Green Design

From Theory to Practice

The Jerusalem Seminar in Architecture

Lecture: Prof. Kee Pho Lam

Opening remarks: Dr. Elias Messians

Good Afternoon. It's my honor to introduce our next speaker Prof. Kee Pho Lam. Professor Lam is an architect by training, He has also worked as an architect – he has practiced architecture in England for a few years, and also teaches architectural design with a focus on systems integration, building performance modeling, building controls and diagnostics, as well as acoustics and lighting. Professor Lam has studied architecture at the University of Nottingham, and he completed his doctorate at Carnegie Mellon University. He was director of the graduate program at the school of architecture at the Carnegie Mellon and is currently visiting professor at the Department of Architecture at the Chinese University of Hong-Kong as well as Xiang Chang Tung University in China. Professor Lam has completed many major funded research projects. And is currently consultant to the Energy Foundation in the United States, working specifically with the China Sustainable Energy Program. Professor Lam was also appointed very recently as a member of the board of directors of the Energy Foundation of the United States. In 1998 he collaborated as a building performance consultant for the project that we saw yesterday in Ken Yeang's lecture, the winning entry for the new National Library in Singapore, which was awarded platinum rating for green building by the building and construction authority in Singapore. This building also, in 2007, won the first place in the Association of South East Asia Nations energy awards. Professor Lam will speak about a concept – it's called the total building performance and it is an integrated and holistic knowledge based framework from conceptualizing, specifying, designing, analyzing and commissioning a building project.

It's interesting that from my discussion with Professor Lam he explained how as a Ph.D student he was actually involved in the creation of this concept back in the 1980s, and this happened as an architect he realized that computer tools for architecture are usually created by programmers and engineers without really understanding the needs the architects have, and so he took the challenge to actually be involved in the creation of a tool that is by architects for architects. And what is very interesting about this concept is that it has to get the numbers right, it is holistic, it looks at the building from different angles, and also it is very important how it has to communicate this information to people. And I think the human factor is what Professor Lam will speak about today and it seems to be the most important factor in the buildings that we do. And I can speak from my own experience, trying to create an ecological community in the Negev, where the building process is actually quite easy – The difficult part is to try to get people to become committed and aware of what they are supposed to do with these buildings and how to do it right. And I am very happy that Professor Lam is here today – Please come to the podium – Thank you. (Applause)

Prof. Kee Pho Lam: Thank you Mr. Messians. First of all let me express my profound gratitude to (inaudible) and (inaudible) and the Rothschild Foundation for this incredible opportunity and the generosity in inviting me to participate in this conference. And the experience has been amazing. This is my very first visit to Israel and to Jerusalem and I think all of us, all the speakers, were really made to feel like we are celebrities, you know. The cameramen were following us everywhere, literally cameras in our face, so I dread to see that footage. I don't know what will come out. But – (laughs) Thank you. But it has been an amazing experience, certainly for me, to be able to visit this country and particularly here in this wonderful city of Jerusalem. Now I don't know, as I was looking around – Besides Ken and I being Chinese I also saw one or two Chinese participants, and you may or may not know, today is the Chinese New Year. (Applause) The year of the ox. So Happy New Year – (speaks in Chinese) and being here today, is also tremendously auspicious for me – You know, in this coming year and I'm extremely grateful - again. As we got down the plane and got into the bus that took us from the airport to Jerusalem, Ken was sitting next to me and he turned around and said, "Kee Pho how old are you?" and I was wondering why, what prompted him to ask that question, particularly that I know him for so long, and we have worked together and we just saw each other seven months ago in Singapore, at the launch of the book that commemorated the successful completion of the national library building. We just met there, and sort of I forget my age. I could understand because many friends of mine and former students, and there are lots of them, because I have been teaching for 25 years, always sort of, when we do meet from time to time they always say Kee Pho you haven't changed. You look exactly the same, you know. So what's the secret? And my answer is – I'm sustainable. (Laughter and applause) And just a few minutes ago, I had to go for an interview, again with the camera and all, I had to powder my face and my nose, and that was the first question – "In your own words what do you mean by sustainable?" And I think there are three points in my own – that governs my life – First: Contentment. Be content with what you have at the various stages of your life. And I was thinking about this and when Elma showed the slide with the bed, the little baby bed and then the single bed, and then the double bed, and then the coffin – Just be content with whatever beds you have, OK? Some of us are fortunate to have a double bed and other may not, but nonetheless, be content.

Second point, is about peace of mind, Shalom, right? Peace of mind – It's an inner peace in oneself that you do not do crazy things, bad things, and so you sleep well. It's not the length of time that you sleep that matters, it's really the quality of sleep that matters. I think many of you would agree with that. I travel a lot and people always say how can you, you know manage to arrive and straight away give a talk, and that happened to me many, many times. One time was because of Ken actually – He pulled out the last minute and I had to stand in for him in Germany. He owes me many big ones. And that is because I sleep and I don't sleep long hours, but I sleep very well and very deep those few hours that I do, because of a certain peace of mind.

And the third point is I can't help it, I'm so inspired being here that I have to quote the scriptures – Is to love your neighbor as yourself. And as you look around you, your neighbor is to your left, to your right, to your front, to your back. By the way they may be the government official who is going to approve your plans, they may be your client who is going to pay your salary, they may be your professor who is going to give you the degree – It doesn't matter – Love one another. Love your neighbor as yourself. Those three are my governing principles. (Applause) Now if you really take this to heart and practice this then I think we can finish this session and have a long break. And you know it doesn't matter any more. I think Arthur said that in the very beginning right, we can really just relax and enjoy ourselves. The reason is why are we here trying to solve all these problems, when it is us who first created the problems? Sounds pretty stupid to me. If we didn't create the problem, then we don't have to come with all these convoluted concepts and theories to solve those problems. Just get rid of the problems and that would be an easy solution and we can all have a good time. But as Bert says – Reality check is that we know human beings are just not like that. We wish they were, but they are not. There will always be greed that drives certain lifestyles, certain people, into doing certain things and hence create all these kinds of problems that we are facing everywhere in the world. So that the human dimension that we need to address. So four words that I would like you to contemplate – as we discuss this idea of human involvement in the creation or the destruction of our environment has to do with theory and practice, knowledge and experience. I think these four are very critical concepts that we need to embrace simultaneously, because without these four elements coexisting, we are simply going to get very lopsided views to whatever we do. So we need to all the time be mindful of this and of course to expect any single individual to have all this is obviously an impossibility which leads to the very important idea of teamwork – of working together in order to solve those tremendous challenges that are in front of us.

