In August of 2006 the first meeting of what would become the Building Technology Educators' Society was held at the School of Architecture, Planning and Preservation at the University of Maryland.

This event brought together nearly seventy architectural technology educators from across the country and internationally for a lively three-day symposium. Themed *"A Gathering of Architectural Educators Passionate about Teaching and Technology,"* the event was a resounding success in terms of both the quality of papers presented as well as enthusiasm from attendees. Many remarked on the wonderful opportunity of spending quality time talking about what motivates so many of us, our students and teaching the technology of construction and structures.

A highlight of the gathering was the opening Keynote Address by noted author, educator and 2005 AIA/ACSA Topaz Medallion winner, Edward Allen, FAIA, who graciously and generously supported the organizing efforts of co-chairs Deborah Oakley (University of Maryland) and Ryan Smith (University of Utah). The preliminary text from this keynote speech was printed in the proceedings from the Symposium, however the speech as presented was slightly revised from this documented version. The audio recording has been available on the BTES web site since the time of the Symposium itself, however this is the first reproduction in print.

Ed Allen giving his Keynote Address at the BTES 2006

Written as a follow-on to his 2005 acceptance speech for the Topaz Medallion, Allen inspires us to recall what is truly important in our teaching and that, while important, formulas and numerics will only go so far in the creation of great architecture and, more importantly for us as educators, only so far to inspire students in their own design aspirations. Rather, Ed counsels us that "getting the form right" is the most important aspect of design, for then the rest will fall into place naturally and with ease. The result will be better quality architecture, more effective use of materials, and perhaps most importantly, students who find joy in the application of technology in service of design.

It is with this guiding vision that the Building Technology Educators' Society seeks to carry out our mission as we continue to grow and become more established as an organization. We owe a great debt of gratitude to Ed for his years of service and inspiration, and look forward to continuing to build on his significant contributions.

We hope that you enjoy this reproduction of the Keynote Speech as presented by Edward Allen on August 3rd, 2006.

Deborah Oakley
University of Nevada, Las Vegas
BTES President, 2009-2010

The Essence of Building Technology

Edward Allen

I believe that nearly all students of architecture enter architecture school wanting to become broadly proficient in all the technical areas of architecture.

They want to learn to design structures like Santiago Calatrava. They wanted to be able to use details and use materials like Renzo Piano does. And they'd like to design for energy efficiency like Malcolm Wells.

But by the end of their first year of study, and all through many schools we have educated that desire out of them.

By the time they've been in school for a year, they realize studio is where it's at. The studio is the all important part of an architectural education and that the technical courses are necessary evils that are to be endured in order to be able to continue to study design.

The end result of this is that we graduate generation after generation of students who are not broadly competent, and whose design work suffers from a lack of understanding of the technical means by which we build. This is a disaster of major proportions for the built environment, and a personal tragedy for thousands of individuals.

Why does this happen? Well, the very simple answer is that it happens because of "the gap", not the clothing store The Gap, but "the gap," that huge, bottomless gulf that exists in the schools between the design studios and the technical courses.

I believe that "the gap" exists largely because of differences in goals and language between the design studios and the technical courses.

In the design studio, the goal is to create good form, and the language is of form and space and shape. In the technical courses, the goal is technical competence, and the language is math and science.

In other words, we technical teachers don't have the same goal as the design studios, and partially we don't speak the same language.

This often means that we communicate poorly, if at all, across "the gap" with those who teach the studios.

Our students suffer because they get a disjointed education that fails to bring out the rich potential of building technology as an integral element of architectural design.

You know, it's always fun to fix blame. Who is to blame for this situation?

Well, let's be honest: A lot of studio teachers are technically incompetent. They show little concern for integrating technology into the studio. It would be easy to blame them for this "gap".

But then we have to ask, "How did these studio teachers get to be this way?"

And the only plausible answer is that they got their negative attitude toward technology by taking technical courses from people like us.

So, if we're looking for someone to blame, we only need to look in a mirror, because WE, the technical teachers, are largely to blame for this "gap".

I hear complaints from architecture students at many schools around the country about many of the technical courses in all areas of building technology.

