

Background:

Hong Kong had been ruled by the British for 155 years since 1842. Indeed the local building and construction codes of practices are copied from the British model. The building regulations adopted in UK are generally good for Hong Kong building industry with certain modifications for high-rise buildings.

Before 1970, most construction professionals were recruited from the UK. They brought in construction technique and know-how, also the construction and project management model and practice. Traditionally, architect first designs the layout with structures and building services input from the structural and building services engineers; then quantity surveyor helps to compile the contract document and bills of quantities so that cost control is vitalized. Construction work is usually monitored by the architect with assistance from engineers, clerks of works and inspectors for architectural and E&M installations. Such arrangement is well illustrated in the Architect's Handbook of Practice Management by the Royal Institute of British Architects.

[1] This information was given by Mr. Leo C. F. Wong, Hong Kong Institute of Vocational Education

The Chartered Institution of Building Services Engineers (CIBSE) drafted the first commissioning code in 1966. The documents were brought to Hong Kong in the early eighties. CIBSE defines the term "commissioning" as "the advancement of systems from static completion to dynamic operation according to requirements". This is obviously a process to test the building systems after completion before the owner and operators take over them. This model is being adopted for years in Hong Kong and up to now, there is no sign of changing in the building industry.

Hong Kong Building Commissioning Centre (HKBCxC):

In the meantime, reputation of Hong Kong construction industry was seriously damaged by some scandals nearly at the end of the last century, and then the Construction Industry Review Committee's report published in January 2001 suggested that the construction process and quality control shall be revised and remodeled. A group of local engineers who are working in owners, consulting firms; academic institutions, contractors and suppliers have discussed the recent issue on building commissioning, and decided to set up a focal point in promoting building systems commissioning, and to produce commissioning models that will be adoptable in local construction industry, and probably extended the applications to the Mainland China.

In the light of the above, the Hong Kong Building Commissioning Centre (HKBCxC) was formed in June 2002 as a non-profit making entity and strategically affiliated with the Hong Kong Institute of Vocational Education (Tsing Yi Nexus). To formulate a better model and practice in building commissioning, the HKBCxC aims to develop in three fields, namely commissioning, energy utilization and operation and maintenance. Besides, short, medium and long terms policies and goals are defined in order to serve the public-at-large. Tentatively, three different categories of buildings, and three trade persons will fit in the commissioning circle as shown in Table 3.

Table 3 Proposed Commissioning Circle (HKBCxC) -Buildings Categories and Trade Persons for Building Project- (Wong)

Buildings Categories	Cx Process	Project Stages	Supervision	Trade Persons
Essential		Program / Design		Certified Cx Administrator
Elegant		Construction		Certified Cx Supervisor
Typical		Acceptance / post acceptance		Certified Cx Technician

Essential Buildings - daily operations and processes inside the building are ESSENTIAL to the public. In case of failure, it will be seriously affected or leading to communal disturbance and social violence

Elegant Buildings - built environment is ELEGANT to the owner and occupants for accommodation. In case of failure, the occupants will be affected and leading to disturbance. Besides, it is encouraged on major projects with $50 million or more in total construction costs.

Typical Buildings - TYPICAL in nature. In case of failure, the effect to occupants and inside operations will be inconvenienced. Besides, it is encouraged on major projects with $10 million or more in total construction costs.

Commissioning Administrator - A certified person who could oversee the Cx process from program to acceptance stages.

Commissioning Supervisor - A certified person who could supervise the construction process and monitor acceptance test on site.

Commissioning Technician – A certified person who could execute acceptance test on site.

Due to the fact that the British model for commissioning in the 'acceptance' stage has been well adopted in Hong Kong, and there are skilled technicians available in the field, the HKBCxC will first put more attention and effort in the review and refinement of the existing practices in commissioning procedures in the 'acceptance' stage. At a later stage, commissioning practice to be adopted in 'construction', 'program' and 'design' stages will be devised. This is indeed a bottom up approach. To achieve the initial goals, the HKBCxC will concentrate their effort in the following ways

Education and Training:

In Hong Kong, university degree courses in architectural studies, building technology and management, building services do not offer practically detailed illustrations on commissioning. In private sectors, the issue on commissioning as a company goal is not addressed. Precisely, the planning, formulating and implementing of commissioning between government and private sectors in different stages have never been coordinated. The sub-degree courses in colleges do include commissioning but it is not comprehensive enough for students to understand the whole Cx process. Indeed students only learn testing procedures, with some basic introduction on Cx process. The integration of Cx with other building quality control processes is not done. Therefore, commissioning is still being considered by most people as a single process before handover.