Theory will tell us this is the way to do it. Right – very neat, clean, this is by the way a critical path of whatever project, could be construction, could be delivering some service, and this is what theory tells us and you can compute this problem, you can put it through the computer and solve it and give the answer quantitatively, how you should do it. However because of the human dimension, this is what happens and we all know it. Those of us who have been in the construction industry long enough would totally be familiar and sympathetic to this condition that we face. The role of the architect, specifically, in this process – What should be that role? What should this person be like? Bear in mind I am talking about team work, not just single supermen but although, historically, that has been the nature of practice. Now this is a stained glass that talks about master builder, and if you look at that piece of artwork closely, the master builder, the architect has all his plans, drawings. He is on site, he doesn't sit in his office, he is instructing the guy constructing it how to do it, where to put it, the way it was designed and the way he, the architect, the master builder, envisaged it to be. And the manifestation of this is abundant in history, when we talk about Renaissance and we are now facing perhaps yet another Renaissance. In the old Renaissance, in the 15th century this was how things were done. – Very sustainable.

The first sustainable point is that it took forever to build. It started in 1296 and it never got finished until 1436 or thereabouts. And today we are rushing through everything. We would like this thing done in 40 days if possible. But that's not how it was. They took time, they took pain, they took care of every detail and they understood the product and the process inherently in the way the relationship between the builder and the apprentice, or the people who build the thing. But even so, there are always going to be unforeseen situations -when they started the cathedral nobody knew how to actually finish it up. The dome was not designed yet. They knew they had to have a dome, but how are you going to finish this and this is 143 feet in diameter, almost 40 plus meters. How do you build this dome? Especially if you want to build it without creating a scaffolding or centering they call it, so that the dome can be built and self supporting. It took them a long time before Brunelleschi came along and solved the problem. And eventually the thing is finished and today after all these hundreds of years still stands, magnificent as a testament to the kinds of ideals the kind of efforts the kind of goals that society is looking for. It was Louis Sullivan who once said "What is architecture? Architecture is the crystallization of the thoughts and feelings of a civilization." And it is not something you can do in 10 days, 20 days, it is a long process. Somehow in our world of speed today we have lost some of that essence and I think we need to begin to think about this and keep track of this issue. So what is a master builder now – all these famous names and I've got lots of questions because I do a lot of work in China, as I go around the world people always ask me about China and all these buildings. The reporters just now asked me the same questions. And here are all these icons we are all familiar with that have arisen during the pre-Olympics. And I am not going to predict this. I will leave it to you to ponder based on all the things I am talking about whether or not this kind of effort is justifiable and for what purpose and for what ends. But I was trying to look for a piece of artwork that demonstrates this modern master builder, like the stained glass window, so I looked and looked and googled – I couldn't find until I can across this little cartoon. I said this is cool – This is probably the closest to what the modern master builder might be. Superman who can do everything with a T-Square and the drawings, notice no computers, a hammer and all that stuff, and then a piece of cake, a pie. I was kind of wondering what that is all about. And then I said let me look at what's the source of this website. And this website was actually a product manufacturer – it wasn't an architect's firm, it wasn't an engineer's firm, it was somebody selling building products that had this cartoon. And he is grinning, happy because he has the big piece and the small piece is for you and I – the architects and the engineers. That's the condition perhaps that we have got ourselves into as a profession. We are no longer in control of the kinds of things we design and build. We don't know what it is, we draw the drawings, send it in for approval and leave everything else to the contractor and the people who build it, and that is a high risk. Talking about risks – That is high risk. The "World Architecture" does a survey of the largest architectural firms in the world and they list them out, the ranking, how many people they employ and what kinds of projects they do, etc. etc. And last year they did…not last year, two years ago, 2007, we are in 2009 now, they published this as their front article, as a preface to their survey of these big firms. And the title caught my attention. "Not everyone is a star architect." As a professor, teaching year after year, class after class, we know the reality is that in a class of 50, 100 whatever, you'll be lucky to get 5 % of those potential star architects. Potential. Everyone else is competent, they do a good job, they are able to deliver their professional responsibilities. And what was very interesting was that some of the personnel managers in these architect firms are beginning to say, "We don't need all these notions of star architects. What we need are leaders in our profession. And what that entails is leader who knows, first of all, what they are talking about, be knowledgeable and be able to communicate with the rest of the team, the people who follow them – Follow after their leadership. That is what is needed in firms today. Leadership and that we can never have enough- because we need lots of them, given the kind of pace of development that we keep talking about.

And how is this leadership built? It is built with experience, hands on, from very early days. We put up this picture. If you see, at the top right hand, that's me by the way in the little blue tee-shirt, and the lady facing me in the pink tee-shirt, that's my wife. That's the way we met, not very romantic, but it works. Hands on – Understanding the very nature of materials - building stuff. And so that during my process in my training days and also in my practice days I was able to actually go help people build something and not just sit in the office and draw lines. That was very useful. The ability to get a really first hand experience of the materiality of what we are dealing with. And obviously the repertoire in those days, a long, long time ago, is limited. Just as you are here in Jerusalem, by law you are limited to certain kinds of materials. So the repertoire is manageable, you don't have learn a million and one types of products, and it works reasonably well. And sustainable, as Stephen said, "Here in Jerusalem, it is pretty sustainable". But again, reality check, the world has changed. This is Hong Kong Shanghai banks as many of you might know, Norman Foster, built in the late70s early 80s. You look at the products that that building has…By the way I love this piece of architecture. Even today, when all these other buildings in Hong Kong are looming over this thing and this becomes such a midget, you can't really see it anymore, because, I. M. Pei's Bank of China and the financial centers all completely dwarf this building. But it is still my favorite. It still stands there as a piece of history – proud and still looking amazingly new by the way. It is fabulous – I love this. But if you look at the number of components that is used – I counted – They come from no less than 13 or 14 countries in the world. It's not something that you just get from your neighborhood anymore. And that is one of the challenges in our sustainability movement.