In many schools of architecture, maybe the majority of them, students don't like laundry courses. They find it boring and irrelevant. We have very serious problems from what we teach and how we teach in building technology.

I have given a lot of thought to this problem over a long period of time. That's the advantage of getting old. I don't think that this problem stems principally from the lack of teaching ability or a lack of good intentions.

Let me include that with most of the dangers that we face, both from within and without, are caused by our own lack of clarity of who we are and what we do.

...we graduate generation after generation of students who are not broadly competent, and whose design work suffers from a lack of understanding of the technical means by which we build.

We've gone about our business for many years without stepping back to look objectively at what we're doing. We've been on automatic pilot as these storm clouds have been gathering.

A host of important questions have come up and they've gone unanswered. So these questions are:

What is it that we teach, this subject called building technology?

What do technical courses have in common that makes them an identifiable area of the curriculum?

Do we teach building science? Building engineering? Building technology? What's the difference between these terms anyway?

What is our purpose? Is it to furnish technical support to the design studios? Or perhaps to teach students what they need to know to pass the Architectural Registration

Examination? Or do we have a mission that is independent of either of these goals?

All these questions can be summed up in one big, important question: WHAT IS the ESSENCE of building technology?

What is the essence of building technology? What is most essential to our teaching?

This question becomes more and more important as we are yanked around in many new directions by building information modeling, computational fluid dynamics, multimedia teaching tools, web based teaching, "green" architecture, design for the physically challenged, computer graphics, all kinds of computer algorithms and simulations, CNC machinery, 3-D photorealistic modeling and rendering. These are all options that are opening up to us in very rapid order.

And in order to evaluate all these options intelligently, we need to know "What is the essence of building technology?"

We also need to know the answer to this question in order to know who we are, what our essential business is, and why it's important.

By not only moving have we allowed others to step in and tell us what we should be doing, like cutting our curriculum requirements to the bone, conducting funded research and pursuing PhD degrees we may not really want in some cases.

I think it's time we learn who we are in order to take control of our own destiny.

"What is the essence of building technology?"

After much pondering of this question I've concluded that it's not mathematics, it's not science, it's not engineering. It's certainly not preparation for the ARE.

Each thing may play important roles in our teaching and building technology, but they're not the essence. For me, the essence of building technology, the concern that should be the primary focus of all of our courses is "GETTING THE FORM RIGHT".

Let me say that again. The essence of building technology is getting the form right. Get the form right and the rest is easy.

Let me give you a number of examples that demonstrate why I believe this. And I'll take these examples from every area of building technology, in random order.

Think about acoustics. What is the most effective, least expensive way to isolate a noisy space from a quiet space in a building? If we form the building in such a way that the two rooms are remote from one another, you've solved the problem. If we insist on putting the noisy room next to the quiet room, we have a whole arsenal of techniques and drills and assemblies that we can use to reduce noise transmission between the rooms, but it'll cost a bundle, and the result will never be as satisfactory as if we had simply put one room at one end of the complex and the other room at the other end. Get the form right, and the rest is easy.

Still thinking about acoustics, think about designing a concert hall. The shape of the concert hall is virtually everything. Make the room a bad shape, and you're faced with poor hearing conditions and increased expense for remediation. Get the form right and the rest is easy.

Think about HVAC. If we want to make a building comfortable to inhabit and economical to heat and cool, it's virtually a matter of horrible decisions. We choose a sheltered place on the site. We choose the proper orientation for the building. We mass the building properly. We provide it with windows in the right proportions and in the right facades, for the render indications. We use thermal insulation and thermal mass intelligently. We plant trees in the right locations. The math and the science become trivial if these formal decisions are made well. Get the form right, and the rest is easy.

Think about materials and methods of construction, once again getting the form right is important above all. Put movement joints where they are needed. Use rain screen configurations in the wall and window details. Simplify the details to make them easier and more economical to build. All these are formal decisions. Get the form right, and the rest is easy.

Daylighting design is mainly about form. It's about window orientations, room proportions, positions and dimensions of reflecting surfaces such as light shelves, reflective qualities of the surfaces in the rooms, distances of visual tasks from windows. Make these formal decisions right, and the rest is easy.