Local engineers are now beginning to realize that the Cx ad-hoc courses conducted by foreign speakers have given them the insight of the importance of commissioning as a continuous process. However, such courses do not have sufficient focus and coverage with respect to local situations and practices. Being practical, the HKBCxC will focus to formulate a series of proper testing procedures for the application to systems commissioning. It is intended to conduct practical courses for the Cx technicians and to certify their competencies after they have satisfied some trade tests applicable to the acceptance stage of Cx. This scheme will gradually further extend to Cx supervisors and administrators who wish to be certified in competency in the Cx process applicable to the erection and program/design stages respectively.

MAINLAND CHINA[2]

From the full concept of commissioning, there is not building energy system commissioning in Mainland China yet. However, some pre-researches and trial practices have been done by universities and some research organizations.

Background, Relevant Codes and Standards:

National code for HVAC system construction and acceptance was issued by Ministry of Construction in Oct. 1997, and was implemented since May 1998. This code involved the regulations and standards related to the tasks in stages of construction and acceptance include TAB and synthesis performance assessment.

National code for HVAC system operation and management, is being written by China Academy of Building Research and China Disease Control Centre, will be issued by the end of 2004. This code will become the first one specifically for optimal operation and management.

GOBAS and Commissioning

A green building assessment system named GOBAS (Green Olympic Building Assessment System) — developed by Tsinghua University and other eight organizations, sponsored by Chinese Ministry of Science and Technology — was published in August 2003.The reason why such a green building rating system is considered as a kind of commissioning standard is that GOBAS is a rating system by stages: planning, detailed design, construction, acceptance and operation. Although there many aspects related to resources and environment impacts are involved in GOBAS, energy consumption and system performance are still the most important contents in this assessment system. Using GOBAS, every stage of the project from planning to operation can by controlled to gain the best system performance and low energy consumption. GOBAS rating system is to be further developed to include different types of buildings in different climate zones in two years, in addition to Olympic-related facilities in Beijing at the present.

Simulation Tools for Commissioning—DeST

DeST (Designer's Simulation Toolkit) is a tool developed by Department of Building Science, School of Architecture, Tsinghua University for aiding HVAC engineer to realize 'design by analysis, design by simulation'. A design is performed by stages, as ASHRAE Air-conditioning System Design Manual describe as follows:

Program Phase→Schematic Design→Preliminary Design→Final Design→ Post Design Phase →Commissioning Phase→Post Occupancy Service

HVAC system or building energy system commissioning is aimed at to optimize the performance and energy consumption through the whole process of building planning/program phase, conceptual design/schematic design, preliminary design, detailed design/final design, construction, acceptance, operation, retrofitting, or through the so called life cycle of the building. However, lack of proper simulation tools is an obstruction to HVAC system commissioning in the early stages.

DeST is developed to pursue the goal of '*Design by stage, simulation by stage*'. It is an annual building energy consumption analyzing software doing simulation hourly for HVAC designers, applying simulation into different stages of design. So DeST can be used as an effective simulation tool for HVAC system optimal design in different stages. Therefore, it can be regarded as a simulation tool specifically for HVAC system commissioning. DeST has been used for commissioning of many existing HVAC systems in China.

Practice of Trail Commissioning

Tsinghua Green Building Research Center, a low energy demonstration building, 3,000m^2 of total floor area, will become the first initial commissioning project in mainland China. Optimal design by simulation and analysis is implemented from the very beginning through the whole process, including the controllable fabrics design and energy and environment system design. GOBAS was used as the reference commissioning standard in this project. The building integrates different kind green building technologies including: 1) Controllable building fabrics with double skin facade, controllable shading facilities and hybrid ventilation paths; 2) Rising floor with shape stabilized phase change material for thermal storage for night ventilation or night electric heating; 3) Independent humidity control for the main air handling process using new brine desiccant system; 4) Combined Heat and Power system for Building (BCHP) with gas engine and fuel cell combined with renewable energy such as solar heat and waste heat from BCHP for regeneration of desiccant system; 6) Natural wind emulated task air-conditioning, cool ceiling using underground water and OA displacement ventilation. Testing and optimal operation will be continuously done by School of Architecture, Tsinghua University. Commissioning experience will obtained from this project.

During the past decade, re-commissioning and retro-commissioning have been applied to more than 20 commercial buildings including hotels, office buildings and shopping centers. For example, the owner of a commercial office building in Beijing, 54,490 m^2 of floor area invited an expert group from Tsinghua University as the consultant for the retrofit project. This consultant group helped them in working out the retrofit plan, checking the BAS technical scheme, on-site test the system operation according to the retrofit design specifics and BAS technical scheme to exam the system performance, and so on.