Lots has been talked about ecological design, I'm not going to attempt to compete with Ken and Bert – They have done it all. So just remember what they said and you'll be OK. So it's a question of scale. From the macro to the micro. Because if you don't get your macro right, by the time you get to design your building, there is very little you can do. Honestly, you think you have a lot of control as an architect. If the environment is aggressive, there is really not much you can do. All the talk about passive design, opening our windows, if the air outside is so bad, no way can you open the window. I was just in Taiwan two weeks ago and we were talking about all this natural ventilation, how to do CFD and all that, and got all excited and then suddenly somebody said, "Oh by the way, we have pepper factory next door." Hello! So the debate went on – Well, can you smell it, can you not smell it. What happens? So that kind of spins off another discussion. So if our environments are aggressive, there is really nothing you can do. If the wind doesn't flow, there is nothing you can do. You can draw any window you like and you can model whatever you like, and be careful, I'll talk more about modeling assumptions in a bit, it is not going to work. You don't need the model to know that if the wind doesn't flow because you jammed the urban environment up, there is nothing you can do. So all these things, as I say, have been covered. And there are examples around the world that shows us already the kind of impact if we are not careful with our urban growth and development. If economics is the thing that drives, if money, greed actually, drives our growth, then you are going to end up in situations like that. I don't care what innovative design you will introduce in that kind of context, you are not going to get the wind. Period. Even if, you do a little wind it is probably coming from the cars below. So here you go.

But one point I do want to emphasize, is that when we intervene, in a building environment, we are not just reacting to the consequence of our design, meaning that by drawing certain windows, there are certain things that will happen, by opening up a skylight, you get light coming in, and so on and so forth. That is only the end part of the equation. The front part of the equation which is very important is that by you building your building, you are actually changing the micro environment. And this is a concept that needs to be really, really clearly understood. And I had the model. Let me go back to show you the model that we did on the top, that model that Ken showed you. Why did we do that? Somebody said, "You don't need to do a wind tunnel, save some money. Just go to the site and measure". Take the meter and go measure the wind. Now what's the problem with that? The problem is you are measuring on an empty site. Of course the wind is flowing. The minute you build your building, the wind is going to change. The velocity is going to change. So how can you go on site and measure and say this is my condition. It is not going to be your condition. So therefore, you need the model and see what the situation is before you even start considering what are the consequences of that situation in your design. Hence, in this case a wind tunnel was the most cost efficient and the fastest thing around for the data that we needed. We could have done a CFD but that would have cost a lot of money, a lot of time and not very accurate to be honest. Because those large scale urban models are still fraught with uncertainties and potentially huge errors. OK? So that is what we did. So the consequence of your imposition on the site is important.

Therefore all this kind of understanding of what actually happens in your building vis-à-vis the site constraints, and I'm particularly talking to students who are here, and we cannot really emphasize this big enough. You know, we keep saying, please draw your site plan with the surrounding buildings, and invariably, many students will come with plans without anything on their drawings. It's like the only thing that exists is their wonderful creation. They did not bother to draw the site. If you don't do that you already committed the first major design flaw. Because if you are not aware of what is happening on the outside, you already started on the wrong premise. But once you are able to conceptualize that then there are tools that allow you not only to qualitatively determine what the impact is, but quantitatively do it. This is the Equaltech software, many of you might be familiar with, it's great for early design support. It's not very sophisticated, in terms of the kind of detail, if you like, but it gives you sufficient information to help you make certain decisions in the early stages of design, and it is very efficient, easy and fast to use. So we are dealing with teamwork. As I said no single person can solve all the problems, or know the answers to everything, but yet at the same time we know the building is connected. So this is the human aspect. Each one of us has a role. I should also add actually the governmental agencies – there is a lot of discussion about that, it will probably take too long. But let's just think about the developer and the consultants and contractors. Each one of them has their own agenda. Don't blame them, that is what they are paid to do. Someone said that how we react, how we respond, depends on who pays us, which is actually quite true in the industry by and large. So if people were to say I'm paid to do this and that's my goal, depending on who you are. And these are your traditional, conventional stakeholder's worldviews of their business.

And education has a lot to do with it obviously. How we educate generations. And this chart was first developed by a gentleman, Mr. Mata, at the Public Works, Canada, when he was doing research about the building industry. And he created this chart and it was published in a paper. And this was a very important starting point for the kind of research work that we do at Carnegie Mellon. This is one of those kinds of motivating factors. He said our traditional education system is like that. You go into architectural school, you go into mechanical engineering or structural engineering school and you only learn that thing. And it is highly contained, precisely defined, accredited - you must do these things - in order to get your license, in some cases, and that is all you do. And at the same time our construction industry structure is like that – it sort of is in stages, in phases, and again we get paid that way – architects get paid that way. You finish your preliminary design you get a fee, you finish the next thing you get a fee, if you need to do iterative work you don't get any fee, which is what is needed in doing good design, good buildings. And when you superimpose those two structures, the resource that you are feeding into industry, versus the practice of the industry, you get all these highlights. That is why we are in such a mess. That is why you see the graph in the beginning, going round and round, everybody pointing fingers at each other. "It's not my problem, it's your problem. I didn't do that, you did that. You were supposed to do that." And who wins in the end. Do you know?