And yes, the field of structure is mainly about getting the form right. Funicular form is the key to the creation of efficient, beautiful long span structures. Proper material and system selection, good bay layouts, and good proportioning and shaping of members are the essence of creating building framing. In seismic design where massing of the building is critical to prevent partial movements and things of that nature. The massing of the building is important so that we don't have building masses knocking against one another during earthquakes and hammering one another to smithereens. Lateral force resistance is largely a matter of putting shear walls, and rigid joints and diagonal bracing in the proper locations. The mathematics of structures becomes almost trivial, because virtually a matter of just verifying rule-of-thumb calculations as it were, extremely close to the truth, once we've got the form right.

All the very best structural engineers in modern times have warned against overemphasizing mathematics in structural design. The great Swiss engineer Christian Menn once wrote:

"Over the last fifty years engineers have paid a great deal of attention to detailed and precise mathematical calculations, especially of stresses. We realize now that reinforcement concepts, construction methods, and details such as waterproofing, drainage, joints, and bearings are even more important than 'accurate' calculations. Now this attention shifts back and forth between calculations and construction, the one constant imperative is the need to give good form to structures."[1]

My colleague and mentor Waclaw Zalewski has put this another way, "A structural designer who is preoccupied with mathematics is like a tennis player who watches the scoreboard and not the ball."

If structures is not so much about mathematics, is it science? The great engineer Ove Arup once wrote,

"Engineering is not science. Science studies particular events to find general laws. Engineering design makes use of these laws to solve particular problems. In this it is more closely related to art or craft; and as in art, its problems are under defined, there are many solutions, good, bad and indifferent. This is a creative activity, involving imagination, intuition and deliberate choice."[2]

Creating appropriate form is the essence of building technology

Think about your own structures course. Do they involve Arup's imagination, intuition, and deliberate choice? What about Menn's reinforcement concepts, construction methods, and details? And did you notice Menn's emphasis on giving form to structures?

In the traditional structures sequence that is still taught at far too many schools, we teach students to check beam and column sizes, but we don't teach them how to make a building frame out of those beams and columns, how to provide lateral load resistance to that frame, how to detail the structure, how to exploit the structures of the feature of the architecture.

In other words, we don't teach students to do the things that the best aren't going to know exactly how to do. Instead we teach in a nonfunctional subset of the mathematics that an engineer uses to check structural members. It makes no sense.

What does make sense in ALL technical areas is to teach students to get the form right. Creating appropriate form is the essence of building technology. But too few of us have figured this out. Maybe we're driven by an obsolete definition of technology as having to do with math and science, but we tend to teach what is mathematical about our subject, or what is scientific, rather than what is essential.

One area of building technology that has successfully bridged this gap is ECS, Environmental Control Systems. And what happened there, as if by magic, decades ago, a few inspired, excitable individuals, like Ralph Knowles University of Southern California, or Jeff Cook – at Arizona State University, or John Reynolds at the University of Oregon, began to teach ECS in a totally new lid. They replaced the dull, useless courses that had concentrated on the sizing of pipes and ductwork with sparkling courses that concentrate on the relationship between building form, comfort, and energy flow. Students now find the field fascinating and relevant in many schools and the ECS teachers' have formed a wonderful organization, the Society of Building Science Educators, that perpetuates this method of teaching ECS. You'll find when you look through these teaching materials that this organization makes available that the emphasis is universally on getting the form of the building right. Get the form right, and the rest is easy.

Curiously absent from our technical curricula at most schools is the subject of architectural detailing. Detailing is absolutely essential to the architect because it's our one means of translating our ideas into reality. When working with a team of professionals on a large project, detailing is the one technical area, the ONLY technical area, in which the architect is expected to be THE expert. But only a handful of schools, to my knowledge, teach architectural detailing. We persist in teaching bits and pieces of other disciplines, specialties, but we don't teach our own field of expertise, detailing. Go figure.