[2] This information was given by Prof. Yingxin. Zhu, Tsinghua University.

KOREA[3]

Background:

Korea having been participated in Annex 40 as an observer, wanted to promote commissioning process by regulation through the construction industry from the viewpoint of energy conservation and quality assurance of the buildings newly built. It has not, however, got a satisfactory result yet. Korean government has no intention to legalize the commissioning process yet, and no organization on commissioning process exists yet, as well.

TAB was introduced to Korea in 1986 and widely applied to any buildings except for apartments. TAB specification is based on the SAREK's (the Society of Air-conditioning and Refrigerating Engineers of Korea), which followed the regulation of NEBB.

Commissioning Guideline

Korea Institute of Energy Research has established commissioning process and guideline with TAB cooperated together. However, it is not yet approved by SAKEK (the society of Air conditioning and Refrigerating Engineer). It will need some time to propagate the commissioning concept among construction industries in Korea.

Commissioning Examples

In spite of the above-mentioned circumstance, several commissioning projects have been completed as shown in Table 3. It is supposed, however, that no project has been done from the pre-design phase commissioning.

Table 3 Commissioning project in Korea

Site	Ordered by	Building Area (m^2)	Period of construction	Status
Green Building	KIER (Korea Institute of Energy Research)	2,000	04/ 2000 – 12/ 2001	From design phase
IBM Korea Building	IBM Korea	3,500	03/ 2000 – 04/ 2000	from construction phase
W-Hotel	Walker Hill Co.	17,873	07/ 2002–on progress	from construction phase
Seoul Central Pest Office	MIC (Ministry of Information and Communication Republic of Korea)	21,979	06/ 2004–on progress	From construction phase

CONCLUSION

In Asia, Hong Kong has been the predecessor in application of commissioning but in the sense of testing learned from UK under the sovereignty of UK before return to China, and still it is running first in promoting new sense of commissioning, that is, commissioning process, by establishing Hong Kong Building Commissioning Center based on Institute of Vocational Center, which supposedly is the first case in Asia. They planned to begin with acceptance phase commissioning and then extending the scope backwards to design and program phases.

In mainland China, building construction is booming especially around coastal area but the quality control, to say nothing of the life cycle point of view of building management as well as the environmental effects, has been very poor. However, the status seems rapidly changing with the trigger of Olympic Game viewed in 2008 in Beijing and World Exposition viewed in 2010 in Shanghai, and in addition, with the desperate view of environmental contamination and power shortage caused by the use of coal and large cooling demand in some biggest class of cities. Introduction of building commissioning process is most requested in this country for the sake of world welfare.

In Korea, commissioning process has been introduced to a certain kind of public buildings and foreign capital based buildings, however, it will need much more time before strong movement of promoting introduction of the process into construction society.

In Japan, general recognition on commissioning process has been very poor before 1990, and actual activities to establish commissioning guideline and introduce the process into Japanese society began after 1996. Few people, including the author, who had been enlightened by discussion on TAB and commissioning during 1980s in ASHRAE and by participation to IEA/ ECBCS/Annex 16, 17 and 25, set up commissioning committee in SHASE. It has finalized drafting commissioning guideline on building services system and, at the same time, NPO organization called as Building Services Commissioning Association has been established in August, 2004. During Annex 40 research Japan could gather plenty of information from other country and participated by developing a commissioning process control tool, MQC, other manual and automatic commissioning tools, and comparative study on applicability of existing system simulation programs for commissioning in each phase. The author expect for the commissioning concept to become popular in Japan as well as each part of Asia, and would like to hold an Asia-Pacific Conference on Building Commissioning inviting experts from around the world, which was an agreement with Mr. Wong who was in charge of establishing HKBCXC when we met in Nagoya University and discussed about the future of the commissioning in Asia in 2002.

[3] This information was given by Dr. Sung-Hwan Cho, Korea Institute of Energy Research

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The author first met 1989 ASHRAE guideline for commissioning and then 1996's. In establishing Japanese guideline, he deeply examined commissioning-specific terminologies and definitions and then proposed several new terminologies in Japanese, making effort to obtain accordance with general building construction and maintenance process in Japan and other countries, through which differences as well as similarities among them were identified. At the first meeting of the Annex in Scheveningen, he recommended Assoc. Prof. Y. Akashi as a member of definition group from Japan. The author gave him his the idea but later he totally depended on Akashi's own effort and on the finest advice by the Operating Agent, and with the review by native English speaking people, especially Ms. N. Castro as the co-leader of the definition team, the author is now satisfied that Japan could contribute to define universal idea on commissioning process.

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