Participant: Nobody

Kee Pho Lam: No – Somebody always wins.

Participant: The lawyer

Kee Pho Lam: The lawyer – Good for you. The lawyer wins because he is collecting from both sides. I shouldn't say it so loud. My son is one of those so – I have to always remind him. So somebody wins always. The economic situation today is so bad, everyone is suffering, you think everyone loses? Not true – There are people who won big time. So it's not all being equal. So in order to create a consistent framework for education, not just thinking of students in universities and colleges, but the profession itself. This is the framework – the concept of Total Building Performance and Diagnostics that have been developed at Carnegie Mellon University since the early 80s. And it has not changed – It has been and will continue to be the framework on which our work is based. Regardless of the changes of technology, all this fancy stuff that is coming out literally every day, that hits the building industry, including all this so called "green materials", energy saving devices, etc, etc, etc. It all goes back to this framework, that has been the guiding principle of everything we do and I think that it is simple enough for everybody to remember so it is like a check list. On the one side you have all your nuts and bolts, if you like, the materiality, the practicality of things, the structures, the things that you have to deal with. And then you need to have a framework to bring all those systems together so they don't clash, and they don't create all these kinds of problems – redundancies as well as clashes in the physical domain.

But why are we doing all this? Just because we want to say that our building is green or because we really are concerned about the human factor? That it has to do with the physiological, psychological, sociological and economic well-being of the people that live and work and play in the buildings that we create. It is only because of those reasons that we build. Otherwise there is really no reason to build. We can continue to sit under the tree and enjoy life. I would say sit under the coconut tree, because we come from Malaysia, so we get those – and have a good time. Then in order to meet those requirements, there are matrices that we need to achieve, not just some sort of vague notion, but things that you can not only conceptualize, not only deal with it in a qualitative sense, but also quantitatively. What are those? Now I know there are skeptics that say there are some things you can never measure. Well I'm not so sure. All things can be measured. It's just a question of scope, scale, depth probability and reliability. So it's not a question of cannot measure. It's how accurately do you want to measure. So there are those six mandates that we have developed called spatial, thermal, indoor air quality, visual, acoustical, building integrity. Most people have a problem with building integrity, - It has to do with how lasting will your structure be in terms of maintenance, external weathering etc. And visual is really the lighting environment. So we constantly deal with those six at any project that we look at – Regardless of whether the client saying you should look at it or not. We do it because we believe it is needed and necessary. And through those ideas we generate a knowledge base, we create frameworks, we build computer programs, we do simulation, we do modeling. And give us some quantitative values, and then as we build those, we then go into the buildings and do diagnostics, whether it is buildings we have designed or building that have already been designed, and perform diagnostic processes in order to learn from them.

You know the law profession and the doctors, they do that as a matter of course. They document their cases, so that they learn from it and next time they don't create the same mistake. Architects, our profession is horrible in doing this. And it is almost like a vicious cycle. If you don't document, you get sued, because you didn't fulfill your contractual obligations. If you document, it didn't work, you also get sued, so people say, "Better not put anything in writing." It's kind of a scary situation sometimes if you think about it. So my solution is I appeal to owners of buildings, "Look, love your neighbor as yourself. Don't be antagonistic and trying to get at each other, but really want to know what your buildings are actually doing." You buy a car, you ask a lot of questions – "How many miles per gallon? What's the zero to sixty speed?" You buy for $20,000, $30,000; you ask a lot of questions. "What is the maintenance? What's the gas? When do I do an oil change?" You buy a multi-million dollar building, billions sometimes, and you don't even know - where is the manual for the building? So I appeal to owners to begin to take on this activity to know what your building is actually doing in order to address those inconsistencies or inefficiencies. Much as we talk about new building, existing buildings, and I think all of you know very well here in Jerusalem, the upkeep of existing renovation and reuse is a big market here and everywhere else. So we can run away – as I said the reality check is always dollars and cents. We can all talk about being happy, somebody is still going to challenge you and say, "How much does it cost me to happy?" Actually it doesn't cost anything to be happy. But never mind I'll try to give you some numbers since you asked. So for many years we have been doing this research, called Building Investment Decision Support at Carnegie Mellon. It is not done by me, it is lead by a colleague of mine, Professor Vivian Lofness, who some of you may know. She is very well known in the United States, very active in the US Green Building Council. For years she teaches a class on productivity and health in architecture and the students go out and look for case studies, where there are scientifically proven reports of the effects of building performance on human health and productivity. Very, very hard job – You'll be amazed. For the last seven years I think we got about 300 case studies that could stand up to court if you like. So it is not easy to find that kind of information. So with that we kind of built up a web simulation engine to be able to do queries and statistical analysis and it is very interesting. You look at the cost distribution of the building. Look at the salary, it's huge compared to energy. Now please don't go away and say, "Energy is not important – Professor Lam said it is not important. Let's forget about that. No it is important, although it is a little blip there. That little blip actually affects that big chunk – 80% or more – in the salaries. If you get your building right, invest in the right technology, not just go out, buy anything that moves, but really do detailed analysis. You're going to help tremendously with the salary part, especially all the health consequences when your buildings do not function well, people get sick, they lose productivity. Just a few percent of their productivity loss will pay more than enough for your energy bill – honestly. Recently Wall Street did a survey of young professionals coming out – and these are the high flyers – the young and the top and brilliant people. They asked them, "What is the criteria for you looking for a job?" Nobody talked about salary, because it is assumed – I'm the best, I will command a salary.

But is the work place healthy? They are beginning to ask those questions. So if you are tying to attract the best you have no choice really to make sure that the environments that you are trying to attract these top people to are in fact healthy, that they are productive and they feel comfortable working in those spaces.