As new tools and approaches become available to us, like Building Information Modeling (BIM) and CNC (Computer Numeric Control) it would be unwise to hurry to restructure our teaching around these latest things to come on the scene. Getting the form right is still priority number one. And by all means, we should teach these new areas, but we must not lose sight of the essence of building technology as we do so.

Now, to this point, I've been largely negative, it's a lot of fun being negative. I've been telling you what's wrong with much of our teaching and now I'll shift to the positive, which is harder, and give you some ideas about how perhaps we can bridge "the gap" and how we can teach better than we do.

I believe that the best way to teach the technology of architecture to students of architecture is to teach them how to use technology to get the forms of their buildings right. If they can get the forms right, the rest is easy.

We should teach them to do this in the context of design problems, either big ones that they are given in studio, or smaller ones that you give them in their technical courses.

This is project-based learning and it has several advantages:

Students like to design. They'll generally put more effort and care into an integrated technical design than they will into some isolated problem sets.

Students learn that solving technical problems as a part of a design process can be fun, and can contribute to the quality of the architecture, which is a very important message to get through.

In information and techniques learned in the context of solving a design problem stick in the mind much longer and much better, because the student knows why these subjects are important, and because they are able immediately to implement this new learning into their design experience.

Given the opportunities, students often turn out more interesting designs in their technical classes than they do in their primary studios. And some of you have had experiences with this and these sometimes lead to conflicts with the traditional studio teachers.

I've had the experience of a studio teacher coming to me and saying you're overworking your students. Your technical class is spending too much time on it and not enough time in the studio. While I have to restrain myself, what I'm saying is, I don't give my students too much work, it's just that my students find the problems I'm giving them, much more interesting than what you're giving them. I think that some of you have had this happen to you as well.

Ideally, I think we teach all of our technical courses in design studios, because the studio is set up to teach the making of good form through project-driven learning.

Preferably, we can do this some of the time at best. Because what we can do is offer secondary studios, as I have done on a number of occasions, that are designed to concentrate on technical issues, but carry fewer credits than primary studios, or we can bring the studio into the classroom this pack of paintings from Utah, are there any others? With design relative teaching and creative exercises given as homework.

My colleague, Pat Ran of North Carolina State University, has brought as his gift to this conference, to each of us, a marvelous paper which I recommend to you highly. And in this paper he writes:

"It is not enough just to teach technology through technology. For instance, we must try to teach architecture through that. If technology courses only address technical considerations then we implicitly teach our students that there need be no connection between what a building is and how it is made." [3]

Now I know some of you are thinking, "Good grief, I can't cover my subject area now in the time that I have. How can I possibly add in design activity on top of everything else?"

Now I'm going to give you the best piece of advice you will have had from me tonight. Because I say to you why try to cover your field? It's impossible–every field of learning is far larger than what we can cover in the time that we have available to us. Furthermore, I've discovered that most of the technical skills that I learned when I was an undergraduate became obsolete within only a few years of graduation.

For example, in the field of structures, every set of calculation techniques that I learned in school has been replaced by a different set of techniques since I've been in practice.

The MIT teaching manual contains a wonderfully liberating piece of advice and this is as good advice as I can promise you.

"That is, don't try to cover your field, it's impossible. Instead, try to UNCOVER a portion of the field and teach your students how to learn the rest for themselves. There's something you can do in a limited amount of time and that hopefully will free up some time that you can spend teaching design in your technical class. Don't try to cover your field, uncover a portion of it and teach your students to learn the rest for themselves."

What will happen if we continue to go on as we have been doing and take none of these actions that I've suggested? What will become of technical teaching in architecture programs? One answer to that question is what will happen to us is very likely to be similar to what has happened to many structural engineering and civil engineering programs across the U.S., and even outside the U.S. These departments are in big trouble. They can not attract enough majors anymore to justify their existence in the University. Enrollments are so low that departments are faced with extinction.

Now we look at a golden age of structural design in my opinion. Dozens of wonderful, exciting structures are built each year all over the world, yet the structural engineering curricula had become so lifeless and dull that students simply won't sit still for it. How can this be?