So this is very convincing data that we have and you could draw down in the details on every performance. Some cases are on lighting, some cases are on air quality – in this case it is air quality – you see the productivity gain averaging 3.3% and that is very significant, but it can be as low as 0.1% and as high as 14.4%. It is huge potentially. And you can talk about temperature control – letting people control the indoor temperature. Productivity gain: 6 – 24%, with a mean of about 5.5. And likewise for lighting: 3.2 % productivity gain, and anywhere between 0.4 and 26. These are data from those 300 plus case studies that we are continuing to pursue. We started off with office buildings but eventually we are also moving into schools as well as, we are doing hospitals. We are beginning to measure hospitals as well – To look at patient recovery rate and so on and so forth. That is something we are continuing to pursue. Cost to me is such a relative thing and honestly I don't like to dwell on it and spend time doing this. I find it is a waste of time. If people don't believe it is very hard to convince them you know. Even if you show them all the facts and figures – what causes all the energy, the oil prices to fluctuate from $40 to $150 and then back to $40 in 3-4 months? Somebody lost a golf game? Somebody had a fight with a wife or a husband? I don't know. Something is obviously causing these fluctuations, and I can tell you it is not supply and demand. "60 Minutes" did a documentary just a couple of weeks ago and said, "It is the stock market. The futures trading is causing the fluctuations". He said now the volume of trade on oil is like a big elephant and the real demand-supply which traditional economics is trying to represent the way we behave as human being, is a little speck on the big elephant. And there is no way this little speck could even begin to influence the big elephant. And who is that big elephant – You and I – We invest. We put those monies into those markets. See? So cost is always a very …. Where do you stop talking about it?

But anyway, even looking at green building – if you say let's limit to green buildings, the World Business Council did a survey and found that people say that green buildings are going to cost 17 % more than convention. When they actually did the research, "they" as in the people in the Green Building Council, they did some very in-depth studies of cost analysis, there were obviously increases, but it's not 17%. It's more like this, and this is Greg Kats' data based on LEED. If you want to do LEED, this is a kind of premium you have to pay, and this was in 2004. Already as you can see it's less than about half a percent to about 6.5 % if you really want to go for the platinum – the top. Between 2004 and now there have been more recent updated reports. I haven't got exact figures, but they are saying that some of the silver is already cost neutral, because everybody is doing it now. And the products that are now being made available to the market are just so plentiful. You know GreenBuild in a conference in the US almost could not find a large enough conference hall to house all those manufacturers who want to advertise their products. So costs will continue to change if we are serious about doing the work and implementing it supply – demand. Hopefully we will begin to change the equation a little bit more than where we are now. And the point about cost is if you continuously think in linear terms – that means – somebody comes along and says, "It's a good thing if you add this to the humidification system in you HVAC unit". Some of you may know how to get rid of the moisture in the air which is cheaper than using energy to cool it down – that the traditional way of getting moisture out of air is to make it very cold and because it is too cold, you cannot supply it to the room and you heat it back up again, without adding water, that how we used to condition our space. Very clever, but energy intensive. So by doing a dehumidification system you can actually use this desiccant system to get rid of your moisture, instead of using energy. Energy in the sense of the heating - cooling. But if you simply add that piece of equipment, of course you are going to pay more. So what you need to do in the design phase is to say "Well now that I want to do this combined integrated system, let's model this and see what is the optimum". And it turns out, no surprise, because you added that piece, to deal with the moisture, you can reduce your coil size and save money on your cooling coil. And then when you add the two together, you know you actually save capital costs. Surprise. Surprise. So who says it is going to be more expensive. It is not true. But you will not get to this kind of information until you do very detailed design modeling studies – and this is work done by my PhD students, one of my PhD students, who graduated recently – A brilliant student.

So the idea of total building performance has first been tested in our own lab – this is the Robert L Preger Intelligent Workplace. It was completed about 10 years ago. We call it the living lab. Students are constantly playing there - Pluck and play, stretching things around, testing all different kinds of things. The difference we do, as opposed to the conventional laboratory design is that laboratory design is very highly controlled, and it is necessary because you need some kind of baseline standard. But we believe as architects and engineers in practice, we want to know what is happening in the real world. So this lab sets up that real world or at least tries to make that real world condition so that the results we get are a little bit closer to real world behavior, especially human behavior, rather than sending people into the lab and getting controlled results. That is the purpose. The next generation is looking at…So we have learned a lot of lessons and I was very much a part of that. I was a PhD student at that time, so I did all the energy modeling and I even did all the IT system. I was the only student interested in IT at that time, 1989. So I designed the entire IT network for the Intelligent Workplace – one of the many other interests that I have.

The next generation of thinking is that just to look at individual systems is not going to be the optimal way of looking at energy efficiency. We've got to begin to think of this kind of concept of cascading energy. The use once and throw out attitude has to change. Right now, by and large, our systems are like that – you supply energy, make it do some work and whatever is not used you dump it out to the exterior. What you dump out can be recouped and then you can actually cascade it right down in order to maximize the use of the energy content that you first introduce into the system. And in fact when I presented this in Taiwan again, immediately they understood and they are going to do that. It's just fascinating – They are going to use ice storage and then the outlet after the cooling coil they'll send the water into the radiant panels. Actually the temperature is about right. So they can extract further radiant cooling from that same source. So by the time you cascade down, to the very last bit, the amount that you actually need to throw out is very minimal. You can have tremendous improvement in energy efficiency this way, because think that the energy that comes in in the beginning has already gone through a lot of processes. The primary energy is already many times bigger than the energy that you actually receive on site. This data, I think all of you are familiar with already - 40%, and that is not just certain countries, it is actually a world wide phenomenon, and it will continue to grow.

So do we have the technology to do better? The answer is yes. It is just a question of will power – political or otherwise, in order to look at that kind of possibility. We compared, for example, the US average, which is of-course ridiculous as you can see – Particularly the primary energy. You know we loose so much energy from the source where it was created by the time it pumps it to your building – we loose 70% sometimes. You know, only 30% actually gets to you and then we waste that 30% on top of that. That is ridiculous. So we have this potentiality and we are saying that codes and standards are getting better and more stringent in Europe, in Germany, for example. Our Intelligent Workplace is in the middle there, just to show you here. And then this is the BFPP (ph.) which we have now designed and in the process of fundraising. So, by the way there is a box outside the door – Just joking! And if you then begin to look at both the supply and the demand, managing those two concurrently through modeling – we are able not only to have zero, which everybody is trying to achieve now – theoretically anyway, […] (inaudible) built it, you are able to actually get more supply than you actually need demand. So you have excess to put it back into the grid. So it's not only net zero, it's actually net negative – And that's potentially possible to do. OK? So there are examples…We've applied this concept not just in the United States. After my PhD I went back to Singapore, because Singapore University sponsored my study. I had to go back and serve out my time. And so we were able to implement – we set up a center in Singapore looking at buildings in the tropics. Now you see the real test of an idea, whether it is in fact universal and applicable is that you should apply it to very different conditions. We did it in the temperate climate; we went to Singapore with a totally different climate right? Same principles apply. Same tools can be used. Just that the conditions are now changed. And we did in various ways: This is a building - The Ministry of Construction. No, the Ministry of National Development – I've been in China too long. The URA building, the Urban Redevelopment Authority, we wrote the performance specs for the client, helped them to actually select – It was a design and build scheme, although the design was very much done in-house, like the library. And it was then contracted out for so-called Design and Build or Develop and Build. So we did the specs, sent it out, helped the client select the contractor. Guess what? The lowest price contract tender did not win. Now for a government contact, I think some of you realize, that is almost an impossibility right? How dare you not take the lowest tender? How are you even going to begin to justify that? And because we have this system in place that everything is highly described and quantified, of course there are qualitative, but also quantitative ideas and requirements embedded in the specs, the lowest price bidder did not meet those criteria. Period. It was as simple as that. So there was no argument. It is highly documented, like a PhD thesis, so it's all defensible.

As much as there were good examples, there were equally and much more bad examples of modeling that are totally out of whack with what is actually happening, the real performance. And the client when interviewed said that we were the only team that provided that information in the first phase. It is a two phase design and we did it without them asking. We were already proving all this information. The energy, the air flow which is very critical for all this ventilation in sky garden and so on and so forth, and particularly in this case on the ground level there is this huge covered plaza, that holds up to 900 people and the client wanted it naturally conditioned and people must be comfortable – in Singapore, which is very hot and humid. That's a challenge. So we did all the simulation and remember the timeline. You see Ken is very good at putting that time, and that basically tells us that the building is dynamic. It is not a static thing. And many simulations have been done in the past that are simply static- they do not capture the dynamic behavior of the building whether it is by use of people or by climatic changes. We make sure that it is dynamic and at that time no fancy interface. You know, we had to build the energy model using Doe-To (ph.), those of you might know Doe-To (ph.), line by line. And because we did that we knew exactly where things are.

Sometimes in today's world because of all these fancy, easy-to-use interface, students pull down the manual, click a few buttons and they get a model, and they get a bit lazy and don't check and they get a wrong answer. One also has to be careful about all these quick and easy fixes even in modeling. So not only do we model, we also have the test – the mixture that what we model and the materiality that is actually being supplied meets the assumption of the model. And those of you who are in this industry will realize the tremendous pressure of value engineering that has been mentioned, even when the building is being built. Product substitution - all the time. I get calls all the time from the contractor – "[…] (inaudible) Lam can we change this glass?" Can we not have that sensor in the escalator? Why do you need that?" and on and on. And we have to say "Sure you can change anything you like, but you sign on the contract, this is the performance. Show me the same, do whatever you like. I'm not controlling you. But we have a contract and that is the performance that you have signed on. Therefore there should be no issue, right? The client already budgeted the money, so why would you worry about saving money in that sense?" So everything is tested, right down to acoustics and temperature. You know these are things that sometimes experience counts. I go around buildings in Malaysia and Singapore and go around touching the curtain wall, and they are very hot inside. The glass is getting better and better all the time. Double layer, low E layer, Low E, Low E coating blah, blah, blah. But people forget the mullions that hold up the glass. And I go around buildings, I teach students to go around and touch things, and they are very hot. They can be 50 degrees, 60 degrees Celsius. I'm not kidding you. You can almost fry an egg sometimes on some of those mullions. So I wrote that into the specs that the curtain wall people must prove to me that the surface temperature inside will not be more than 40 degrees Celsius, plus minus one or two – I'm not that strict. They said.

"Well we never do this sort of stuff, you know, in Singapore anyway. We do it in the temperate climate". I said "What is the difference?" "Oh you know they are cold and hot" I said, "Well, we also have cold – just that our cold is inside. Buildings in Singapore are conditioned to 20 degrees Celsius, which is really cold. Somehow the people got used to it. That's why they have to change the law now, to reset the minimum temperature. So because of that, I told them you have to show that your performance of that curtain walling will in fact meet not only the U value or the R value, but you also must meet the surface temperature. They argue with me, "We have never done this before". I say, "Well it's in the contract." It's a very good thing you know after you write it down. You can always say, "It's in the contract. You've got to do it." And they did it. They thought they could just use their conventional solution to solve the problem. They did a simulation. Gave me their first report. Guess what? 60 degrees – They were shocked. They said, "Whoa, we didn't know this happened." I said, "I just told you, didn't I? You should have saved your money and not run it, just listened to me. You would have saved a few thousand dollars." You know. You just have to go touch. Experience, yeah? Not everything needs to be simulated. Especially there are so many examples around us. Just learn from those. Don't waste money and reinvent the wheel.