Well I believe that it's larger than a result of long standing policies of most engineering schools through hiring it's teachers only people who hold PhD's. So what's wrong with that? Well there's nothing intrinsically wrong with a PhD, and the one thing right about it is an excellent credential for doing a search for teaching science and mathematics.

From the stand point of a university administration an all PhD faculty is the highest possible goal. It generates new knowledge in research. Not that importantly it generates grant money to support the university and it sounds really

first class to say that all of your professors have the highest academic degree.

The flaw for architecture program is this requirement tends to select for teachers who are scientists and theoreticians and to bar entry to people who are primary practitioners. Scientists, like the rest of us, can only teach what they know. What they know is theory, science, research and mathematics. They can't teach what they don't know which is design.

I had occasion to observe some civil engineering professors try to teach design, and believe me it's not a pretty sight.

There may be a golden age of structural design as I said, but you wouldn't know it by sitting in their classes. In this very exciting time structural engineering professors have sucked all the life out of structural design and made it a dry, unattractive option.

They teach only what is scientific and mathematical about structures. They teach nothing about getting the form right.

Several years ago, I received a letter from a student at Swarthmore College who had seen my little book on structures. He was double majoring in structural engineering and studio art and I want to quote from his letter. He wrote:

"In the last four years, I've caught glimpses of how unbelievably interesting structural design can be, but have had very few first-hand experiences...The bridges of Calatrava, Menn, and Maillart make clear that creative decisions can be made in a structural design, but I've never had a professor who embraced those ideals. Last Fall I took a directed reading course in bridge design, but I got so bogged down in load and resistance factor design that it wasn't very enjoyable.

"Can you recommend any graduate programs in structural engineering that would teach the DESIGN of structures? Any ideas would be greatly appreciated."

I don't know what you would have told this guy, I told him he had to go outside the country. I suggested that he go to Stuttgart and study with Jörg Schlaich or perhaps to Switzerland at the EteHa and he might do better there.

I went to a conference a few years ago where a professor named Robert Warren from the University of Adelaide in Australia gave a paper and he was very excited as he gave his presentation. He and his colleagues have instituted a curriculum in civil engineering in which every student takes a design studio in every semester of the curriculum, from the very start to the very end.

They were ecstatic with the results. To quote from his paper:

"Experience shows that a sudden switch from analytic work to create a problem solving in design is always very difficult. And the later that change is made, the more difficult it is. It means that psychologists suggest over emphasis on analytic thinking without adequate early exposure to open ended problem solving can be an incurrent to design skills. An alternative approach is to introduce design and open ended problem solving at the start of the course of study.

There are various advantages inherent in this approach. Firstly it solves the motivation problem. Also, creative thinking is introduced to students at the beginning of the university studies and not at the end, so the analytic and creative problem solving work can run throughout the course."

I believe that if we fail to take action now to improve our teaching and make it more design oriented our courses will continue to decline and except for the architecture students "the gap" between the studios and technical courses will grow even wider.

Warner goes on to mention the advantages of introducing analytical tools of what he calls a "just in time" basis, which means that lectures on the analytical tools are given just when the students in any course of their design work realize the need for them. There is no more powerful way to present work than that.

He didn't explain in his paper whether teachers are qualified to teach engineering design and I should add that I'm not aware of other engineering departments that will follow Warren's lead.

Now turning our attention to circling the architecture departments I believe that if we fail to take action now to improve our teaching and make it more design oriented our courses will continue to decline and except for the architecture students "the gap" between the studios and technical courses will grow even wider.

This brings me back to my argument that building technology is principally about getting the form right.

Another aim for getting the form right is design. Of all those technical teachers or should be design teachers, who specialize in the design of the technical systems abilities.

This brings up what I think is the greatest danger of all to us, which is that hardly anybody knows what design is. To the general public, design is generally the application of window dressing to products that have somehow magically been conjured up through the miracle of science.

Teachers in grades K through 12 think that design is the same as art. There are hardly any school, any place before architecture school, that teach anything about the design process.

Engineering is, or at least should be, a design discipline, but most engineering teachers haven't a clue what design is. They teach math and science and call it design.

Nobody in the U.S. government has ever realized that design excellence is in the national interest and should be a high national priority. It takes good designers of every kind to produce goods that will be competitive in the world markets. With all this utilization, we sit and watch our trade deficit pile on.