Spend the time and money doing useful things like creating this kind of situation so that an architect like Ken could use and begin to look at the impact of the shading devices for different orientations. Different height to depth. How wide should the shading be and how tall should the glazing be and what kind of shading do you get. This is the kind of information that architects need, in order to make the decision. How big should that shading be? And after making the big shading, we have to again go back to our total building performance concept and say, "Hey, wait a minute, now you have such a big shade, not those little eyebrows that often we see on buildings and they say, "Oh this is shading", and it shades nothing, it is so tiny. This one is serious shading, but then it generates the problem of noise, because in Singapore we have lots of rain as you know. And this rain comes pouring down and when it hits this huge shade, it is going to generate a lot of noise. And our neighbors are going to hate us, right? So we have to make sure that these shades are not only used for redirecting light and shade the sun, which we all know what to do. Make sure they acoustically perform. So there was a testing for the impact noise when the rain falls on it so that it doesn't transmit in to the space. So that is another very important total building performance consideration beyond just the color mock-up. This was a color mock-up, and by the way, he is working for the project, and he is one of my students who graduated. It is a nice building and it got a lot of accolades, wonderful garden in the sky and so on. And it won all the awards, including as mentioned the Asean Energy Award, which we are very pleased. More importantly though, as Ken showed you the graph, what was modeled and what was actually achieved were very, very close. We are very pleased about that and there are many things that one needs to deal with in order to deal with that. How much time do I have? Are you still awake? You alright? Can I go on? All right, thank you.

Last bit – has to do with the future, what is the future like? This like captures this. "Never before has so much technology and information been available to mankind, and never before has mankind been so utterly confused." It's great to have a conference, but I think all of us as speakers here owe you the duty so that you don't leave this place more confused than you first came in. So we try our best. But if you think that this is a modern phenomenon, modern as in only applies to new buildings and modern buildings think again. I took this as walking through the old Jerusalem (laughs) – none of us can escape, so we had better do something about it. So the future challenge is really not only integrating all the nuts and bolts, but really the information that comes implicit in those systems that we put into our buildings. And begin to lay them up, go through them rigorously, locate them, put them into drawings, so that that becomes your manual, like your car manual – the building manual, where things are. We call it "as built" and I think many of us know "as built" looks like in today's world. But looking on the positive side, there are technologies that are coming out that will enable us to track all this stuff. We are very much part of R&D work at Carnegie Mellon as well, that we begin to track this. Now, it's really no joke - you say, "All right, we are going to have a bio-diesel fuel engine generator", which is a great thing – This is one of those green technologies that we all want. Look at the number of companies that supply the parts to make up that system. Every little part there is a separate company. Somebody providing the sensor, somebody providing the controller, somebody providing the pipe, the tube… You have to manage all this. If this thing breaks down, you'd better know who supplies what. Otherwise you are sunk, your system will be a white elephant sitting in the room. So you really need to track this, and there lies the importance of modeling and putting them into a computer system, a well defined computer system, a computer database. So that we can not only track the material, we can actually track the entire design process looking at the outdoor conditions, looking at the impact I talked about when you build your building. What is happening indoors. All the parts that actually come in and finally how your building is actually performing – the temperature, the humidity, how much energy you are using and tracking all the manufacturers and replacement model numbers and sensing the calibration etc. etc. All this stuff can be managed with current modern technology. We just need to come up with a simple, repeatable program framework and not make life more complicated than it already is.

And then, more importantly – there comes my architect's hat – put in the visualization. Show people where things are. Where is your thermostat? You know half the time we have complete disconnection with our energy consumption; it is not because the system inherently is wrong, but somebody put the thermostat in the wrong place - Measuring the wrong temperature, so your system is running when actually it shouldn't be. Simple things like that happen all the time. In Singapore I used to be an expert witness for many court cases and people tend to make life very complicated, but often it is just that the sensor is in the wrong place. You relocate that, the problem is solved. So to be able to visualize that in software, walk through, getting the data on the fly, real time, is what we are going to be seeing in the future. All this stuff is coming. And in America this building information modeling is a big, hot topic right now. Lot and lots of people are debating and discussing, a lot of confusion I must say still going on, but nonetheless it is a first step to try and set up that kind of framework to capture all the data, including the one that Elma was talking about – the deconstruction and recycling. We could capture all that in the building information model. And the important thing is the recycling of the knowledge that goes back to my point so that it doesn't sort of spiral into thin air. Now we talking again all those stuff about technology, it is all fun and exciting and challenging, but we mustn't forget...You know maybe different statistics, different people quoted different things – 10% of the population of the world is using 80% of the resources, or something like that. There is still the other 90% that are not as fortunate. And they are confronted with sometimes manmade, other times natural disasters, in this case it is the Sichuan earthquake, which I think you are all aware of that happened last year in May, dislocated millions of people, thousands died. And I was again very privileged to be involved in the reconstruction of the school, and they showed us plans and I went and helped them using that same concept that I told you – Total Building Performance, to basically re-look at the kinds of schemes that they come up, and they are building hundreds in the next two or three years just to replace existing and within the next five or so years they are building a thousand schools. The order of magnitude is scary, you make one mistake you are going to replicate it a thousand times. So it is a tremendous responsibility and at the same time, a tremendous privilege. And these are the kind of design guides that they generate. And in this particular case I must say I am also partly responsible for those magic arrows. I call them magic arrows. It is so easy to sketch all those arrows saying, "Air is going to flow this way", but unfortunately life is not so simple. This is actually what happens. There are so many parameters, assuming the air is good. First parameter, depending on how much opening you have, what is the velocity of the wind, what direction is the wind blowing, how often is it blowing. So we have got to really track all these different matrixes in order to come up with that simple magic arrow. It is not easy as you can see. One of my PhD students is working on exactly that problem. How to reduce all this into those one or two magic arrows, that are actually realistic and not just some architectural dream.

So we do lot of modeling, looking at the different positions of the fans assisting the ventilation, because right now the fans are over the head and sometimes if the building rocks, the fans drop on the kids and things like that. So maybe it is good to put the fans on the side wall and we look at the effect of doing that. So we do a lot of CFD and it turns out that it actually works, as you can see those results at the bottom, natural ventilation with ceiling fans, whether it is on the side or on the top. So we have data like that now to show them for a typical classroom what is actually happening. And we also do day-lighting for example. They will say, "How many rows of lamps? Can we cut down the lamps in the space? Is there going to be a glare problem?" Glare was never even a consideration until we introduced the concept of Total Building Performance. So we do modeling to show them the trade-off, whether you can save on the light and at the same time improve your environment vis-à-vis the daylight availability in the space. And acoustics – Now this is by far the least considered anywhere in the world. We only think of acoustics for concert halls and very obvious building types that we have to employ an acoustic consultant. What about classrooms? We build classes all over the world. America has a very bad track record. In the year 2002 they did a survey of schools. You know they found they got a D minus grade for acoustics in classrooms in the United States. 30% of the communication between the teacher and the children… the loss in communication is up to 30%. In other words, the students are only getting two-thirds of what the teacher is saying, based on poor acoustic environment. So we told them what needs to be done and again, it is a very, very complex. It may seem simple with the window open, especially when you introduce this notion of passive design, suddenly your window is open, you have a hole in your wall, there is no reflection, there is no absorption. Suddenly the outdoor conditions become very critical. So you need to be able to see, what if there is zero window opening, what if all your windows are open. And you will see that the determination, the impact of the speech intelligibility depends on those conditions. If you open your window, outside sound source is critical. When you close all your windows, you make sure all your materials in the space have enough absorption. Otherwise you get very reverberant spaces, echoing spaces. So we were able to do all this for them.

So finally, in summary, we think ecological design is a holistic approach. And all these words have been said. And you have to think about the macro and micro environment, as has already been said. We believe, and we continue to practice this notion of Total Building Performance and Diagnostics, because it is proven to be universal, comprehensive, consistent and an objective and proponent (ph.) framework. The mandates are both qualitative and quantitative, which is what is needed. And then, it is a knowledge base and a human centered approach that kind of reminds us why we are doing what we are doing. In future the Integrative Information Management System, the Dynamic Life Cycle Information Model System is going to be, I hope anyway, one of the tools we will be able to use to deal with that. So here is your stakeholder's value chain. And as I said, I have been privileged working in China as part of Energy Foundation, working at the Central Government, looking at demonstration case studies and then looking at regional…..You know these books here are from Shanghai, from Hangzhou. And also to be in the field. Look at what they are building, how they are building. What is actually going on – to be able to visit the sites. And then interact with the young professors. The slides on the left are the young professors in the University of Hangzhou. The Chechung (ph.) University. This is Southwest University so I was able to interact with the young professors and then ultimately the students to teach them – tell them about this stuff. So they will be able to put into use earlier rather than later. So with that, thank you very much and thank your for your patience. (Applause)

Dr. Elias Messians: Can we get the microphone to work…It's not working …I would like to thank Professor Lam. Since we are a little short of time we will take only one or two questions.

[…] (inaudible)

Dr. Elias Messians: Could you stand up and go to the microphone please?

Participant: It was a lot of information. As an architecture student, and very interesting thank you. I am wondering… You spoke about keeping it simple, and as a future architect, this is a broad topic, very deep topic, what would you, if you can, in a few simple guidelines guide future architecture student, and maybe it is also good for architects who are practicing. This is new for many people I am sure. As an architect who is not going to probably know every detail of this kind of process, what is important for us to pay attention to? What is important for us to know in a practical, pragmatic sense, where to focus?

Kee Pho Kam: Good question. Students always ask me and professionals also ask me this question. It seems a lot and very overwhelming, I appreciate. But if I were to tell you, "Keep it simple" I would be doing you a disservice. And that is what I tell my students. Life is not simple. We have got to apply ourselves to understand those materials. And frankly we are all capable. Your know architecture students are often the top students in the high schools that apply to university, I don't know the situation here, but in the United States, all the tops students apply to university of architecture. So they have the capability of doing it. If we shortchange and simplify, it's a problem. So I just want to say that to start off with. The concern that I have always in education is that on the one hand we swing from the kind of diagram of being very, very detailed, to very, very general. Now there is this movement that says we have to know everything about everything. And then you end up knowing nothing about anything. Because it is so shallow. So please do not take that attitude that we can simplify things. However, having said that, a checklist is important. And I would refer to you that diagram that I have again – That Total Building Performance and Diagnostic Framework. Keep that by your bed, keep that by your drawing board. Go and ask those experts who come to your studio, who come and greet you – How do I solve those? Because the answers are there. There are many people out there who are very knowledgeable who will help you if you ask those intelligent questions and not say, you know, "It is too difficult". If your do that, there is no way, no one can educate you ok? So that diagram, that Total Building Performance concept is what I would advocate and it has helped me in my student research, it has helped me in my professional consulting life, and when I show this and talk to clients… even in China, you know the earthquake situation, I used the same diagram. And they said, "Professor Lam, you are so right". I said "Really?" And you know what happened? They built all those hundreds and thousands of those temporary shelters for the earthquake people. They provided everything, they have shelter, they have food. You know what they forgot. They had forgotten their sociological and psychological life. They are now suddenly put into very dense environment, sitting there everyday with nothing to do. They get bored, they get irritated and then they started fighting with their neighbors. If they had understood, took out the chart and said, "Hey, before we build this thing we had better think how to keep them busy, psychologically and sociologically productive, so that they don't become bored and irritated and fight with each other". So that was what I was told. So you see time and again – please do not underestimate that chart – it has gone through over 20 years of history all over the world. Until today, until two weeks ago, I was still using this in my project in Taiwan. That is as simple as I can get you and then go and look for the specialists who can help you, teach you to get through those steps. But no short-cut – You have to learn. Our students in Carnegie Mellon, my students, architecture students will go to computer science and take computer programming at the same time as PhD students in computer science. How else are you going to learn? I am not going to teach you, you know, what that down (ph.) stuff. You would never be able to do this kind of work that architects need, so architecture students actually go and sit with the computer science students. No short cut. I hope that answered your question. Thank you.

(Applause)