Most damaging to us as technology teachers is, that university administrators don't know what design is. They force us to function as scientists or artists to gain credit toward academic advancement. They don't recognize that design is one of the most expletive of all human intellectual activities. What that is, it is a reinforcement of society.

You know who else who doesn't know what design is? A lot of architecture teachers, including technical teachers. They think that design is a process that can be applied only to the form and space of buildings and that the technical systems are created through a boring process of applied science and mathematics in problem. We have a lot of technical teachers who will need this.

This means that we have work to do and not merely to teach our students what design is but to teach everyone else in society what design is and why it is important to all of us.

In doing so, we will eventually eradicate the external threats that I mentioned because people will understand what we do. We won't be burdened with PhD requirements necessarily or disproportionate share of responsibility conducting the search. We'll be better able to define ourselves on the mission from the university instead of letting others make those definitions for us.

Well, happily this talk has strayed very far from the version that is printed in the proceedings and its time to bring it to a close.

To summarize the main points of what I said – we face grave dangers from within and without. These are caused largely by their own lack of clarity about who we are and what we do.

If we can overcome this lack of clarity then we can make the case for retaining and expanding our courses while others are seeking to cut back on theirs. We could also define ourselves clearly as designers and avoid being misidentified by others.

By having been unable to figure out who we are and what we do, we've excavated this huge gap between our technical subjects and the design studios and this had led to irreparable harm to the cause of good architecture. We have to fill this gap and we have to do it now.

We can begin to do this now by realizing that the essence of any technical field is not math and science, it's about getting the form right. This brings us to a crucial realization, getting the form right is also about the traditional architecture studio is all about. This means that maybe, just possibly, we and the studio teachers should be able to share similar goals and speak the same language.

We have to fill this gap and we have to do it now. We can begin to do this now by realizing that the essence of any technical field is not math and science, it's about getting the form right.

It doesn't have to be the techies on one side of "the gap" talking math and science, and the touchy-feelies on the other side talking about form and space and light.

The whole faculty can be on the same side talking about getting the form right, and the students will be much better designers if we can do that.

This would mean that we could all work together to make our students better designers rather than working across purposes as we often do now.

And this would mean that the quality of our new buildings, those that will be designed by our students can get better and better in the years ahead.

All this will take time, but it can happen, if we realize that building technology is not so much about math and science as it is about getting the form right. Get the form right and the rest is easy. Thank you.

Notes:

1. Christian Menn, quoted by David P. Billington in *Robert Maillart and the Art of Reinforced Concrete*. Cambridge, MIT Press, 1990, p. x.

2. Ove Arup, *Ove Arup & Partners, 1946-1986*, London, Academy Editions, 1986, p.9.

3. Ove Arup, *Ove Arup & Partners, 1946-1986*, London, Academy Editions, 1986, p.9.

Mission Statement of the BTES

The Building Technology Educators' Society (BTES) is an organization of architectural educators, passionate about teaching the technology of building design and construction.

The mission of the BTES is to promote and publish the best pedagogic practices, relevant research, scholarship, and other creative activity to facilitate student learning, advance innovation, and enhance the status of our disciplines in the profession at large.

To achieve this mission, the BTES seeks to:

- Promote and share the best architectural technology teaching practices among all who are concerned with effective teaching in these subject areas.
- Promote critical discourse and the scholarship of teaching on issues related to pedagogic theory in architectural technology, with peer-reviewed publications of its work for public dissemination.
- Enhance the mentoring process among faculty, students and practitioners for the enrichment of all involved and for the preservation and propagation of accumulated experience and wisdom.
- Stress the issues concerning technology in architectural curricula to help influence change when necessary in the related accreditation process.
- Foster the continued betterment of the profession by serving as a point of contact for the discussion of issues related to building technology with the design professions and building industry at large.
- Bring issues of concern to affiliated entities in the Academy, profession, industry and associated regulatory agencies and
- Facilitate connections among like-minded individuals for collaborative research.

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Passionate about Teaching Architectural Technology

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